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Neurological Rehabilitation Module 818

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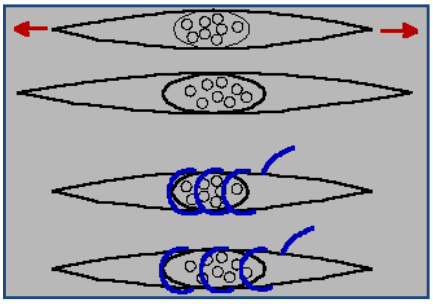
Muscle Spindle Receptors

Their Importance to Rehabilitation

The Muscle Spindle & Stretch



- Stretching the equatorial region of the muscle spindle may be accomplished by gamma-motor neuron activation and intrafusal muscle contraction.
- Another way to stretch the equatorial region of the spindle is to stretch the muscle and thereby stretch the entire spindle.
- Muscle spindle receptors respond to stretch of the muscle and signal *muscle length* and *rate of change of length* to the central nervous system.
- Depending on the length of the muscle prior to its loading and or stretching will dictate the balance of Grp Ia, II and Ib fiber integration.

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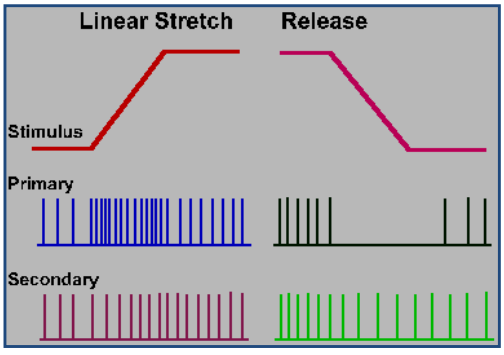
Spindle Stretch Response



- Both primary and secondary spindle afferent fibers give **static** or length-sensitive responses to stretch, i.e., they respond to maintained stretch in a sustained (tonic) fashion at a discharge frequency proportional to the length of the muscle
- Both primary and secondary muscle spindle afferent fibers usually discharge tonically when the muscle is at its resting length.
- When the muscle is stretched and held at some new length (left side of figure, lengthening is an upward deflection of stimulus trace), both types increase their discharge rates and maintain a discharge for as long as the new muscle length is maintained
- The greatest amount of input always occurs during movement because of the Grp 1a fiber activation.

*(Matthews PBC: Physiol Rev **44**:219-288, 1964)*

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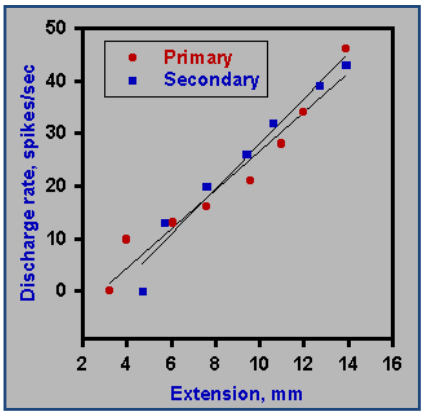
Spindle Stretch Response



- The greater the muscle length, the greater is the stretch on the spindle and the greater is the static discharge of either type of spindle afferent fiber.
- In fact, for static conditions, there is an approximately linear relationship between the rate of discharge of the afferent fibers and the length of the muscle.
- This must be considered though in light of the Grp 1b fibers which show significant activation whenever a muscle is loaded in a lengthened position.
- In NeuroRehab the clinician must examine the balance between Grp Ia, II and Ib Integration to the desired result.

*Jansen JKS, Matthews PBC: Acta Physiol Scand **55**:376-386, 1962)*

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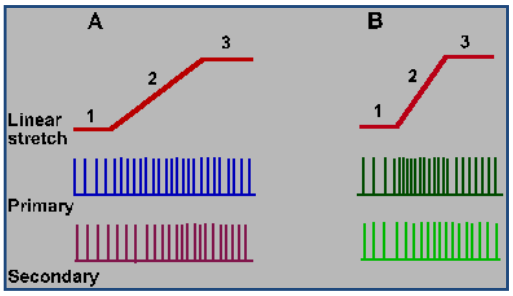
Spindle Stretch Dynamic Response



- The presented figure monitors the primary and secondary responses to stretch at two different rates (A and B).
- Note that both stretches start and end at the same muscle length.
- The responses of a primary ending are shown in the second traces; those of a secondary ending are shown in the third traces.
- Note the higher frequency of discharge of the primary ending at the higher rate of stretch (B).
- Again this does not take into account the 1b responses to tissue load under different speeds.

*(Matthews PBC: J Physiol (Lond) **168**:660-678, 1963)*

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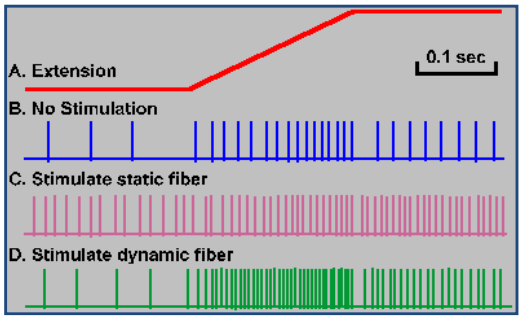
Effect of Gamma Motor Neuron Discharges on Spindle Sensitivity



A. Monitor of the muscle length during a stretch.
B. Response of a primary spindle ending to stretch.
C. Response of the ending to the stretch during continuous stimulation of a single *static* fusimotor neuron at 70/sec.
D. Response of the ending to the stretch during continuous stimulation of a single *dynamic* fusimotor neuron at 70/sec.
E. Thus, clinically one can always improve the effectiveness of the dynamic and static responses by changing gamma motor neuron activity

(Crowe A, Matthews PBC: *J Physiol (Lond)* **174**:109-131, 1964)

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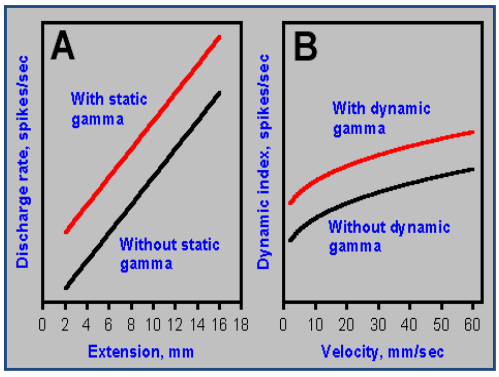
Effect of Gamma Motor Neuron Discharges on Spindle Sensitivity



- Dynamic fusimotor neuron stimulation increases the velocity discharge of a primary muscle spindle afferent fiber for any velocity of stretch.
- The effect of both static and dynamic fusimotor neurons on the muscle spindle receptors is to increase their discharge.
- In rehabilitation one can improve the primary and sensory responses of any group of muscle by altering the rate of firing of the presynaptic neurological pool to the Gamma Motor Neurons:
- Consider:
  - Cross Cord Reflex
  - Nociceptive Input (TENS Use During Movement)
  - Vestibular Inputs
  - PMRF Inputs
  - MES RF Inputs
  - Visual Inputs
  - Auditory Inputs

(Crowe A, Matthews PBC: J Physiol (Lond) ***174****:132-151,1964)*

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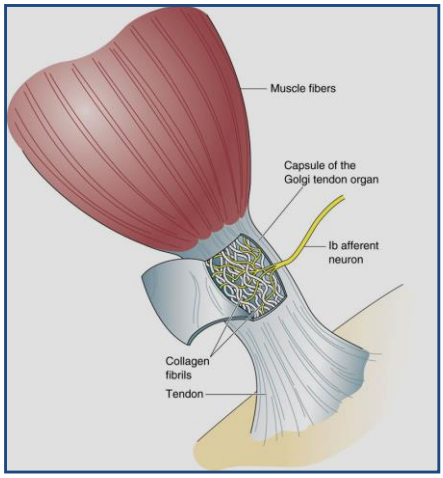
Golgi Tendon Organs



