

## NEURO-OPTOMETRIC REHABILITATION ASSOCIATION CLINICAL SKILLS LEVEL ONE

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Enhancing Neurological Recovery Through Vision Rehabilitation

### **Course Objectives**



Take you beyond vision to be able to look at the whole person and use vision rehab strategies to treat individuals with neurological dysfunction using a multidisciplinary approach

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**Plan for Today** 

- Introductions
- ICF Framework
- The Interdisciplinary
   Team Role of OT & PT
- Systems Theory of Motor Control, Normal Movement & Postural Control

Cognition & Perception

- Vestibular System
- Vision System

What happens after a Brain Injury:

NCRA

- Post Trauma Vision Syndrome
- Visual Fields & USI
- Visual Midline Shift Syndrome
- Assessment vision, vestibular, gait, cognition...
- Breakout sessions

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# **ICF**= International Classification of Functioning, Disability and Health

Different perspectives of health: biological, individual and social

http://www.who.int/classifications/icf/en/

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- ICF is Patient/Client/Person centered care
- Look at the relationship between the person and the context in which daily living occurs



## Previously

• Called the ICIDH (International Classification of Impairment, Disability and Health)



- Negative focus, unidirectional and inevitable
- No mention of what a person CAN do



Body Fun psychologi	ctions are physiological functions of body systems (including ical functions).
Body Stru and their c	ctures are anatomical parts of the body such as organs, limbs, omponents.
Impairmer cant deviat	nts are problems in body function or structure such as a signifi- tion or loss.
Activity is	the execution of a task or action by an individual.
Participati	ion is involvement in a life situation.
Activity Li activities.	imitations are difficulties an individual may have in executing
Participati involvemer	ion Restrictions are problems an individual may experience in nt in life situations.
Environment i	ental Factors make up the physical, social, and attitudinal en- in which people live and conduct their lives.

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Evaluation within the ICF Model:

Acquired Brain Injury or CVA

- What is the patient able to do?
- Is the task important to the patient
- What is stopping him/her from doing the task?
- What are the environmental factors to consider?
- What are the personal factors?



- Your client should have an active role in the evaluation and interventions
  - Let the client be a part of assessing their performance/progress
  - Define their own deficits and their own goals or outcomes
  - Are the goals based on what you think they need or what they want?



Focus on the context of their environment, their roles, interests and culture



P – E – O Model of Practice







P – E – O Model of Practice



## Canadian Model of Occupational Performance (CMOP)



# Case study



- Molly: 62 year old woman suffered a CVA resulting in decreased gross/fine motor coordination in her right (dominant) upper extremity.
- Also impaired cognition: short term/working memory, executive functioning
- Many issues slower with dressing, assist with buttons/tie, shower chair needed, no longer able to drive, needs assistance managing her meds, needs supervision for shopping/money management.
- But what was her primary goal?

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Patient Centered





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Four pillars of function Function Vision Somatosensory Vestibular Cognition and Perception

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## Rehab Health Care Team

• We cannot work alone, we NEED each other to make our therapies successful.





What is OT?

# What is OT?



#### According to the Canadian Association of Occupational Therapists:

 Occupational therapy is the art and science of enabling engagement in everyday living, through occupation; of enabling people to perform the occupations that foster health and well-being; and of enabling a just and inclusive society so that all people may participate to their potential in the daily occupations of life (Townsend& Polataiko, 2013, p. 380).

 "Supporting health and participation in life through engagement in occupation"

## What is OT?

 Occupation refers to everything that people do during the course of everyday life. Each of us have many occupations that are essential to our health and well-being. Occupational therapists believe that occupations describe who you are and how you feel about yourself.





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# An Easy Way to Remember?

• PHYSIOs get you MOVING; OT's get you DOING



• OT is about return to activity, and developing (or rehabilitating) SKILLS FOR THE JOB OF LIVING





# Partnership between Optometry and Occupational Therapy





Physical Therapy

# Partnership between OT and OD?



- Assess and diagnose visual changes post neurological insult
- Prescribe vision therapies and lenses Suggest treatment
- options and progressions

#### Occupational Therapy

NCRA

- Assess and diagnose function
- Provide support for instructions given by OD and explain to family
- Carry out vision therapies
- Provide feedback to OD about changes to function and progress

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**OT Assessment Areas:** 

NORA

- Activities of Daily Living (ADLs)
- Instrumental Activities of Daily Living (IADLs)

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- Sleep and Rest
- Education
- Work
- Play
- Leisure
- Social Participation

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# Canadian Model of Occupational Performance (CMOP)





# **Evaluation and Treatment**

- NCRA
- · When evaluating a patient, we are looking at what they can do for themselves, and what is difficult
- · What are the components that make up each task (activity analysis) and which components are they/will they have difficulty with?
- Can the activity be modified or adapted to allow patient to participate? Can the patient compensate for a loss of function in one area?

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# **Functional components:**



- Range of motion (PROM and AROM), strength
- Tactile perception (2pt discrimination, sharp/dull, temperature, stereognosis)
- Coordination
- Proprioception
- · Vision (acuity, stability, attention, visual field/awareness, tracking, pursuits, saccades, convergene, double vision)
- Vestibular
- · Hearing, smell, taste





NCRA

# **Functional Components**

Emotional/Affective

- Mood
- Level of anxiety
- Coping skills
- Changes to behavior
- Anger
- Family dynamics
- Return to social roles

May need referral to social work or psychology for counselling









Pain levels

Visual disturbance

Hearing difficulties

Fatigue

Reading

Screen use

Sleep

**OT Assessment** 

Self-reported level of symptoms:

Cognition (memory/attention/problem solving)

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## What OD's can learn from OT's?







## The Bobath Concept in Current Clinical Practice

- Is a *problem solving* approach to the Ax and Rx of individuals with CNS dysfunction
- Can be applied to individuals of all ages and degrees of physical and functional disability
- Utilizes an individualized reasoning process rather than a series of standardized techniques



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# The Bobath Concept in Current Clinical

### Practice

- Advocates a 24 hour holistic approach which involves the whole patient
- Treatment involves using sensory input as well as manipulating the environment and the task
- Theory evolves with greater understanding of neurophysiology and neuroplasticity



Sensory Input

## **Systems Theory of Motor Control**

- NCRA
- Developed by Berstein (1967) and expanded by Shumway-Cook and Woollacott (2007)
- Motor behaviour is based upon a continuous interaction between the individual, task and the environment
- Movement results from a dynamic interplay between perception, cognition and action systems
- The CNS has the ability to receive, integrate and respond to the environment to achieve a motor goal
- Many systems and subsystems work cooperatively for the integration of movement and function

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# Systems Theory of Motor Control

#### • The Degrees of Freedom Problem

- Many joints in the body
- How to control them and have them working in a coordinated fashion
- Balance between stability and mobility

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## **Dynamic Systems Theory**



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## Neuroplasticity

 Neuronal connections are strengthening and remodeled by our experiences and movements

"What fires together, wires together"







- Need to have a solid understanding of what is normal movement in order to teach patients how to relearn functional tasks
- Efficient movement is dependent upon the ability to limit and combine movements *selectively* into the desired functional activity under a *wide range* of environmental conditions
- Ability to integrate sensory information from a variety of afferent inputs in order to shape muscle activation patterns for task performance

## Normal Movement in Action

• Reaching



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## **Requirements for Efficient Movement**



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# **Postural Control**

- "the ability to control the body's position in space for the dual purposes of stability and orientation."
- Postural orientation for task performance requires interplay between *stability* and *mobility*
- Utilizes anticipatory and reactive postural control mechanisms
- Term can be applied to trunk, hand, limb, etc
- Alignment of body segments relative to each other influence the ability to activate appropriate postural control

# **Postural Control**

- Essential foundation for movement
- Requirements for functional movement:
  - Balance strategies
  - Patterns of movement
  - Speed and accuracy
  - Strength and endurance



# Base of Support

- Can be any body part:
  - Feet
  - Hands
  - Trunk
- System needs to accept base of support in order to build movement on top

CENEER OF GRAVITY OVER BASE OF SUPPORT = BALANCED





# Postural Alignment in Standing





Sitting Postural Alignment



## Alignment – Impact on Movement



## **PT Examination Process**

- Focus is on general mobility, less on hand-eye coordination
  - Balance and postural control
  - Gait, transfers, sports, wheelchair mobility
- Perform detailed motion analysis
- Expertise in gait and vestibular dysfunction
- Trained to screen and refer to other professionals

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#### Sensory Input & Integration • Systems are precisely calibrated Sight Tactile Visual Seamless integration is integral for Sensory Body Position Taste Integration efficient performance of Balance cognitive & physical

## Sensory Inputs that Provide Equilibrium



ALL THREE SYSTEMS INTERGRATE TO FORM A COMPLETE MENTAL PICTURE

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tasks



## Proprioception & Somatosensory

- Proprioception refers to sensory messages about the position, force, direction, and movement of our own body parts.
- Our muscles and joints assist us with "position sense".
- Sends messages about whether the muscles stretch or contract and how the joints bend and straighten.
- Gravity can stimulate the proprioceptive message without our conscious awareness.