- The Golgi tendon organ signals to the central nervous system the tension developed by the muscle during contraction or exerted on it during a stretch.
- For many years, it was thought that these receptors had high thresholds to muscle tension and participated in controlling muscle activity only at extremes of tension, functioning as a protective device.
- Actually, the tendon organs are relatively insensitive to tension *applied to the muscle* by stretching it, but they are extremely sensitive to tension *developed by the muscle* when it contracts.
- The reason for this is that the tension on tendon organs is different under passive and active conditions.
- Clinically one must consider the factors that increase tendon load Which are:
  - Speed of movement
  - Length at which the muscle is loaded
  - Direction of the loading:
    - Concentric
    - Eccentric
  - The degree of protein concentration within the muscle

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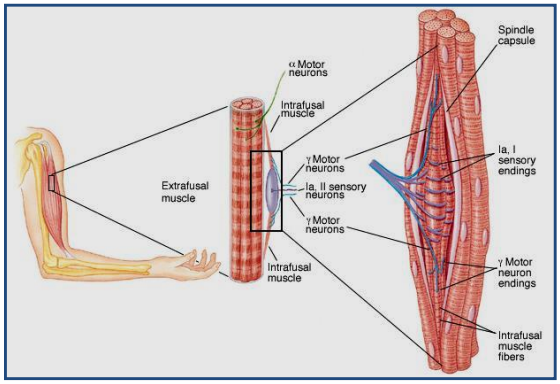
Descending Cortical Influences

On Receptor Summation
On Muscle Tone
On Gamma-Motor Neuron Activation & Muscle Sensitivity/Gain Bias

Efferent control of sense organs



- Neural signals sent from CNS to the gamma motor neurons regulate the sensitivity of the muscle spindle.
- Central control can also occur within CNS by modulation of sensory information in brainstem or thalamic nuclei by other CNS structures
- Functions:
  - Helps generate smooth muscle actions via sensory feedback while muscles contracting under voluntary control
  - Can help compensate for sensory signals that arise as a consequence of animal's own movements
  - Provide limited protection of sensory system against damage or adaptation
  - Provides a means by which animal can selectively suppress unimportant input

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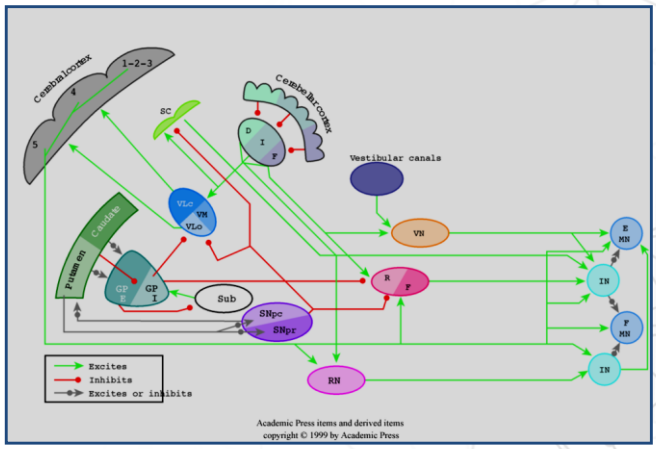
Suprasegmental Innervation

- The only clear monosynaptic output from the brain to the alpha motor neurons is via the lateral corticospinal tract
- Other descending pathways modulate motor and sensory integration through polysynaptic pathways.
- These polysynaptic pathways are mediated through the basal ganglia and brainstem.



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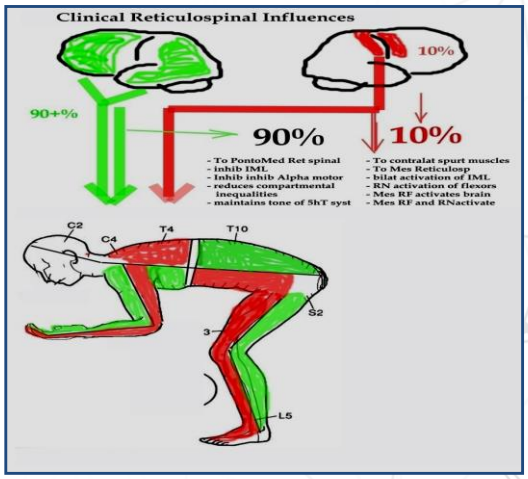
Pontomedullary Reticulospinal Output:

- Inhibits IML ipsilaterally.
- Increases spindle sensitivity ipsilaterally
- Inhibits anterior compartment muscles above T6 ipsilaterally
- Inhibits posterior compartment muscles below T6 ipsilaterally



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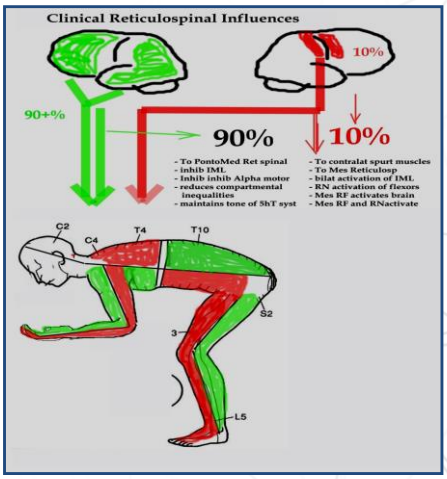
Mesencephalic Reticulospinal Output:

- Excites IML bilaterally but clinically we tend to see a contralateral effect.
- Increases alpha motor neuron sensitivity contralaterally.
- The Red Nucleus activates primarily contralateral proximal flexor muscles.



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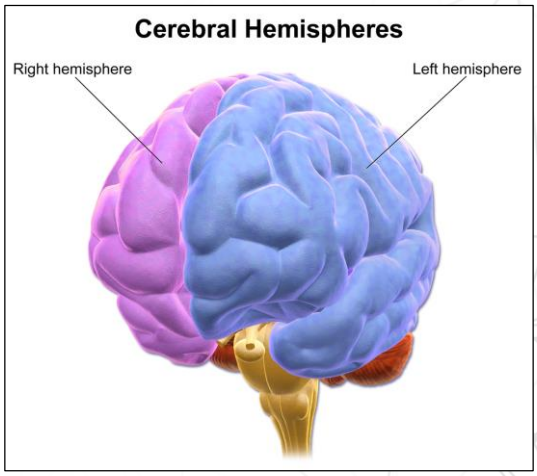
Right Hemispheric Lesions

Right Hemispheric Deficits

- Difficulty focusing attention (ADD)
- Impulsivity
- Obsessive or repetitive thoughts or actions (OCD)
- Poor spatial orientation and memory
- Difficulty remembering directions
- Inappropriate or poor social behavior/does secondary to poor abilities to read or interpret social cues (facial expression, body language, etc.)
- Difficulty-recognizing objects when seen from an unusual perspective.
- Tend to neglect or ignore the left side of space or body.



16

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Right Hemispheric Deficits

- Poor geometry skills.
- Poor math reasoning skills.
- Poor reading comprehension
- Poor time estimation (underestimates)
- Tone deafness or poor musical ability.
- Tends to focus on small details.
- Cannot easily identify out of focus pictures or incomplete pictures.
- May rush to name something or to explain something, even when they are presented with ambiguous information.
- Lack of understanding context or meaning of words.

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Right Hemispheric Deficits

- Difficulty recognizing environment sounds or low frequency sounds.
- Spacial dislocation of where things are happening around them.
- Dislocation of where the person is.
- Body image distortion.
- Feel as they have fused with objects or the universe.

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Right Hemispheric Deficits

- Unable to identify voices with cues, especially within crowds.
- Confuse their internal voice as coming from an external voice.
- Believe they are hearing a voice from God.
- See things that are not there (delusions).
- Extremely religious or strongly believe in U.F.O.'s
- Hallucinations or delusions/increased speech/may have thought disorders (derailment, tangentially of speech and clanging).

19

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Right Hemispheric Deficits

- Over interpretation of isolated bits of reality.
- Seeing patterns where there are none.
- Feel as if they do not understand their purpose or what they are meant to do.
- Difficulty decoding the emotions of other people.
- Difficulty with perceiving meaning and intonation in others speech.
- Poor understanding of indirect meaning or metaphors.
- Poor block design and picture arrangement ability.

20

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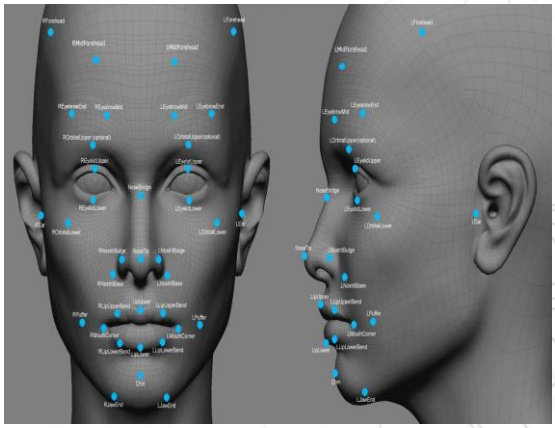
Right Hemispheric Deficits

- Extremely literal.
- Lack of imagination and pretense in play.
- Treats people as objects and treats body parts as if they were independent things.
- Notices great detail about the environment.
- Avoid eye contact.
- Act awkwardly or inappropriately.
- Competent or superior intelligence with calculations or puzzle solving.
- Lack of social intelligence to understand other's minds and feelings (mind reading ability).



21

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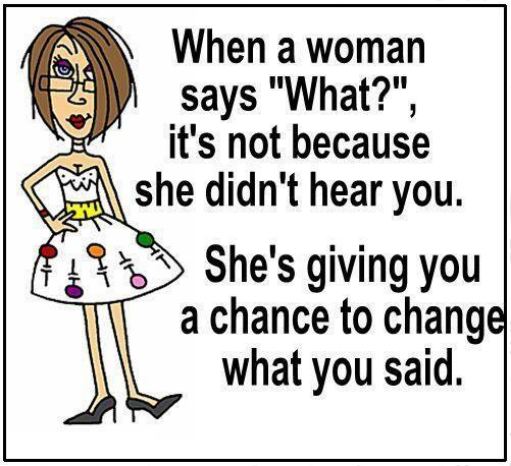
Right Hemispheric Deficits

- Cannot predict what others will do.
- Cannot pretend play as normal 18 to 24 month old children would.
- Does not show or share interest with another.
- Does not understand false beliefs.
- Does not understand jokes.



22

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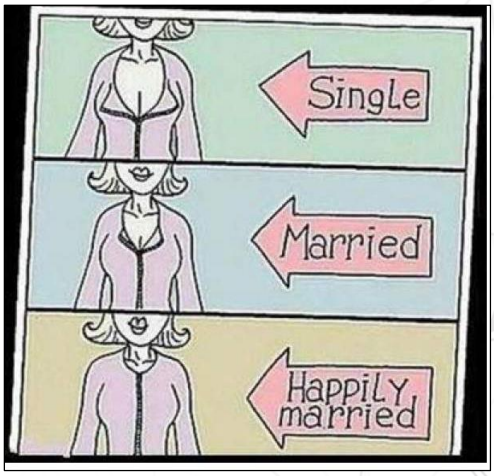
Language Syndromes of the Right Hemisphere

- Decreased prosadic contours in voice
- Decreased prosadic gestures of face and body
- Decreased prosadic contours in voice
- Decreased prosadic gestures of face and body
- Amelodic singing
- Disturbed comprehension of paralinguistic domains



23

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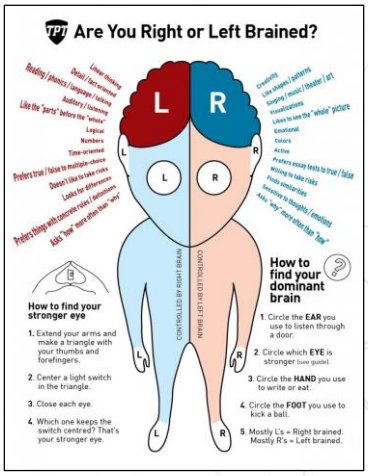
Left Hemispheric Lesions

Left Hemispheric Deficit

- Poor reading ability.
- Poor speech development.
- Difficulty with understanding words or receptive speech.
- Poor auditory processing or central auditory processing deficits.
- Poor memory for facts and figures.
- Acalculia or difficulty with math calculations.
- Poor sequencing ability.



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Left Hemispheric Deficits

- Poor academic ability.
- Lower IQ test results.
- Poor verbal memory.
- Poor object identification.
- Cannot focus on small details
- Focus on the big picture.
- Poor verbal communication skills.

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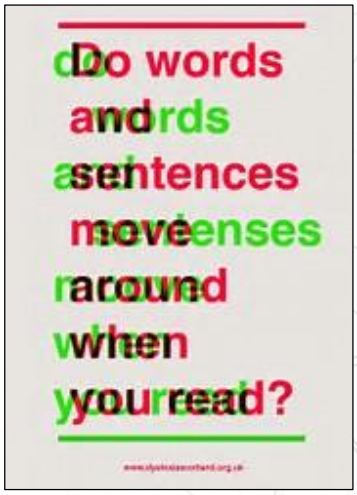
Left Hemispheric Deficit

- Decreased speech in general.
- Uses mostly nonverbal forms of communication.
- Knows what they want to say, but cannot find the words.
- Lack of speech or speech content. Blocking (inability to express thoughts).
- Poor performance on verbal tests.
- Lack of ordered sequence of thoughts.
- Decreased intellectualization or analytical thought.
- Dyslexia (difficulty reading).
- Need to be told things several times before they understand.



27

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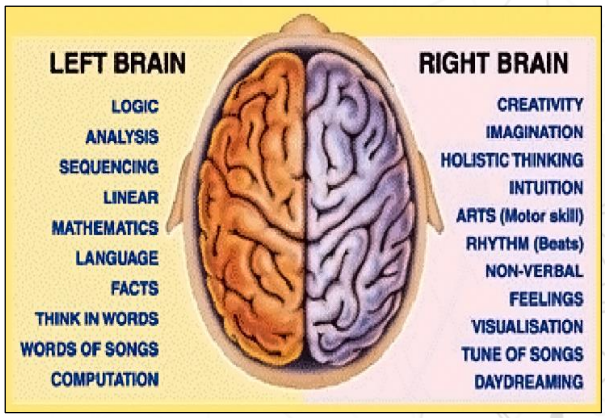
Left Hemispheric Deficit

- They like to draw pictures.
- They enjoy music.
- Difficulty initiating a response without prompting.
- Inappropriate syllable stress
- Deficits in the retrieval of verbal material
- Dysphonia
- Dysprosody
- Stuttering
- Persistent non-fluency
- Disturbance of syntactic function and agrammatism (Nadeau, 1988).
- Transcortical motor aphasia (TMA)Wernicke (1886)



28

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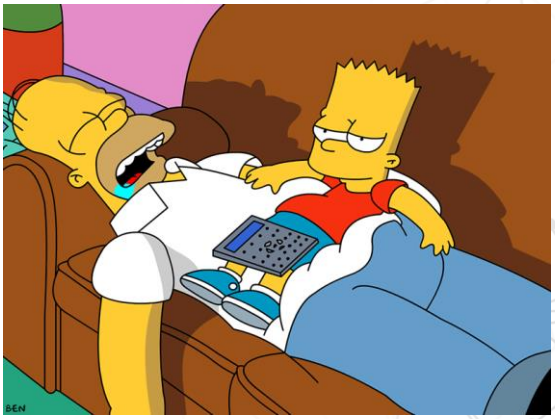
Left Hemispheric Deficit

- Slow or lack of movement.
- Hypoactivity.
- Inability to start an inactivity without prompting.
- Poor fine motor coordination.
- Poor hand writing.
- Pyramidal weakness on the left side.
- Pyramidal weakness is defined a weakness of the left facial muscles.