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## Organization of the Vestibular System



## Vestibular System in Normal Function

## NCRA

Postural control:

- Sensory input about head position in space (related to gravity) and acceleration.
- 2. Input for appropriate motor response to conflicting visual/somatosensory input.

#### Visual control:

- 1. Gaze stabilization with head motion
- 2. Head stabilization with respect to vertical

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## **Peripheral lesions**

- Does the problem involve cranial nerve 8?
- Does the problem involve infection?
- Does the problem involve vasculature?
- Does the problem involve the canals?
- Does the problem involve the cochlea?
- Does the problem involve the middle or outer ear?
- Does the problem involve trauma?
- Does the problem involve autoimmunity?
- Does the problem involve ototoxicity?

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NCRA

## **Causes of Dizziness**

- Cardiovascular System
- Neurological Dysfunction
- Visual Defects
- · Psychogenic Dizziness
- Vestibular System Disorders
  - Head trauma (whiplash)
  - Vestibular system degeneration ie. elderly
  - Vestibular neuritis/labyrinthitis
  - Benign Paroxysmal Positional Vertigo (BPPV)
  - Endolymphatic hydrops (Meniere's Disease)
  - Ototoxicity, barotrauma, acoustic neuroma

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## **Central lesions**



- Is the problem in the brainstem?
- Is the problem in the cerebellum?
- Is the problem in the cortex?
- Is the problem vascular?
- Is the problem systemic?
- Is there infection?
- Is the blood brain barrier intact? Is there a chronic underlying inflammatory problem?
- Is there physiological problems, cortical imbalance?
- Are there emotional issues related to the condition?
- DRUGS! DRUGS! DRUGS! also Cardiac! Cardiac! Cardiac!

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## **Peripheral Lesions**



#### **Peripheral lesions**

- Benign Paroxysmal Positional Vertigo
- Vestibular neuronitis
- Otosclerosis

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- Meniere's Disease / Hydrops Infections / labryrinthitis
- Fistulas / Dehiscence
   Nerve Compression (Acoustic
- Neuromas)
- Bilateral vestibular disorders`

Subjective!

- With a peripheral lesion, fixation decreases it. With central, fixation either does not change it or makes it worse.
- With a peripheral lesion, nystagmus is increased with gaze towards the direction of the quick phase. With a central lesion, the nystagmus either does

What to expect

- not change or reverses directions. With peripheral lesion, the nystagmus is
- usually mixed torsional and horizontal, with central it is usually in a single plane, torsional or vertical.

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## Nystagmus



- First degree: Nystagmus is only present when looking in the direction of the fast phase.
- Second degree: Nystagmus is present when looking in the direction of the fast phase and looking straight ahead.
- Third degree: Present in all planes. It is always indicative of a central disorder, regardless of direction.

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## New or old?



- Acute unilateral vestibular loss leads to spontaneous and gaze evoked that is present in the light and dark. Head shaking induces the nystagmus.
- The VOR is abnormal with slow and rapid thrusts.
- Romberg may be and typically is positive.
- · Cannot perform a sharpened Romberg.
- Cannot perform a Fakuda without rotation.
- Typically has a wide based gait that is slow and cautious. May need some help for a while with ambulating.
- Cannot turn the head and walk without falling.
- Compensated unilateral vestibular nystagmus is spontaneous in the dark and may be induced with head shake.
   VOR is not typically only abnormal when done rapidly in the direction of
- Work is not typically only abnormal when done rapidly in the direction of the loss.
   Romberg is negative as well as Fakuda, walking with head turn and
- Romberg is negative as well as Fakuda, walking with head turn and sharpened Romberg.

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# Vestibular System



- · Directly or indirectly it influences everything we do
- Unifying system in our brain
- Modifies and coordinates information received from other sensory systems
- It functions like a traffic cop telling each sensation where and when it should go

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#### Several structures and tracts...very complex

Inner ear-vestibular labyrinth

- Semicircular canals
- Otoliths

Receptors for vestibular sensations
Vestibular information via
vestibocochlear nerve(CN VIII) to...

Cerebellum

Nuclei in the brainstem (vestibular nuclei)

Passing information on to various targets

- Muscles of the eye
- Cerebral cortex (frontal lobe)



NCRA



#### Sensory to the brain • Motion

- Head position
  Spatial orientation
- oputationentatio

#### Motor (posture)

- Balance
  Stabilize head
- Stabilize head
   Stabilize body
- Essential for normal movement and equilibrium.



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### Peripheral Vestibular System

#### 1. Bony Labyrinth

- surrounds the membranous labyrinth
- contains perilymphatic fluid (like CSF)

#### 2. Membranous Labyrinth

- suspended within the bony labyrinth
- contains endolymphatic fluid (like ICF)
- consists of five sensory organs:
  - Three Semicircular Canals anterior, posterior and horizontal which lie at 90° to each other
  - > Two Otoliths saccule and utricle

Membranous and Bony Labyrinth







## NOW.....the otoliths

- Similar to the semicircular canals
- Hair cells called macula
- Gelatinous layer above the hair cells
- The otoliths have an additional fibrous layer called otolithic membrane above the gel
- Otolithic membrane-calcium carbonate crystals called otoconia Crystals make the otolithic membrane heavier than at rest
- Linear movement—membrane shift relative to macula—displaces hair cells—releases neurotransmitters from cells
- Sensitive to movements(linear) and head tilts



### Geometry of the Otoliths



#### **Ocular Tilt Reflex**



- Compensates for body tilt by righting the head towards the earth vertical, torting the eyes opposite to the body tilt and elevating the dependent eye
- OTR is driven by input from the otoliths
- Right body tilt right eye elevates, left eye depresses, both eyes torsion to the left and head tilts to the left on the body



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## Vestibular Ocular Reflex (VOR)



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- Reflex eye movement that stabilizes images on the retina during head movement
- Produces an eye movement opposite to head movement
- Integration between vision and vestibular systems

### Vestibular Reflex Loops

#### Vestibular-ocular reflex (VOR)

• Maintains stable vision with rapid head motion (up to 400°/second)

#### Vestibulospinal Reflex (VSR)

- Stabilizes the body
- Motor output produces appropriate trunk and limb extensor and flexor activity
- Also has connections to limbic system Vestibulocollic Reflex (VCR)
- Stabilizes the head via the neck muscles •



NERA

# Vestibular system

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#### Information about movement

Semicircular canals—pitch, yaw, roll Otoliths—utricle—forward/backward; side to side

- Saccule-up/down
- Balance
- Stability
- Posture
- Reflexes

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- VOR-gaze stabilization-hold the eyes on target when the head moves VCR-neck VSR-spinal
- Mismatch-pathology, transient state(alcohol)
- .
  - Vertigo Nausea .
  - Loss of balance Disequilibrium Syncope

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• Dizziness

#### Eye movements and canals

- Horizontal canal: ipsilateral medial rectus & contralateral lateral rectus
- \* eyes move laterally to contralateral side
- Anterior canal: ipsilateral superior rectus & con-
- tralateral inferior oblique

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- \* eyes move up & out to ipsilateral side · Posterior canal: ipsilateral superior oblique &
- contralateral inferior rectus
- \* eyes move down & out to contralateral side









NCRA



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## DR. PADULA'S DEFINITION OF VISION

A dynamic, interactive process of motor and sensory function mediated by the eyes for the purpose of simultaneous organization of posture, movement, spatial orientation, manipulation of the environment and to its highest degree of perception and thought.