29

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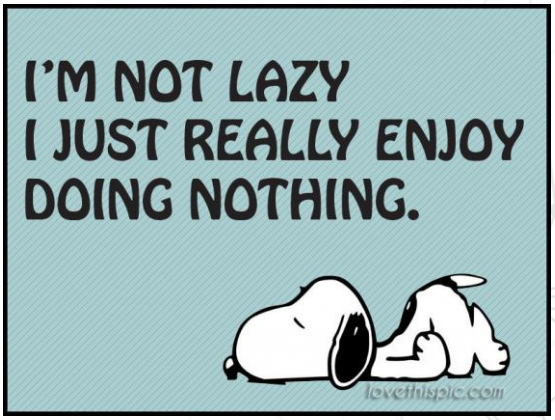
Left Hemispheric Deficit

- Chronic infections in general.
- Prone to tumors or cysts.
- Chronic ear infections.
- Poor immune system.



30

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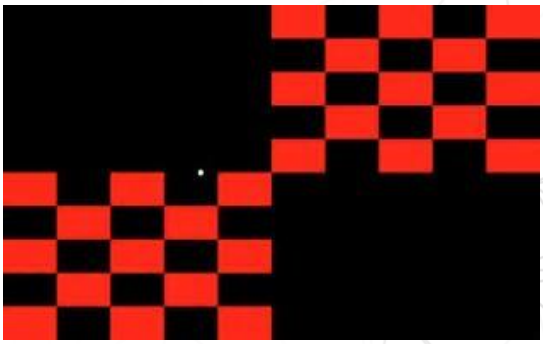
Computer Applications

For Hemispheric Consideration

Hemi-Stim Program

- Hemi-Stim Program
- Right Brain Settings
  - Parietal Lobe:
    - Large squares
    - Low contrast between colors.
    - Blue/Green/Grey color shades
    - Rapid change between colors
  - Temporal Lobe:
    - Small Squares
    - High contrast between colors
    - Blue/Green/Grey color shades
    - Slow change between colors



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Hemi-Stim Program

- Hemi-stim Program
- Left Brain Settings
  - Parietal Lobe:
    - Large squares
    - Low contrast between colors.
    - Red/Yellow/Orange color shades
    - Rapid change between colors
  - Temporal Lobe:
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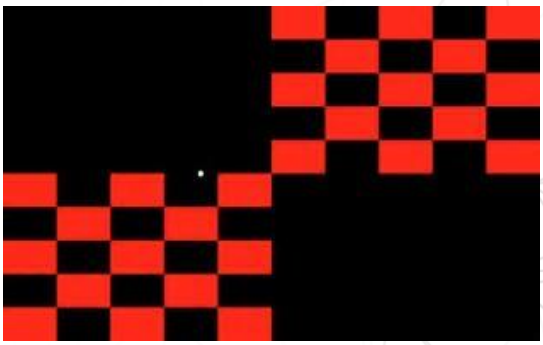

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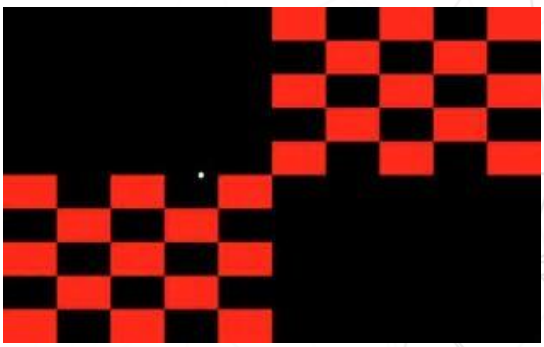
Hemi-Stim Program

- Best utilized in concert with other modalities.
- You can couple it with:
  - Figure Eight Exercises
  - Electrical Stimulation
  - Traction
  - Cold Laser



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Mind Games

- Good Windows App
- Provides a lot of different variety of games that can be used to exercise different areas of the brain.
- Games:
  - Attention Training: Prefrontal Cortex
  - Math Operations: Semantic Memory (Temporal Lobe)
  - Mirror Images: Parietal Lobe
  - Face Memory: Right Parietal

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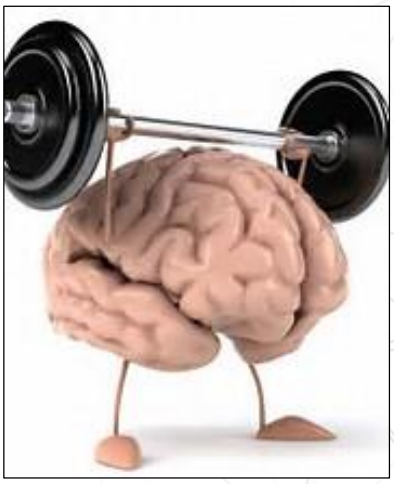
Brain Training App

- Windows based app
- Good for parietal and temporal lobe integration



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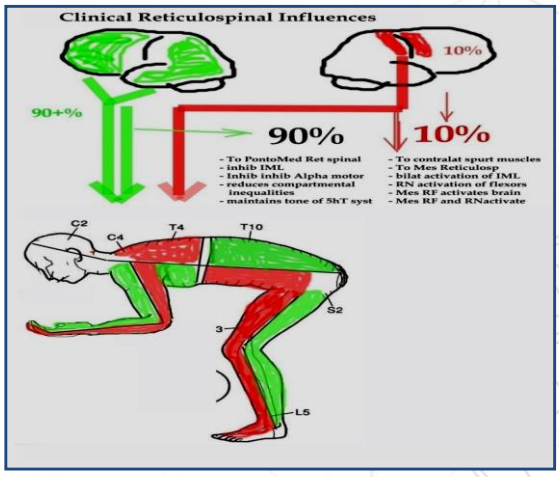
Upper Extremity Adjustments

For Pyramidal Weakness

Pontomedullary Reticulospinal Output:

- Increases spindle sensitivity ipsilaterally
- Inhibits anterior compartment muscles above T6 ipsilaterally
- Inhibits posterior compartment muscles below T6 ipsilaterally



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Pyramidal Weakness

- General idea is that you want to decrease the tone of the anterior group musculature in the upper extremity on the side of hemisphericity and the posterior group musculature on the side opposite the hemisphericity.
- This is done by augmenting tendinous load thus taking advantage of the reflexogenic 1B integration.
- Tendinous load is can be augmented under the following scenarios:
  - Loading the muscle in a lengthened state
  - Loading the muscle quickly
  - Decreasing the amount of protein in the muscle
  - Resisted pre-contraction of the muscle.

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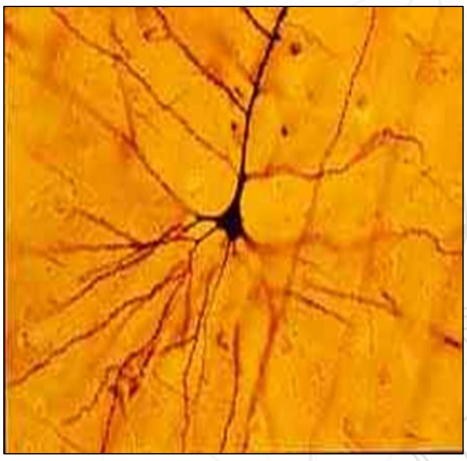
Pyramidal Weakness

- Since the musculature of the upper extremity with regards to anterior group and posterior group have different representations in the brain the effect of these adjustments will not be the same from side to side.
- It is important to note the anterior group musculature of the upper extremity has a far greater representation in the brain then the posterior group musculature.
  - Thus decreasing the tone of the anterior group musculature will have a greater influence on the brain then the posterior group musculature.
- These adjustments are commonly referred to as “Fast Stretch” adjustments
- Their post manipulative effects are to decrease group 1a/II integration centrally.



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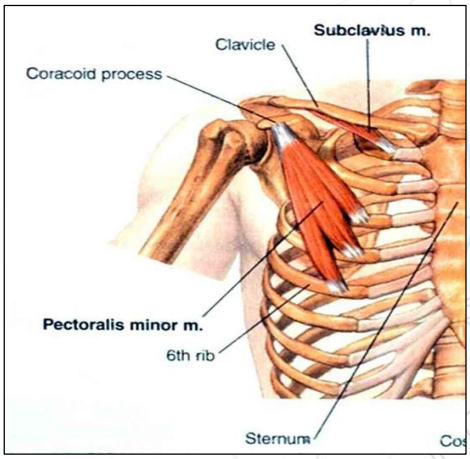
Fast Stretch
Pec Minor & Sub-Clavius Muscle

- Indications:
  - Ipsilateral to the side hemisphericity
  - Decreased posterior rotation of the clavicle on arm abduction
- Patient Placement:
  - Standing or sitting (Doctors preference)
- Doctors Position:
  - Behind the patient with the involved arm in a "Half Nelson" position
- Contact Point:
  - Doctors hand threads up under the patients forearm
  - Doctor the brings the forearm down and medial so that the doctors thumb lays across the inferior lateral aspect of the clavicle.
- Stabilizing Hand:
  - Reaches over the patient form the opposite side to be placed on the patients flexed elbow
  - Promotes posterior line of correction
- Line of Correction:
  - Posterior/superior



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Cervical & SC Joint Coupled Adjustment

- Indications:
  - Restricted positive z-translation on the side of hemisphericity.
  - SCM & Scalene myospasm
  - TOS
  - Cervical Radiculopathy
  - SC Joint fixation
- Patient Placement:
  - Side Posture with involved side.
- Contact Point:
  - Lateral aspect of neck-facet joint on the restricted segment.
  - Index and third finger on the medial aspect of the clavicle on the downside SC joint
- Stabilizing Hand:
  - Lateral aspect of neck contralateral to the contact hand
  - Index and third digits split SCM
- Line of Correction:
  - Lateral to medial with coupled theta y rotation
  - Stabilizing hand applies long axis traction to the cervical spine.

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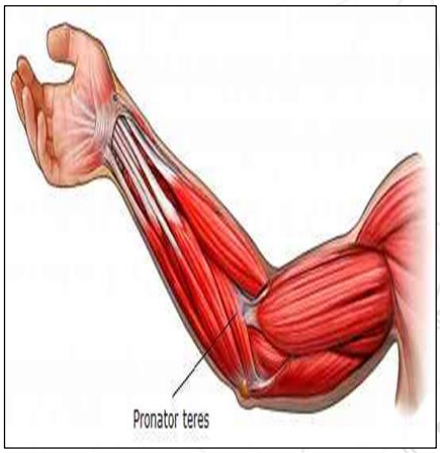
Pronator Teres

- Indications:
  - Ipsilateral to the side hemisphericity
  - Pronator Teres Syndrome
- Patient Placement:
  - Standing or seated (Doctors Preference)
- Doctors Position:
  - Offset laterally to the patient
- Contact Point:
  - Index finger over the pronator teres muscle
- Stabilizing Hand:
  - Distal forearm applying supination with long axis traction
- Line of Correction:
  - For the hand over the pronator the line of correction is from distal to proximal.
  - For the stabilizing hand the line of correction is proximal to distal with supination
- Note:
  - This is a coupled adjustment requiring the coordination of both hands.



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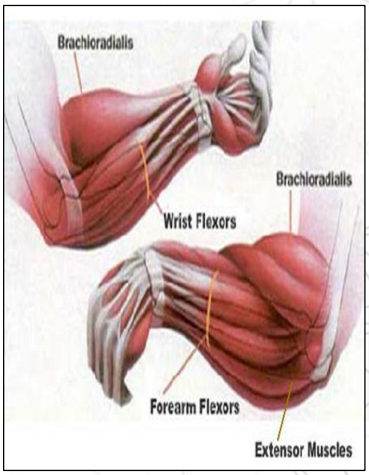
Fast Stretch Carpal Flexors

- Indications:
  - Ipsilateral to the side hemisphericity
  - Carpal tunnel
  - Wrist joint dysfunction
- Patient Placement:
  - Standing or sitting (Doctor's preference)
- Doctors Position:
  - Distal aspect of the patients wrist
- Contact Point:
  - Dorsal aspect of the proximal row of carpals with the doctor's thumbs while the doctor's index fingers wrap around to the volar surface and contact the distal row of carpals.
- Stabilizing Hand:
  - Non- applicable in this adjustment
- Line of Correction:
  - With the Thumbs:
    - Dorsal to Volar/Distal to Proximal
  - With the Index Fingers
    - Proximal to distal promoting long axis.



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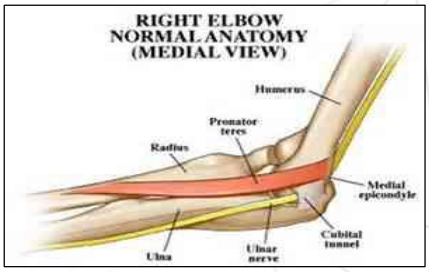
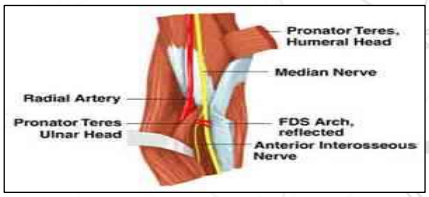
Adjustments for Median/Ulnar Nerve Entrapments At The Elbow

- The basic premise is that the contacts are similar to that which is used to fast stretch the pronator teres and or flexor carpi-ulnaris muscles.
- The main difference is in the contact point.
- The doctor want his or her contact point right over the area of the nerve that is being entrapped.
- The correction is such that the examiner is attempting to free the nerve from fibrous adhesions.
- A good analogy to visualize is the gluing of two pieces of would together and before the glue sets you realize you made a mistake and attempt to pry the two pieces of wood apart.
- The gooey glue connections that form when the wood pieces are being pried apart is analogous to the fibrous adhesions restricted motion of the nerve.
- It is those fibrous adhesions that these manipulations break resulting in a release of the nerve.





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Use of Pre-contraction in Adjusting

- Pre muscular contraction just prior to the manipulative event is a great way to increase the load of the muscular tendons being eccentrically loaded during a manipulative event.
- As the load on a muscular tendon increases the rate of group 1B afferent fiber firing also increases.
- The central effect is that the increased firing from the 1B afferents of the muscle being eccentrically loaded with further pre-contraction is a greater inhibitory barrage to that muscle.
- This results in the practitioner requiring less effort to overcome the series elastic elements shunt stabilizing force.
- This allows for easier joint cavitation requiring less force and a overall greater central 1B afferent integration.

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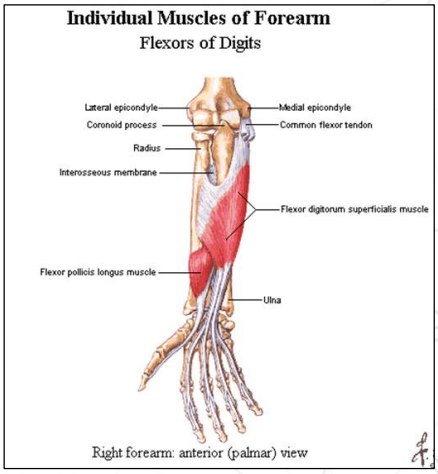
Fast Stretch Finger Flexors

- Indications:
  - Ipsilateral to the side hemisphericity
- Patient Placement:
  - Standing or sitting (Doctor's preference)
- Doctors Position:
  - Distal aspect of hand
- Contact Point:
  - Index/3rd finger at the middle interphalangeal joint
- Stabilizing Hand:
  - Wraps around dorsal surface of wrist
- Line of Correction:
  - Long axis with extension.