# The tricky part...



- Visual disturbances after a brain injury can be covert
- "I have frequent headaches"
- "I don't like to go grocery shopping"
- "I keep bumping into walls/furniture"
- "I am nervous when I walk down the stairs"
- "I hit my head again getting into the car"
- "I just feel off sometimes"
- "I don't go: to the movies, out with my friends, walking in the snow,...."

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## How Common Are Vision Problems After ABI? (Greenwald et al 2012)

- Research has documented 50-90% of individuals with ABI demonstrated visual dysfunction
- 90% of TBI patients experience 1 or more oculomotor dysfunctions
- 40% of TBI have visual dysfunctions that persist > 3 months



# The Reality of Vision

- Vision is in the brain facilitated by the eyes
- There is a brain behind the eyeballs
- If the brain is damaged there is a high probability vision has been affected



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# Vision

- The visual world is a mental construction
- Constructing a visual world requires energy & effort
- Half of the cerebral cortex is devoted to this task





# Vision

- Vision system is not passively recording images
- Light patterns on the retina are transformed into a stable, 3D representation of our visual space world.





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Can you change the direction of the train – just by thinking about it?



# **Visual Processing**

 It is how our brain interprets what we see and puts it together into a meaningful way



NCRA





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# What might happen if?:



- You could see but could not perceptually interpret what was being seen?
- You were unable to accurately locate objects in space, judge the space between objects or understand the relationship of the objects to oneself?
- You had trouble directing the eyes to a desired location?
- You had a lack of coherence within visual pathways but also between vision and other systems (auditory, vestibular and somatosensory)

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## Spatial vs Focal Systems

#### SPATIAL/M Pathway

#### Proactive

- Lightning fast
- Subconscious
- Movement
- Spatial Localization
- Figure ground segregation
- Larger impact on balance/posture &



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## • FOCAL/P Pathway

#### Reactive

- Slower
- Detailed
- Object identification
- Guidance of fine motor
- (reaching, grasping)
   Secondary to ambient process





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# Visual Processing & Balance

- Visual processing is bi-modal
  - -Spatial Vision Where Am I?, Where is it?
  - -Focal Vision What is it?

Trevarthen published these 2 mechanisms of vision in primates in 1968

Demo



# **Three Visual Pathways**

- Parvo-cellular (80%) - Occipital Lobe
  - What?/Temporal/Ventral
- Magno-cellular (18%)
  - Midbrain
  - Where?/Parietal/Dorsal
- Konio-cellular (2%) - Midbrain



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# Ventral--Central/Focal/Parvo/What?

- Focal central mostly macular function
- Detail discrimination visual acuity
- Attention
- Concentration
- Orientation to present consciousness
- Slow speed in processing/occipital cortex
- Mostly cortical/higher processing



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# Dorsal----Peripheral/Ambient/Magno/Where? Spatial orientation

- Posture/balance
- Movement
- Anticipates change in the preconscious

Rapid speed in processing

Fight or Flight -

survival



20% of the nerve fibers from the eye do not go to the occipital cortex-goes to midbrain

Midbrain delivers SENSORIMOTOR!

Spatial visual processes include:

- Preconscious and proactive
- Receives feedback from the cortex
- Brings forward all possibilities for neuro organization

Dorsal--

Peripheral/Ambient/Magno/Where?

# Koniocellular



Balances information between parvo and magno

 Understanding Koniocellular may help explain suppression (research is being done)

- About 2% of nerve fibers go to Konio
- Can operate in closed eye situations

# **Spatial Visual Process**



- Organizes spatial information
- Allows for the development of concepts of midline, position, and orientation
- <u>Feed-forward phenomenon</u> visual information relayed from the midbrain to the occipital cortex to pre-program the higher cortical areas to first evaluate visual information spatially before focalizing on detail

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## Spatial and Focal Visual Processes

- Need to be able to use the spatial and focal systems together & switch back and forth easily between the 2 systems
- Neurological events may affect the balance between these two systems.
- An imbalance between the two processes results in information being received by the occipital cortex without spatial preprogramming.

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# Posture & Vision

- If we have to devote attention to posture we cannot attend to other things
- Posture should be part of an organizational set that does not require conscious attention
- Organization set for sensorimotor system, if it is not in balance it will affect visual processing
- If visual processing is not in balance it will affect sensorimotor processing
- A mismatch!

# **Spatial Vision**

NCRA

- Release from focalization for movement
- Assists in creating relationship to verticality
- Frees up higher level process from postural organization and control
- Major contributions to the overall cognitive function
- Suppresses background info to allow for attention

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Now imagine a grocery store...



# Vision Anatomy

 Superior colliculus in the midbrain involved in spatial orientation and eye movement control and integration of spatial information with vestibular, tactile and auditory information.



## **Posterior Parietal Cortex**



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## **Posterior Parietal Cortex**

- Center of multisensory convergence where visual, proprioceptive and vestibular information are combined
- Awareness of the movement and direction of movement of objects
- Localizing objects in space in relation to our bodies
- Awareness between objects in space
- Organizing and preparing our bodies for action



# Coordinated Movement in Space

- Requires efficient interaction between multiple systems: *Vision, Vestibular, Proprioceptive*
- Need intact pathways to superior colliculus and posterior parietal cortex



# Now imagine the neural highway after a brain injury?...



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NORA

# Aspects of Cognition



- Memory: long term, short term/working memory
- Processing speed
- Executive function: Reasoning, Planning, decision making
- Auditory and communication
- Emotional: controlling impulses
- Visualization?

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# Spell the last name of the first US President, backwards



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- Attention: Hear the instructions
- STM: Remember the instructions in their entirety
- LTM: Recall who the first president was, his name and how to spell it
- Working Memory: remember the letters in the name in the correct order while trying to reverse them.
- Processing speed: Do this fast enough to keep up with the rest of the group
- Reason/Plan and Decide: Can you carry out the multiple steps necessary to answer this? Once you think you know the president's name what do you have to do next?
- Auditory/Communication: Were you able to follow the words I used? Can you give the answer accurately?
- Emotion: Are you feeling pressured or anxious to answer?

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# notgnihsaW



- Visualization:
  - Did you picture the name Washington in your head to help spell it backwards?
  - How do we use visualization to help with cognitive tasks?

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# Perceptual Processing



- The organization, identification, and interpretation of sensory information
- Perception is dependent on cognition so that we can derive understanding and meaning from what we experience



# Aspects of Perceptual Processing



- Visual Motor Integration
- Body Image: Laterality, directionality
- Visual closure, visual discrimination, figure ground

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# Visual Perceptual deficits



- Lack of awareness—not being aware of people, things, or even body parts on the affected side usually left side but can occur on the right side
- Focused on the unaffected side—constantly turning toward the unaffected side(often the right side)
- Confusion—with inside-out, right from left with clothing
- Clumsiness—not being able to walk or navigate the wheel chair through a doorway without bumping the door frame

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Visual Motor Integration



- Visual Input, Motor Output
- How can a person safely/effectively interact with the world around them when he is not able to accurately process where objects are located in space, or understand the relationship between the objects and themselves

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Impact on Function



- This is how individuals plan, execute and monitor motor tasks
- If the information is not perceived correctly, the muscles will get the wrong message and produce the wrong motor response.
- This can impact eye/hand coordination, eye/foot coordination, bilateral coordination, body awareness
  - Which in turn impact a persons ability to participate in their ADLs and their daily roles





- Laterality: using the concept of midline to divide the body in half. Creates an awareness of "sidedeness" or the separation of left and right.
- Directionality: the understanding of where everything else in space is positioned in relation to the left or right side of the individual.

# **Impact on Function**



- Reversal of letters or words when reading
- Difficulty reading maps
- Difficulty filling out forms or putting information in the right location
- Can make a person more indecisive as they figure out what they should do or where they should go
- Slower physical reaction time, may often move in the wrong direction or move too slowly as they decide which way to go
  - · Return to drive?

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## Visual Closure

• To mentally be able to "fill in the blank" or close an incomplete picture/image/concept when analyzing or organizing information.



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# **Impact on Function**



- In critical thinking this can impact completing a thought from partial information or drawing conclusions.
  - Cannot recognize inferences or predict outcomes
- May not be aware when their work/ADLs are not completed
- Increased difficulty visualizing how parts fit with the whole
  - · Impacts return to work, return to school, driving

## Visual Discrimination

· The ability to discriminate similarities and differences in shapes, letters, or forms.



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# Impact on Function



- Can be difficult to compare concepts with minor differences
- Can misread numbers or confuse similar letters
- May not see they are making errors so cannot self correct
- Leads to frustration, higher failure rate in school/work tasks

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## **Figure Ground**



 The ability to discriminate an object, shape, word or letter from the background in which it is embedded.



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# **Impact on Function**

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- May impact the ability to attend to individual letters and words presented on a page full of sentences and paragraphs
- Can lose your place while reading
- Difficulty with competing information on the television or computer screen
- More easily distracted, overwhelmed and needs extra time getting ready or performing ADL/IADLs
- Can be conceptual as well –unable to distinguish between primary and secondary information.
  - What to prioritize, what needs to be acted on immediately vs in a little while

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# Psychological, Behavioral and Social Considerations



- Addressing emotional needs of the patient and the family
- Behavioral outbursts
- Support return to social roles
- Patient centered care
  - Refer to psychology

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# WHAT HAPPENS AFTER A BRAIN INJURY?





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### Common Visual Defects of ABI

- Post Trauma Vision Syndrome (PTVS)
- Visual Field defects
- Unilateral Spatial Inattention
- Visual Midline Shift (VMSS)/Abnormal Egocentric Localization



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### Neuro-challenged

- They have a disconnect between the 80% oculomotor and 20% proprioceptive
- Neurological event vision dysfunction will directly influence posture, balance and movement
- Mismatch between vision and sensorimotor information – balance, posture, movement and spatial orientation (hallucinations, false sense of movement, etc)
- Vision impairment anxiety, loss of independence, decreased socialization

### Post Trauma Vision Syndrome (PTVS)

- · Constellation of problems after brain insult
  - Signs and symptoms may include:
  - Eyes drifting outward
  - Eyes not working together
  - Double vision
  - Blurred vision
  - Light sensitivity
  - Visual field loss
  - Concentration difficulties
  - Reading problems
  - Poor spatial judgment/depth perception
  - Possible midline shift







Memory & Cognition



Speech & Language



Motor Performance



Concentration

# **PTVS:** Development & Cognition



- Proactive affect of vision and motor are compromised
- Visual dysfunction causes developmental delays
- Interference with learning
- Problems with communication
- Disrupts time and space by focal binding
- Affects memory ٠

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# PTVS: Speech and Language

- Speech requires temporal context between thought, language and oral motor response
- PTVS over-focalization interferes with release
- Causes inability to release thought-language-oral motor flow
- Affects temporal • relationships which ambient vision provides for speech-language fluency



# **PTVS: Motor Skills**

- Focal binding compromises • preconscious/proactive relationship between ambient and motor
- Movement becomes conscious and isolates function (lack of automaticity)
- No fluency because the system is unable to anticipate (i.e. reading, etc.)



### Over-Focalization of Vision "Focal Binding"

- Causes inability to release detail
- Environment becomes over stimulating
- Movement in the environment (busy, crowded) becomes chaos to the visual system
- · Print on page becomes a mass of detail
- Movement of the eyes is projected into the field causing movement of print or ground being walked on







**CAN YOU GO INTO** 



DO YOU DRINK COFFEE

FEEL, SOMETIMES

THE WALLS MOVE .

Write (don't print) the word **concussion** on your paper...

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# Visual fields

- How read them and how to take them
- Confrontation—cover each eye, use 1 or 2 fingers—pediatric use distraction
- Automation— Humphrey



Flow

- Optic nerve
- Chiasm
- Tract
- radiations



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### Common Field defects in CVA and TBI

- Unilateral
- Bitemporal
- Hemianopsia
- Quadranopsia
- · Pie in the Sky
- Scattered Islands



# Rules to reading visual fields

 the more posterior the lesion(stroke) the more congruous (similar) the defect
 Occipital cortex lesions often

spare the macula

3) The more posterior the defect rotate it 180 degrees and it will tell you where the lesion is at ie "Pie in the sky"(lower right—temporal) "pie in the floor"—parietal







Visual-Spatial Neglect Unilateral Spatial Inattention



### Definition and Types:

- A clinical syndrome whereby patients exhibit a lack of awareness to objects, people, or visual stimuli in the visual space <u>contralateral</u> to the cerebral lesion
- It is heterogeneous, and <u>cannot be attributed to a</u> <u>sensory or motor deficit</u> (can be visual, motor, auditory, sensory, body image, or a combination).
- Also called visual-spatial inattention, unilateral spatial inattention (USI), hemi-inattention, etc.

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Unilateral Spatial Inattention (USI)

- Awareness—attention—does not bring eye movements to that field
- Exploration and curiosity are not there
- It may look like a visual field defect
- · Very much impacts negatively daily living skills
- Can be in tandem with a visual field defect
- With therapy mild, moderate and severe will respond

Different from a Visual Field Cut



### USI vs Hemianopsia

- Hemianopsia arises from damage to the primary visual pathways cutting off the input to the cerebral hemispheres from the retinas.
- USI is damage to the processing areas
- The cerebral hemispheres receive the input, but there is an error in the processing that is not well understood.

### **Unilateral Spatial Inattention**

Right parietal lobe allocates attention to both sides of the body Left parietal lobe allocated attention to the right side of the body Can be personal space, peripersonal space and extrapersonal space



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### **USI Allocation of Attention**

- Right parietal lobe allocates attention to both sides of body
- Left parietal lobe allocates attention to the right side of the body
- Location of Impact on Function:
  - Personal
  - Peripersonal
  - Extrapersonal space



- Brain areas in the <u>parietal</u> and <u>frontal lobes</u> are associated with the deployment of attention (internally, or through <u>eye movements</u>, head turns or limb reaches) into <u>contralateral</u> space.
- USI is most closely related to damage to the temporoparietal junction and <u>posterior parietal cortex</u>.
- The lack of attention to the left side of space can manifest in the visual, auditory, proprioceptive, and olfactory domains
- Although hemispatial USI often manifests as a sensory deficit, it is essentially a failure to pay sufficient attention to sensory input.

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### USI

- Although hemispatial USI has been identified following <u>left hemisphere</u> damage, it is most common after damage to the right hemisphere
- This disparity is thought to reflect the fact that the right hemisphere of the brain is specialized for spatial perception and memory, whereas the left hemisphere is specialized for language
- Hence the right hemisphere is able to compensate for the loss of left hemisphere function, but not vice versa.

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### USI

- · Neural substrates for "sight" are intact
- Neural substrates for visual awareness and perception are damaged—part of the Big Map (parietal lobe) is missing or exploring eye movements (frontal lobe) are missing
- May change with attentional demands (ie-posture and gravity)
- May exist in the presence of normal sensory input and muscle movement
- Mild to moderate inattention frequently responds well to therapy
- Severe inattention can also improve
- You should still check for USI without a motor component (always include testing for dual extinction). If found, likely frontal or temporal lobe damage.

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### What's missing here?



### Subtypes

- Can include inattention to objects, parts of objects, parts of scenes, personal space, body parts.
- Overall, patients believe they have an appropriate representation of their environment, so many have decreased awareness for the need to compensate (they anticipate no issues with tasks that involve the neglected side).