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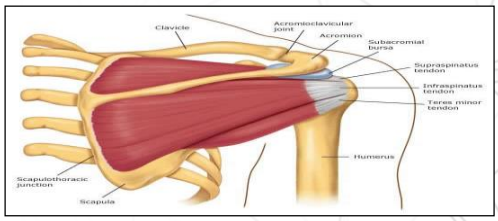
Fast Stretch Rotator Cuff

- Indications:
  - Side opposite hemisphericity
  - Shoulder fixations
  - Impingement syndromes
- Patient Placement:
  - Standing or seated (Doctor's Preference)
- Doctors Position:
  - Behind the patient offset to the side of the shoulder being adjusted.
- Contact Point:
  - Both hands reach around the patient and cup the elbow when the arm is flexed to 90 degrees, adducted and the elbow flexed to past 90 degrees
- Stabilizing Hand:
  - Not applicable in this case
- Line of Correction:
  - Anterior to posterior and medial to lateral



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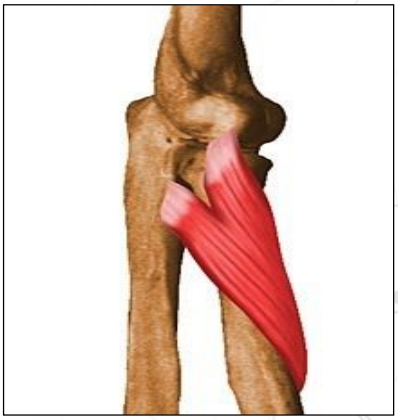
Fast Stretch Supinator

- Indications:
  - Side opposite hemisphericity
  - Supinator syndromes
- Patient Placement:
  - Standing or seated (Doctor's preference)
- Doctors Position:
  - Offset lateral to the patient's forearm
- Contact Point:
  - Proximal hand thumb contact on the radial head
- Stabilizing Hand:
  - Wrist promoting pronation
- Line of Correction:
  - Lateral to medial of the thumb on the radial head promoting pronation.



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Scapular Winging in Pyramidal Weakness

- This is a common finding often associated with cortical hemisphericity.
- It is seen most often on the side of the decreased cortical output. i.e. on the side of hemisphericity.
- It can lead to a host of should issues as the shoulder becomes more unstable as the scapular winging progresses.
- An effective way to correct for problem is to:
  - Decrease the tone of the antagonistic muscles on the ipsilateral side.
  - Prescribe strengthening exercises to the side of involvement in such a way that the muscle is exercised in a shortened ROM and in a more concentric fashion.
  - The opposite Rhomboid can be exercises in a more lengthened range.

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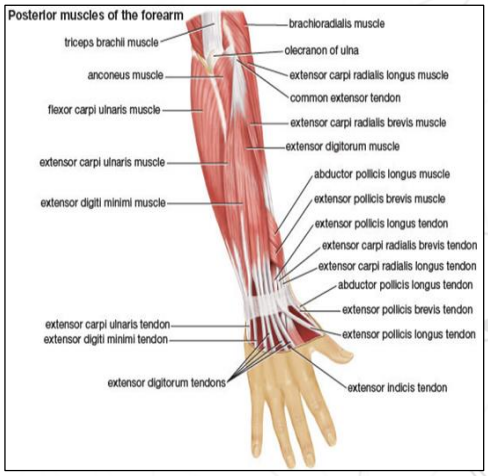
Fast Stretch Wrist Extensors

- Indications:
  - Side opposite hemisphericity
- Patient Placement:
  - Standing or seated (Doctor's preference)
  - Forearm fully supinated
- Doctors Position:
  - Distal end of hand
- Contact Point:
  - Two thumbs on the volar surface of the wrist contacting the proximal row of carpals
  - Index fingers supporting the distal end row of carpals on the dorsal surface of the wrist
- Stabilizing Hand:
  - Not Applicable
- Line of Correction:
  - Anterior to posterior with coupled long axis traction at the wrist.



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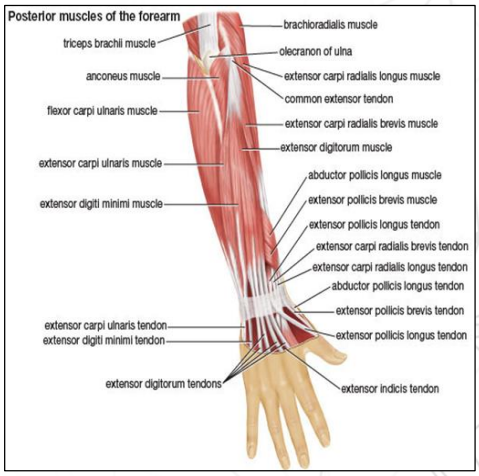
Fast Stretch Finger Extensors

- Indications:
  - Side opposite hemisphericity
- Patient Placement
  - Standing or seated (Doctor's preference)
  - Forearm fully supinated
- Doctors Position:
  - Distal end of hand
- Contact Point:
  - Middle aspect of the metacarpals between the doctor's index and middle 3rd fingers.
- Stabilizing Hand:
  - At the wrist apply flexion and distal to proximal traction
- Line of Correction:
  - Long axis traction



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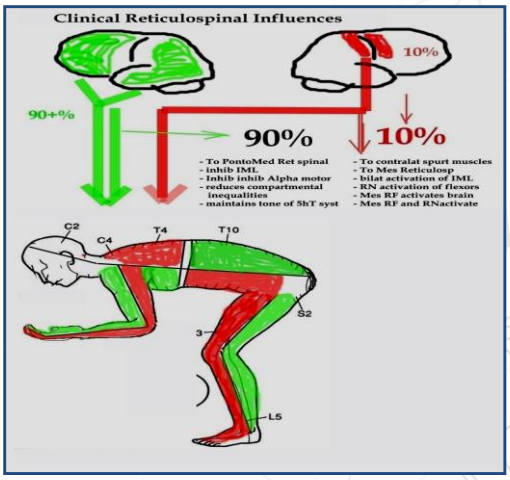
Lower Extremity Adjustments

For Pyramidal Weakness

Pontomedullary Reticulospinal Output:

- Increases spindle sensitivity ipsilaterally
- Inhibits anterior compartment muscles above T6 ipsilaterally
- Inhibits posterior compartment muscles below T6 ipsilaterally



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Fast Stretch Distal Hamstring

- Indications:
  - Side opposite hemisphericity
- Patient Placement:
  - Supine with the knee flexed to 90 degrees and the ankle on the doctors shoulder
- Doctors Position:
  - Offset laterally to the patient
- Contact Point:
  - This adjustment utilizes post contraction of 1b homonymous muscle inhibition
  - Patient contract hamstring to flex the knee against the doctors shoulder for a count of 3.
  - At the moment of relaxation the doctors rapidly extends the knee.
  - The sequence is repeated 3 times with the hip in greater flexion on each repeat.

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Fast Stretch Distal Quadriceps

- Indications:
  - Ipsilateral side of hemisphericity
- Patient Placement:
  - Supine
- Doctors Position:
  - Lateral to patient on the affected side
- Contact Point:
  - Two hand contact
    - Proximal hand to patient under the knee in the popliteal fossa
    - Distal hand on the anterior aspect of the distal tibia
- Stabilizing Hand:
  - Not applicable
- Line of Correction:
  - To lines of Drives occur in this adjustment:
    - Proximal hand promotes long axis at the popliteal fossa
    - Distal hand promotes rapid flexion of the knee in essence promoting a pivoting motion about the index finger in the popliteal fos

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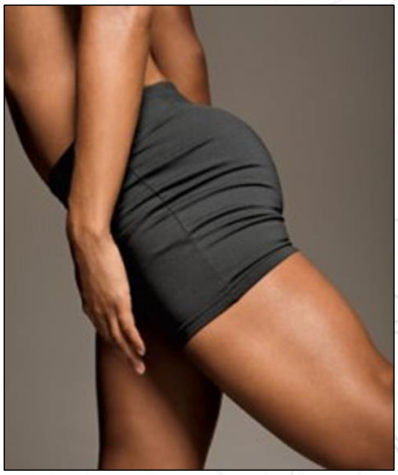
Fast Stretch Gluteal Musculature & Piriformis (Side Posture)

- Indications:
  - Ipsilateral side of hemisphericity
  - Sacroiliac Syndromes
  - Piriformis Syndromes
  - Sciatica
- Patient Placement:
  - Side Posture with affected side up
- Doctors Position:
  - Facing the patient
- Contact Point:
  - Proximal forearm over the glute musculature
- Stabilizing Hand:
  - Anterior shoulder
- Line of Correction:
  - Internal pelvis rotation with flexion at the SI joint



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Fast Stretch Gluteal Musculature & Piriformis (Supine/Toggle Board)

- Indications:
  - Ipsilateral side of hemisphericity
  - Sacroiliac Syndromes
  - Piriformis Syndromes
  - Sciatica
- Patient Placement:
  - Supine with affected side hip flexed to 90 degrees and adducted.
- Doctors Position:
  - Opposite side of the affected hip
- Contact Point:
  - Distal hand of the doctor on the patient's greater trochanter
- Stabilizing Hand:
  - Proximal hand of the doctor on the patient's knee
- Line of Correction:
  - Medial to lateral and anterior to posterior.