# **OBLIVIOUS!**

isn't it funny how obvious oblivious

• New term, "Left Oblivion" vs. Inattention









LISA

ER STRE ALICE



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### Signs, Symptoms and Functional

### Issues:

- Decreased balance, veering left and bumping into • doorframes, walls & furniture on the left (falls risk)
- Reading-missing words on the left, not finding the next line, etc
- Difficulty finding things
- · Meals missing food on the plate
- · Decreased spatial orientation (and way finding) Not completing grooming tasks on left side (hair,
- shaving, etc.) • Unable to spatially orient objects (i.e. setting the
- table or spreading cookies on a sheet)
- DRIVING! (EEK!) •
- Head turned away from affected side: makes it • challenging to work on affected side and can be socially awkward with conversations







# Visual Midline Shift Syndrome

- Neurological event following TBI or CVA
- The ambient visual process changes its orientation with regard to the midline of vision
- · Both lateral and transverse midlines are affected



# VMSS caused by

- Spatial vision dysfunction
- Impaired extraocular proprioception
- Impaired efferent copy
- Tonic oculomotor imbalance
- Spatial shifts caused by unilaterial hemispheric damage
- Other

### Conditions that affect VMSS

- Hemianopia
- Unilateral Spatial Inattention (USI)
- Increased Extension
- Increased Flexion



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# Visual Midline Shift



- A mismatch between the perceived egocentric visual midline and the actual physical visual midline
- DO NOT confuse this with saying "midline shift" that is a term used by neurology and the MD world to indicate a physical brain midline shift
- We are talking "visual midline shift"
- Abnormal Egocentric Localization (AEL)

### VMSS

- Parietal lobe integrates all sensory input, vision included
- Visual input from the left eye is processed by the right side of the brain and input from the right eye is processed in the left side of the brain
- When this process is altered by a neurological event or injury it creates a perceived amplification of space internally on one side and compressed amplification of space on the other side







### Where is "spatial" vision in the brain

- Spatial vision comprises the visual functions that are associated with the maintenance of spatial orientation and that depend on peripheral, preconscious visual inputs.
- These findings provide further evidence that the spatial vision signal is either processed or transmitted throughout the entire brain, as befits a visual function that is fundamental to all other perceptual systems.
- http://www.mbfys.ru.nl/staff/j.vangisbergen /endnote/endnotepdfs/visueel/ambientvision.pdf





### Symptoms of VMSS

- Dizziness and nausea
- Spatial orientation difficulty
- Constantly stays on one side of the hallway
- · Bumps into things when walking
- Poor walking or posture: leans back on heels, forward, or to one side when walking, standing or seated in a chair
- Perception of the floor being tilted
- Associated neuromotor difficulties with balance, coordination and posture



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### **Right Visual Midline Shift**



Anterior Midline Shift



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## **Pusher Syndrome**

- "Pusher syndrome" is a clinical disorder following left or right brain damage in which patients actively push away from the non-hemiparetic side, leading to a loss of postural balance.
- The patients experience their body as oriented "upright" when the body actually is tilted to the side of the brain lesion (to the ipsi-lesional side).
- Paradoxical Visual midline shift

### **Pusher Syndrome**





A patient with right-side brain damage and pusher syndrome. The characteristic feature of the disorder is that these patients, while sitting (left) or standing (right), spread the nonparetic extremities from the body to push away actively from the nonparetic side. The result is the typical tilted body posture of these patients. If not assisted by the examiner, the patients push themselves into a lateral inclination until they fall toward the hemiparetic side.

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# Vestibular System







- Recent study indicated that as many as 35% of Americans over 40 years old (70 million people) have experienced some form of vestibular dysfunction
- 80% of people over 65 years have experienced dizziness and BPPV is the cause of approximately 50% of dizziness in older persons
- 11.5% of adults with chronic dizziness and 33.4% of adults with chronic imbalance report significant impairment in basic ADL
- Pediatric vestibular disorders, once thought to be rare, are now appreciated as an overlooked problem

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# INTRODUCTION

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- The term dizziness is used to describe a variety of sensations (light headed, swaying, disorientated etc.)
- Vertigo is a specific type of dizziness defined as the illusion of movement occurring in the environment.
- Vertigo and dizziness are not interchangeable terms
- Because the causes of dizziness are so varied, medical assessment should be conducted prior to initiating treatment
- Vestibular impairment is an underlying cause in as many as 45% of people complaining of dizziness

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# INTRODUCTION



- Only 11% of all providers assessed patients for BPPV using the Dix-Hallpike
- "almost no clinicians assessed patients for vestibular loss except those in ENT or audiology"
- Referrals to specialists were infrequently made even though vestibular impairment was rarely ruled out by physicians

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# Signs and Symptoms of Vestibular Disorders

- Nystagmus hallmark of BPPV
- Vertigo bed spins
- Dizziness equilibrium off
- Imbalance or Ataxia
- Poor gaze stability compromise in ability to maintain vision/gaze in a moving environment

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#### Peripheral hypofunction: Ototoxicity Acoustic neuroma

#### Peripheral hypersensitivity:

BPPV Fistula Meniere's disease Vestibular neuritis Labyrinthitis

#### Central pathology: CVA ABI Brain tumor

Multiple Sclerosis

#### Non-vestibular sources:

Cervicogenic dizziness Migranes Mal de Débarquement

### Vestibular Disorder Categories

#### Peripheral loss: Unilateral hypofunction:

- Remaining vestibular apparatus has resting firing rate
- Body interprets this as turning, since one side is firing faster than the other (push/pull mechanism)
- Over time patients can adapt to the inaccurate sensory information
- Many remain symptomatic for long periods
- -VOR remains permanently diminished on one side

### Bilateral Vestibular Lesions (BVL)

- Often due to ototoxicity, commonly the aminoglycosides (Gentamicin or Streptomycin)
- In high doses, they consistently destroy the hair cells of the inner ear
- In normal doses, ototoxicity occurs spontaneously in 3% of the population
- Vertigo is infrequent in these patients because the vestibular loss is bilateral and symmetrical
- BVL may also be asymmetrical (e.g. sequential bilateral vestibular neuritis or age related degeneration)

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### Bilateral Vestibular Lesions (BVL)

### Primary Complaints in Patients with BVL

- Balance problems during standing or walking
- Oscillopsia
- Disequilibrium and Dizziness
- Physical Deconditioning

### **Vestibular Disorder Categories**

#### Peripheral hypersensitivity: Motion sensitivity

- General hypersensitivity to vestibular and/or visual input.
- Symptoms IMMEDIATELY after mild stimulation
- · Often people report limiting activity to avoid symptoms
- Can present as a vicious cycle
- Responds to habituation training
- Strong link to visual system as symptoms often triggered by visual stimulus
- (e.g.. Looking down from heights)
- Vestibular reflexes will be normal

### Vestibular Neuritis and Labyrinthitis

- Often termed a Unilateral Vestibular Lesion (UVL) or unilateral vestibular hypofunction (UVH)
- the second most common cause of vertigo
- ? due to a viral infection
- in *neuritis*, the superior division of the eighth cranial nerve is commonly affected, hearing is preserved
- in *labyrinthitis*, the entire labyrinth is involved and hearing loss is present
- Acute vs. Chronic
  - Acute: nystagmus, nausea, vomiting, imbalance (often do not see as physios)
  - Chronic: persistent dizziness and imbalance due to lack of compensation

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### Vestibular Disorder Categories

#### Central Pathology

-Pathway disorders	-Degenerative disorders
-CNS disorders	-Brain injury

- More complex to diagnose and treat.
- Pathology can occur in a single area of the pathway or impact multiple areas
- Impaired vestibular reflex findings may be peripheral AND central in origin.
- Degenerative disorders have poorer prognosis

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### Symptoms of Dizziness

Symptoms	Mechanism
Disequilibrium: imbalance or unsteadiness while standing or walking	Loss of vestibulospinal, proprioceptive, visual, motor function, joint pain or instability and psychological factors
Lightheadedness or presyncope	Decreased blood flow to the brain
Sense of rocking or swaying as if on a ship (mal de debarquement)	Vestibular system adapts to continuous, Passive motion and must re-adapt once environment is stable, anxiety
Motion sickness	Visual-vestibular mismatch
Nausea and vomiting	Stimulation of medulla
Oscillopsia: illusion of visual motion	Spontaneous: acquired nystagmus Head-induced: severe, bilateral loss of VOR
Floating, swimming, rocking, and spinning inside of head	Anxiety, depression, and somatoform disorders
Vertical diplopia	Skew-eye deviation
Vertigo: rotation, linear movement, tilt	Imbalance of neural activity to vestibular cerebral cortex