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Fast Stretch Gluteal Musculature & Piriformis (Supine/Long Axis Traction)

- Indications:
  - Ipsilateral side of hemisphericity
  - Sacroiliac Syndromes
  - Piriformis Syndromes
  - Sciatica
- Patient Placement:
  - Supine
- Doctors Position:
  - Distal aspect of foot on the affected side
- Contact Point:
  - Two handed contact on the dorsum of the foot approximately at the level of the talus and transverse tarsal joint
- Stabilizing Hand:
  - Not applicable
- Line of Correction:
  - Prior to thrust doctor applies approximately 30 degrees of hip flexion with internal rotation
  - Line of correction is long axis traction to the hip.

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Fast Stretch Proximal Quadriceps & Psoas Muscles

- Indications:
  - Opposite side of Hemisphericity
- Patient Placement:
  - Prone
- Doctors Position:
  - Offset laterally to patient
- Contact Point:
  - This adjustment utilizes post contraction of 1b homonymous muscle inhibition.
  - The knee rests on the doctors thigh while the doctors distal hand wraps around the medial anterior aspect of the knee
  - The doctors proximal hand is placed over the SI joint promoting extension
  - The patient contracts downwards against the doctors thigh for a count of 3.
  - Upon relaxation the doctor pulls up on the knee with the distal hand and pushes down at the SI joint with the proximal hand thus effectively extending the hip.
  - This sequence is repeated 3 times with each time the hip extended more.

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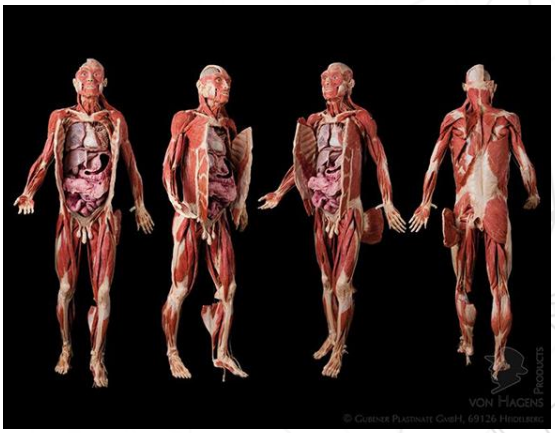
Summary of Extremity Adjusting For A Left Hemisphericity

- Fast Stretch Right Rotator cuff
- Fast stretch Right Supinator
- Fast Stretch Right Wrist Extensors
- Fast Stretch Left finger Flexors
- Fast Stretch Left Wrist Flexors
- Fast Stretch Left Pronator
- Fast Stretch Left Subclavius
- Fast Stretch Left Piriformis/Gluteus
- Fast Stretch Left Distal Quadriceps
- Fast Stretch Left Glute
- Fast Stretch Right Proximal Quadriceps
- Fast Stretch Right Distal Hamstring



See Video Demonstration

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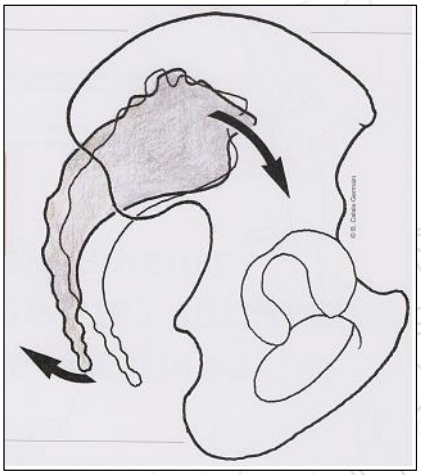
Sacral Self Bracing

Implications in Rehab

Self Bracing

- Nutation of the sacrum is critical.
- Can be viewed as a primary movement in the pelvis to prepare the pelvis for increased loading.
- It is accomplished by tightening most of the SIJ ligaments.



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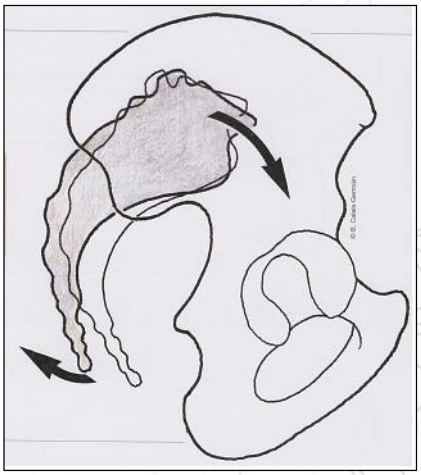
Self Bracing

- Two major ligaments come into play:
  - Long Ligament:
    - Connects the sacrum to the PSIS
    - Decrease tension promotes nutation while increased tension prevents counter nutation
    - Tension is seen to decrease with:
      - Ipsilateral Gluteus Maximus Contraction
      - Contralateral LD contraction
      - Contraction of the multifidus muscle
    - Tension is seen to increase with ipsilateral erector spinae contraction
    - Pain along the long ligament suggests ipsilateral sustained SIJ counter nutation.
  - Sacrotuberous Ligament:
    - Connects the sacrum to the ischial tuberosity.
    - Increase tension prevents nutation while decreased tension promotes counter nutation
    - Biceps femoris contraction increases tension



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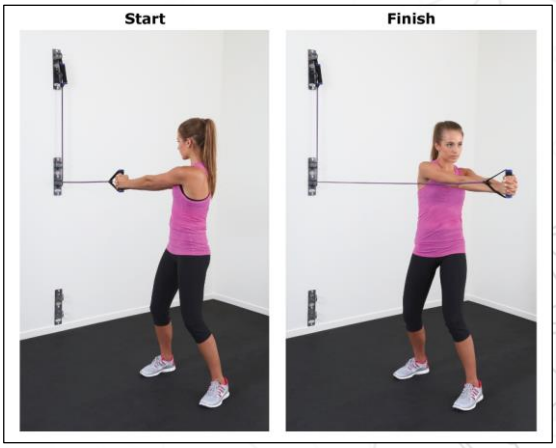
Truncal Rotation

- During left truncal rotation the following muscle recruitment pattern is considered normal:
  - The left LD is more active then the right
  - The right GM is more active then the left.
- Patient with SIJ pain have a different pattern:
  - On the side of pain the ipsilateral GM is more active on the side of truncal rotation then the contralateral one as seen in normal subjects.
  - Example: With Left SIJ pain you will see on left truncal rotation more activity of the left GM then the right which again is a reverse of the normal pattern



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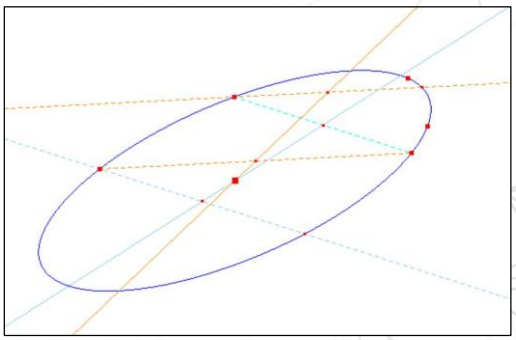
Postural Ellipse & Sacral Bracing

- Examine the anterior and posterior direction of sway in combination of right and left directions.
- For example if the ellipse of sway has its axis pointed right anterior and left posterior that suggests increases muscle tone in the:
  - Right anterior group above T-6 and left posterior group below T-6
  - The apposing muscle groups will be weak:
    - Left anterior above T-6
    - Right Posterior below T-6
- Since the GM contributes more to the sacral bracing mechanism then the LD one would find the mechanism failed on the side of weak glute maximus or on the direction opposite the posterior direction of the ellipse.
- In this example on the right side.