Disorder	Tempo	Symptoms	Circumstances
Vestibular Neuritis	Acute	Vertigo, disequilibrium, N/V, oscillopsia	Spontaneous, exacerbated by head movements
Labyrinthitis	Acute	Vertigo, disequilibrium, N/V, oscillopsia, hearing loss and tinnitus	Spontaneous, exacerbated by head Movements
Wallenberg Infarct	Acute	Vertigo, disequilibrium, N/V, tilt, ataxia, lateropulsion, X-sensory loss, oscillopsia	Spontaneous, exacerbated by head movements
BVL or UVL >3 days	Chronic	Dizzy, disequilibrium, occasionally oscillopsia	Head movements, walking (in dark or uneven surfaces)
Mal de Debarquement	Chronic	Rocking or swaying as if on a boat	Spontaneous while lying or sitting. Rarely occurs in motion
Oscillopsia	Chronic	Subjective illusion of visual motion	Spontaneous with eyes open
Anxiety/Depression	Chronic	Lightheaded, floating or rocking	Occurs in a variety of circumstances
Benign Paroxysmal Positional Vertigo	Secs	Vertigo, nausea	Positional: lying down, sitting up, turning in bed, bending forward
Ortho Hypotension	Secs	Lightheaded	Positional: standing up
TIA' s	Mins	Vertigo, lightheaded, disequilibrium	Spontaneous
Migraine	Mins	Vertigo, dizziness, motion sickness	Occurs in a variety of circumstances
Panic Attack	Mins	Dizzy, nausea, diaphoresis, fear, palpitations, paraesthesias	Spontaneous or situational
Motion Sickness	Spells: hrs	Nausea, diaphoresis, dizzy	Movement-induced, usually visual- vestibular mismatch
Meniere's Disease	Spells: hrs	Vertigo, disequilibrium, ear fullness from hearing loss and tinnitus	Spontaneous, exacerbated by head movements

# Assessment









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# Potential Domains of Assessment

- Vision
- Vestibular
- Posture
- Balance
- Gait
- Cognition

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### 4 Tiered Conceptual Model of Vision Assessment (in mild TBI) (Ciuffreda et al 2016)



# **1**. Basic Vision Exam

- a) Refractive Status
- b) Binocular Status eye tracking, pursuits, saccades, NSUCO, Right Eye, VOMS
- c) Ocular Health Status pupils, macular integrity, dilated fundus exam

Timing? Acute vs later

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NCRA

# 2. Oculomotor Based Vision Problems

NCRA

a) Version – fixation first, pursuits, saccades

- b) Vergence NPC & NPR repeated
- c) Accommodation flippers, MEM, DEM
- May not need to initially prescribe if this is an acute injury
- Changes can be an indicator of recovery

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### How to assess eye movements



- 9 positions of
- gaze
- H pattern
- Star pattern







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### Vertical Deviations

- Trochlear nerve palsy (CN IV) most commom congenital palsy but also easily acquired in mTBI
- Most common reason that depth perception is lost
- · Patients come in with complaint of motion sickness
- 75% of vertical deviations are due to cranial nerve IV
- You can do Parks three step
- But the golden rule is that it is CN IV until proven otherwise



- Look for head tilt
- Or roll towards the opposite shoulder
- This picture the guy has a right
- CN IV—trochlear palsy
- Look for a little larger area of sclera between
- The lower lid and the limbus
- Common in children and patients who have sustained
- A head injury



### CN IV

- Motion sickness or vertigo but patients often do not report because they have been have not had it addressed
- Riding in car—motion sickness– and head tilt highly suspicious of CN IV
- Motion sickness—think vertical!!

### **CN IV**

- Primary gaze—right eye slightly hyper—tilt of head toward left shoulder
- Up and to the right is the best
- Down and to the left the right eye does not depress fully—this is the action field of the muscle
- Most diplopic down and to the left

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### CN IV

- Used mostly for intorsion not elevation/depression
- When the muscle is weak they tilt their head away from the paretic muscle
- Because of the long tortuous route over the sella tursica—highly suspectible to trauma
- Does not relieve the vertical
- Runs in families
- All vertical deviations are due to Superior Oblique muscle until proven otherwise
- Symptoms or not you want to know if it is newly acquired—potential for intercranial mass



- Trochlear nucleus is up in the midbrain north of the pons—enters in near the posterior aspect of the cerebellum
- It is susceptible to injury for a couple of reasons
- One little insertion point near the midbrain runs close to the petrous bone and sella tursica—so a patient with a mild whiplash can get a newly acquired trochlear palsy

# Causes of CN IV



# Trochlear nerve vs Skew deviation

- Gives the same presentation in primary gaze vertical with new onset
- Skew deviation—vestibular nuclei at the bottom of the pons where it joins the medulla—vestibular symptoms beyond motion sickness—same deviation in all gazes—body thinks the body upright when it is not upright

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# Symptomatic exo deviations

 CN IV and CN VI do not cause exo deviations suspect for CNIII even without the ptosis and the blown pupil

# Causes of the CNIII

- Ischemic (most common cause) from embolic or thrombolic occlusion of the small, dorsal perforating branches of the mesencephalic branches of the basilar artery
- Less often from occlusion of the distal portion of the basilar artery(top of the basilar syndrome)
- Hemorrhage
- Infiltration or tumor
- Inflammation
- Compression
- Others (rare)—cephalic tetnus, amyotrophic lateral sclerosis,Kukelberg-welander disease

### CN III

- · Scanning does not show anything
- Diagnosed through eye movement and watch for progression
- More than a third of them accounts for some kind of vascular accident--stroke

### DDx of CNIII

#### **Obligatory nuclear lesions**

- Unilateral third nerve palsy with superior rectus palsy and bilateral ptosis
   Bilateral third nerve palsy with levator function(sparing the central caudal nucleus) or normal pupils (sparing the E-W nucleus ) or both
- Possible nuclear lesions
- Bilateral total third nerve palsy
- Bilateral ptosis (affecting the central caudal nucleus only)
- Isolated weakness of any single muscle except levator, superior rectus and the medial rectus

#### Not nuclear lesions

- Unilateral third nerve palsy with normal contralateral superior rectus function
- Unilateral internal ophthlmeplegia
- Unilateral ptosis
- Isolated unilateral or bilateral medial rectus palsy

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Grading CNIII

- Grade 1: acquired exotropia
- Grade 2: exotropia and hypotropia
- Grade 3: exotropia, hypotropia, lid ptosis
- Grade 4: Text book—exotropia, hypotropia, lid ptosis and pupil involvement
- Because of the ptosis patient do not always have diplopia
- Even with easy and affordable CT scans they would not give any diagnostic benefit

### **Etiology of CNII**

- Ischemia (most common) due to occlusion of the basilar artery or occlusion of the perforating or medial interpeducular branches of the posterior cerebral artery
- Hemorrhage
- Infiltration
- Inflammation
- Compression
- Trauma
- Demylination

### CN III

- Weber Syndrome: ipsilateral 3<sup>rd</sup> nerve palsy plus contralateral facial hemiparesis including lower face and tongue (3rd nerve with other side Bell's palsy)
- Claude syndrome: 3<sup>rd</sup> nerve palsy with cerebellar ataxia due to involvement of superior cerebellar peducle plus contralateral tremor due to the involvement of the red nucleus (hands on legs and rotating as rapidly as you can)

### **Eso-Deviations**

- · When symptomatic crosses eyes at far and near
- Easy to treat with prism because can wear far and near
- Most common CN VI palsy—DI
- · Injury need to check for blowout fracture
- 6<sup>th</sup> nerve runs close to the petrous arch and temporal bone

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15 Series 3 Series 2 Series 1

### **CN IV**

- Cancer patients known to have mestasis to the pons or cavernous sinus-intercranial mass-demylinating
- Should not see eso tropia increase
- Check for papilledema
- Facial palsy
- Vomiting
- Get a visual field—see if any field damage
- Methadone may cause a 6<sup>th</sup> nerve palsy

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# Causes of CN VI



### Causes of CN III



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# 3. Non-oculomotor-based vision problem

- a) Abnormal spatial localization visual midline shift test
- b) Photosensitivity patient complaint
- Motion Sensitivity pt complaint, stand behind & wave
- d) Vestibular Dysfunction Dix Hallpike, Dynamic Visual Acuity test, VOR challenge
- e) Visual Field Deficit Humphrey's visual field, confrontation testing
- f) Visual information processing dysfunction ImPact testing, MPV, TVPS, Berry



 Stand to the side of patient on an angle and ensure the patient does not have an object in front of their face to orient themselves to midline.

VMSS - Visual Midline Shift Test

- Patient to keep face looking straight ahead but eyes follow a wand as you move it across their vision at a consistent speed. Hold patient's head steady if necessary.
- Patient tells you to stop when the wand is directly in front of their nose.
- Check left to right, right to left, anterior to posterior and posterior to anterior.
  Use a face diagram to draw a line
- Use a face diagram to draw a line indicating where the patient reported their midline was.

# Confrontation Testing (HH or USI?)

- · Patient looks directly at the therapist
- Present fingers in the patient's right visual field, they see it.
- Present fingers in the patient's left visual field, if they see the fingers, there is no field loss, if they don't, they most likely have HH (or a very severe neglect).
- Present fingers in both the right and the left fields; if there is an inattention, they will ignore the left side b/c there's a stimulus in the right.
- Movement can help stimulate attention

# How do we tell the difference between Visual Field Loss and USI ?

- Double simultaneous stimuli during confrontation testing
- Neglect is a competitive process
- Dual Extinction
- Line Bisection

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- Star Cancellation Task
- Draw a picture (clock)
- Observation and Report

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# **USI** Assessments

- Line bisection tests (verbal vs. traditional)
- Letter cancellation test
- Line cross-out tests ightarrow
- Number cross test
- Clock or Flower Drawing
- Pencil test / 3 Foot Rod
- Midline test
- Looking at large panoramic scenes
- 100 letter grid
- Extinction Testing







### Object Centered vs. Scene Based USI

 Object centered USI shows when errors are made in perceiving the left side of an individual object, regardless of where that object is placed in space.



 Scene based USI shows when errors are made when an object is placed on the left side of space, defined by the midline of body, head or retina



# Object vs. Scene Based

• GAP test

8 7 W 4 B Looks like: 3 1 V 1 3 NORA

NCRA

# BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV)

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# **BPPV**

 the most common cause of vertigo due to a peripheral vestibular disorder

- accounts for 20-30% of all patients seen for vertigo
- more common in the elderly (some studies: 50%)
- ↑ symptoms with looking up, lying down, bending forward, and rolling in bed
- Majority of BPPV occurs in the
- posterior canals 88.4%
- anterior canals 5.2%
- horizontal canals 6.4%

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### NCRA

- Overall incidence in general population is approximately 2.5%
- majority is idiopathic
- related to head trauma

Causes of BPPV

- related to labyrinthitis/neuritis,
- related to ischemia of anterior vestibular artery and cardiovascular disease
- Recent studies relate BPPV to osteoporosis and vitamin D deficiency

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# **BPPV**

### NORA



 A biomechanical problem in which one or more of the semicircular canals is inappropriately excited, resulting in vertigo, nystagmus and occasionally nausea

#### Mechanism

Involves otoconia that have become displaced from the utricle and float into one of the three semicircular canals

#### Types of BPPV

- Cupulolithiasis
- Canalithiasis

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# Dix-Hallpike Test (DH)



- used to assess BPPV
- allows you to identify the side of the lesion and the canal involved



Patient is seated with their head turned  $45^{\mathrm{o}}$  toward the test side

Patient is rapidly moved supine with the head extended  $30^{\mbox{\scriptsize o}}$ 

Observe the eyes for nystagmus and note the direction, latency, duration

Wait until the nystagmus stops and slowly sit the patient up (typically go ahead and treat, patient does not sit up).

Repeat to the other side (dependent on results)

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# Assessing the horizontal



- Head Roll Test places the horizontal canals in the plane of gravity
- Horizontal nystagmus and reports of vertigo with rolls to both the right and left sides
- The assumption is made that the most symptomatic side is the affected side when you detect geotropic nystagmus
- Assume the less symptomatic side is affected when you detect ageotropic nystagmus

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- Observe the eyes for nystagmus and note the direction, latency, duration
- $4. \ \ \,$  Bring the patient's head back to the neutral position and roll the head quickly to the right and observe

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### Canalith Repositioning Treatment (Epley): Posterior and Anterior Canalithiasis



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### Canalith Repositioning Treatment: Barbecue Roll



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### Other Vestibular Tests

• Dynamic Visual Acuity Test -Have the patient sit the appropriate distance from the chart. <u>Be sure they wear their glasses if they need distance correction</u>. Instruct the patient to read the lowest line that they can until they cannot correctly identify all the letters on a given line. Note the line where this occurs. Then, stand behind the patient and grasp the sides of their head firmly with both hands. Tilt their head forward 30. While rotating their head side to side at a frequency of 2 Hz, have the patient read to the lowest line until they can no longer correctly identify all the letters on a given line. Note the line where this occurs. Keep the range of motion of head movements small so as not to restrict the visual field that may occur with patients who wear glasses. If the patient can only read letters 2 or more lines above their initial static visual acuity, they likely have a vestibular deficit.

# **VOR Screening**



- Have patient look at a target and maintain fixation while shaking head side to side(about 20 degrees ROM at 120 bpm) can also do up/down
  - Can they maintain fixation?
  - Can they tolerate the movement
  - Can they maintain their balance if standing?
- VOR Cancellation eyes fixated on thumb with arm in front of nose, move head and arm in sync side to side while maintaining visual fixation

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# 4. Non-vision based problems

- a) Depression
- b) Fatigue
- c) Cognitive Impairment
- d) Behavioural Problems
- e) Cervical Spine\* ROM
- f) Balance Impairment\* static & dynamic

#### \*not in Ciuffreda's model

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# Review: Aspects of Cognition Assessment

- Attention: sustained, selective, divided, alternating
- Memory: long term, short term/working memory
- Processing speed
- Executive function: Reasoning, Planning, decision making
- Auditory and communication
- Emotional: controlling impulses
- Cognitive Endurance

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# Depression & Fatigue Screening Tools



NCRA

- Patient Health Questionnaire-9 (PHQ-9)
- Beck Depression Inventory
- Fatigue Severity Scale

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# Other OD ideas for Cognition

- Parquetry
- Sanet Integrator
- Dynavision
- ImPACT
- Can they follow multistep instructions? are they slow to answer questions? Are they easily distracted?

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## **Cervical Spine**

- Neck is an important structure that we usually overlook
- The neck stabilizes chin
- Allows eyes to have stable platform
- Visual scan eyes supported by head and neck rotation
- Triad: VSR (vestibulo-spinal reflex), VCR (vestibulo-collic reflex), VOR (vestibulo-ocular reflex)
- Refer to manual therapist to 'clear' or treat cspine dysfunction

### **Cervical Spine & OD**

- · Are their indicators in the history that indicate cervical spine issues?
- Do they have reduced Passive Range of Motion?
- Ask patient to turn head left/right, ear to shoulder, chin up/down - if obvious restriction refer out
- Can have full ROM and still have c-spine dysfunction

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# **Cervicogenic Headache**



- Diagnostic Criteria (Sjaastad & Fredriksen 2000)
  - · Pain related to head movement
  - Restricted ROM
  - Ipsilateral neck, shoulder or arm pain
  - · Moderate-severe , non-throbbing, non-lancinating
  - Episodic or fluctuating
  - Usually starts in the neck
  - Unilateral, without side shift (can be bilateral)

\*these criteria differentiate from migraine but not mTBI H/A

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### **Differential Diagnosis of Headache**

CERVICAL HEADACHE	TENSION TYPE HEADACHE	MIGRAINE WITHOUT AURA
Episodic, varying duration	Lasts 30 min – 7 days Chronic: hours to days/unremitting	4-72 hours
Unilateral, Side locked	Bilateral	Unilateral, switches sides
S&S of neck involvement, decrease ROM, provoked by movement, starts in neck	Tenderness on palpation of pericranial muscles: frontal, temporal, masseter, pterygoid, SCM, splenius & trapezius	Can be associated with neck pain
Mod to severe, non-pulsating	Mild to moderate, pressing or tightening pain, non-pulsating	Moderate to severe, pulsating
Non-dominant autonomic symptoms	Min autonomic symptoms No nausea or vomiting < 1 of photo/phonophobia	Autonomic symptoms common – nausea, photo/phonophobia
+ve response to diagnostic blocks	Not aggravated by physical activity	Aggravated by routine activity Respond to migraine meds

Taken from Carol Kennedy – PCS: What about the neck? Course 2015

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# **Cervicogenic Dizziness**



- Mechanical provoked by neck movements & positions
- Dizziness & neck pain intensities are correlated
- Episodic/fluctuates
- Non-accommodating

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### Differential Diagnosis of Dizziness

Causes	Descriptors	Behaviour	Other Symptoms
VBI	-dizziness -faintness -unsteady -can be vertigo	-episodic -related to rot/extension -long latency -non-accommodating	-5D's & 3N's -cord, cerebellar -neck pain & severe headache (dissection)
Vestibular	-vertigo: spinning/motion	-head movement in space – rolling over, quick head mvts -accommodating, subsides -peripheral – severe, intermittent, short duration -central – constant, less severe	-nausea -vomiting -nystagmus -other ear symptoms -tinnitus
Cervical	-dizziness -unsteady -off-balance -light-heading -disequilibrium	-mechanical, provoked by neck movts/positions -dizziness & neck pain intensities are correlated -episodic, fluctuates -non-accommodating	-neck pain -headache -facial pain / P&N -visual -nausea -cognitive
Concussion	-dizziness -uncoordinated -loss of balance -'foggy'	-aggravated by: physical exertion, fatigue, cognitive tasks – concentration, reading	-irritability -sleep disturbance -cognitive impairment -light/noise sensitivity -vision impairment -nausea

Taken from Carol Kennedy – PCS: What about the neck? Course 2015

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# **Gait Assessment**



# Normal Gait



Basic observation is inadequate!

- Can they walk and talk at same time?
- Can they turn head with no disruption?
- Can they look away from path?
- Can they walk quickly?

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## **Gait Descriptors**

Spatial Descriptors of Gait

length = 144 cm

Left heel contac

Spatial: Stride or step length Step width, foot angle

Walking speed (gait velocity)

Cadence







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### Gait cycle

Heel strike  $\rightarrow$  heel strike same leg Stance phase 62% Swing phase 38%





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**Terminal Stance** 







Mid Swing



Terminal Swing



NCRA

# Posture and gait observations

- Normal posture and gait are:
  - 1. Symmetrical
  - 2. Energy efficient
  - 3. Varied
  - 4. Sub cortical



# GAIT

- Assessment of dynamic postural control mechanisms
- Evaluate the patient's gait in a variety of situations
- Look for the presence of gait deviations
  - Veering right or leftWidened BOS
  - Widened BOS
     J gait speed or arm swing
  - Shortened step length
- J ability to perform multiple tasks when walking
- 'en bloc' or slow turns
- Be systematic when looking top down/bottom up

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### ABI with Ataxia



### **Incomplete SCI**



ABI





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### Balance

- Controlled by 3 systems: Vision, Vestibular & Proprioceptive
- Static & Dynamic
- Righting Reactions, Balance Reactions, Protective Response
- Three postural control strategies:
  - Ankle strategy
  - Hip strategy
  - Stepping strategy







#### Ability to:

- Stand still or quietly in place (slight sway is normal)
- Move voluntarily
- Respond automatically to external challenges (like a bump/perturbation) and regain quiet stance
- Perform these tasks under various environmental conditions

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#### **Static Balance Tests**

- Used clinically to assess balance
- Vestibular patients may have normal results
- 1. Romberg eyes open and closed
- 2. Sharpened Romberg (tandem) eyes open and closed
- 3. Single Leg Stance
- 4. Modified Clinical Test of Sensory Interaction and Balance (m-CTSIB)
- Stand on foam with eyes open (alter SS input)
- Stand on foam with eyes closed (alter SS and visual input)
- Therefore can rely only on vestibular input
- 5. BESS test/modified BESS

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### Dynamic Balance Assessment

- walk at normal speed
- walk at an increased pace
- walk while changing pace
- walk with horizontal/vertical head turns
- walk and turn rapidly
- walk tandem forwards, backwards
- walk eyes closed
- Stairs
- Dual task while walking

During the Vision Assessment in your Clinic:

- Many won't tolerate HOURS of assessment, it may need to be broken down into smaller, shorter sessions (and allow for breaks)
- Any information you verbally give to them, ensure they get it in writing as well
- Choosing glasses; may need assistance
- Try to book a time of day that is less busy in the office

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### Dr. Fitzgerald's Essential Components of Neuro Assessment

- VA's, pupils, symptom survey
- · Eyetracking-fixations, pursuits, saccades, NPC
- VOR, VOR cancellation
- Balance—BESS or Romberg
- Cognition--ImPACT

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The views expressed in my portions of the presentation are my own and do not reflect the official position of the Veterans Health Administration.

# Dr. Fitzgerald's Deluxe Neuro



- VA's, pupils, symptom survey
- RightEye
- OCT/OPTOS
- DynaVision/Sanet/Senaptec
- NeuroTracker
- VEP
- NeuroCom
- · Blood Work up
- ImPACT

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### Spinal Nerves ≈ Cranial Nerves

These are the neurology texts that describe the functional relationship between different CNs, and with spinal nerves

The Human Brain: An Introduction to its Functional Anatomy By John Nolte NORA 2006

Clinical Neuroanatomy By Stephen Waxman
#### Spinal Nerves ≈ Cranial Nerves



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**Cranial Nerves** 



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Cranial Nerves are grouped according to embryological and phylogenetic origins ≈ type of nerve fibers

Somatic Efferent: III, IV, VI, XII Branchial Efferent: V, VII, IX, X, XI Visceral Efferent: III, XII, IX, X Visceral Afferent: IX, X, (VII – taste) Somatic Afferent: V (VII, IX, X) Special Sensory: I, II, VIII



### Homologous column

Somatic Efferent III, IV, VI, XII

spinal nerves (Innervate intrinsic spinal muscles)





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**Functional Anatomy** 

# What is wired together fires together

• Video of young girl

Neuronal connections are strengthening and remodeled by our experiences and movements





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Can I eat it or can it eat me? (fight or flight)

A connection between the autonomic nervous system, gut, and jaw/neck tension



What about Trigger Points?



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### Homologous column

#### **Branchial Efferent**

V - Jaw muscles VII -Facial muscles IX- glossopharyngeal (visera) X- vagus (viscera) XI -Accessory



Can I eat it or can it eat me?

Autonomic Nervous System

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Somatosensory vs Proprioception

Meissner's corpuscles Merkel's discs Ruffini endings Pacinian corpuscles Free nerve endings Muscle spindles Golgi tendon organs

receptors in skin, muscle, bone, connective tissue, internal organs

There are no "Proprioceptors"

Proprioceptive information comes largely from mechanoreceptors in muscles and joints

Receptor information contributes to sense of position of self and body parts, and movement of body parts

Areas that provide a disproportionately large amount of proprioceptive input

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Changing the Way the ground talks to the person





Trauma, and treatment, can disrupt proprioception

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# Central Impact of Local Muscle/Joint Treatment

- Increase Afferent to Brain Stretch Deep Massage Joint Adjustment
- Decrease Afferent to Brain Strain Counter Strain Joint Centration

Postures and Reflex Patterns

can be used to organize the CNS

## Central Impact of Local Muscle/Joint Treatment

Key Points:



Don't Stretch hypersensitive muscles!!!!

Think in terms of Neurology not just Biomechanics!

Think in terms of Patterns not Muscles

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