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Gait & Sacral Bracing

Functional Hallux Limitus

- Represents the complete locking of the primary sagittal plane of the first MTP joint during all or portions of the single support phase of gait.
- This occurs despite the full ROM of this joint in non weight bearing.
- The manifestations often occur in areas that must compensate for the failure of this joint to provide the motion necessary for forward body progression

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Functional Hallux Limitus Hip Extension

- The most evident marker for the presence of FHL is the loss of ipsilateral hip extension.
- During normal gait the hip will extend about 15 degrees by the end of the single support phase this allows the following to occur.
  - Permits the torso to remain erect.
  - Allows the thrust of the foot against the supportive surface
  - Positions the limb appropriately so it can be lifted for the next swing phase.
    - Important as the weight bearing limb makes up for about 15% of ones total body weight.
    - Results in a large mechanical load for the body to deal with
  - Closes the angle between the posterior aspect of the thigh and the ischial tuberosity of the weight bearing limb
    - Anterior ilium rotation dependent on biceps femoris tension as increased tension reduces this.
    - Failure of the hip to extend causes the angle between the posterior thigh and ischial tuberosity to open tensing the biceps. This is made worse with compensated torso flexion.
    - If bad enough the ilium will rotate posteriorly thus increasing the tension on the sacrotuberous ligament resulting in sacral counter nutation a failure of the motion needed for the pre-swing phase.
  - Note:
    - Patients with chronic low back pain often have very tight hamstrings that do not respond to stretching.


Figure 2

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Failure of Hip Extension

- When failure of the load bearing hip to fully extend in the late stance period, the ability to create the next swing phase is compromised.
- A common compensation is that patient will commonly laterally bend their torso's away from the side of restriction.
- This involves contraction of the contralateral gluteus maximus and contralateral quadratus lumborum muscles.
- This results in a lateral trunk rotation away from the restricted side thus attempting to "drag" the trailing limb into the swing phase.

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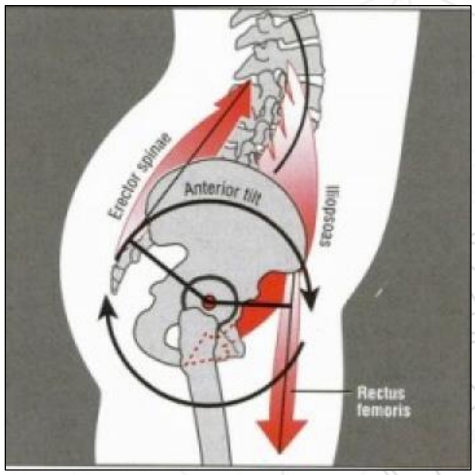
Associated Conditions of Anterior Rotated Ilium

- Ipsilateral SI joint pain radiating caudally and rostrally.
- Reduced tension of the iliolumbar ligaments increasing shear stress at L4-S1.
- Makes the ipsilateral leg appear longer.
- Biceps femoris muscle is stretched which may contribute to the recurvatum of the knee.
- Psoas as muscle is stretched as well as the spinal nerves.
- Note:
  - The sensory roots are more susceptible then the motor roots.
  - Total mechanical block can occur with at least 15% elongation.
  - Stretching the psoas is counterintuitive because it also results in anterior rotation of the ilium.
- Abdominal pain at Baer's Point:
  - Located when drawing a line from the umbilicus out to the ASIS.
  - Pain at this point is often confused as:
    - Appendicitis
    - Ovarian Pain



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Common Maladies Associated With Asymmetrical Overload Syndrome (AOS)

FPA

- In left frontal plane asymmetry (FPA):
  - Pelvis drops to the left
  - Lumbar spine side bends to the right
    - Increases the compressive loads on the right
    - Increases the tensile loads on the left.
    - The ipsilateral knee undergoes valgus stress
    - The contralateral knee undergoes varus stress
    - The ipsilateral foot pronates
    - The contralateral foot supinates

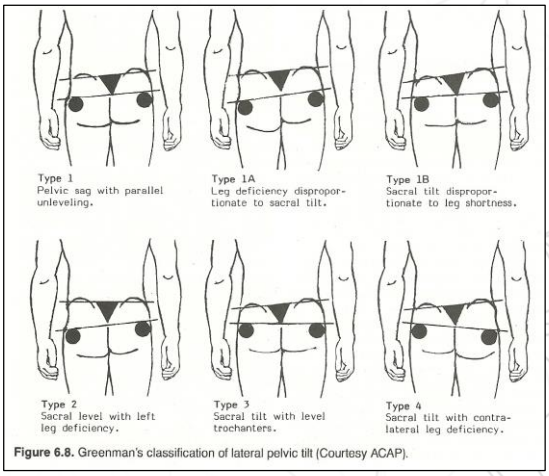

Figure 6.8. Greenman's classification of lateral pelvic tilt (Courtesy ACAP).

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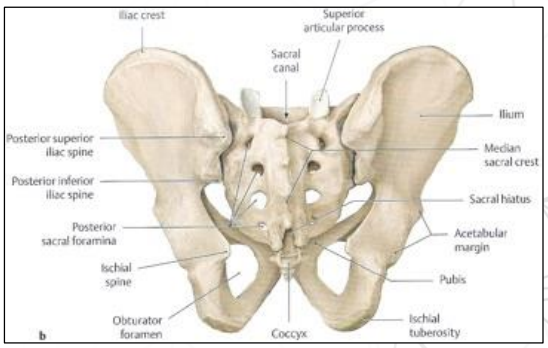
FPA: SIJ Changes

- As the pelvis drops on the left the right SIJ becomes more vertical and is subjected to greater shear stress.
- The ipsilateral SIJ becomes more horizontal and is subjected to more compressive stress.
- Pain is most commonly seen on the long leg side or on the side of "shear stress" suggesting that shear force as a greater negative consequence then compressive stress.



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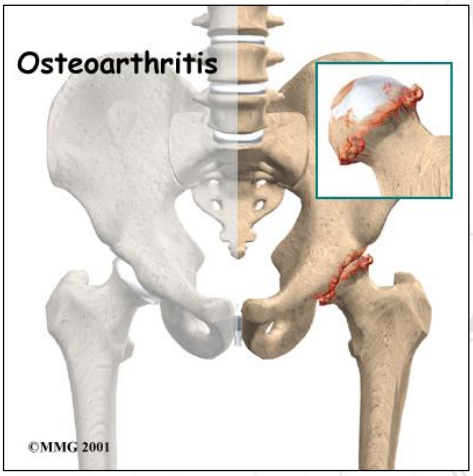
Hip Joint Changes: Left FPA

- Osteoarthritis:
  - Right femur is adducted and the left femur is abducted.
  - Results in an increased bending moment over the left hip and an increased compressive moment over the right hip.
  - There appears to be more degeneration on the long length or adducted hip side.
- Greater Trochanter Bursitis:
  - Located just under the aponeuroses of the gluteus maximus muscle.
  - Increased compressive stress to the bursa is seen on the long leg side (right) as the pelvis tilts down on the left resulting in the right femur being in a more adducted position.



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Piriformis Syndrome

- Described as a persistent tenderness and irritation at the mid buttock region.
  - Note:
    - The name may be a misnomer naming the exact painful tissue
    - Rather it is used to depict tensile overuse syndromes of the deep rotators and abductors of the hip
- Seen on the long leg side (right) as the right femur enters a more adducted position.

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Iliotibial Band Friction Syndrome

- Often results in lateral knee pain.
  - Easily diagnosed because of the specific point tenderness at the lateral distal femur that radiates both distal and proximally.
  - Can be seen during gait when one observes the sacrum drop down and away from the weight bearing limb during heel strike at a greater rate and amount on the other side:
    - Left FPA left side drops more than the right on left heel strike.
    - This results in left knee valgus stress and right knee varus stress
  - Thus the syndrome is often seen on the long leg side
  - In the case of left FPA the Iliotibial Band Syndrome would be seen on the right
- Note:
  - Due to the increased varus stress at the knee on the long leg side the medial knee joint can be excessively compressed resulting in medial knee pain.

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Yaw Preferencing and FPA

Determining Yaw Preferencing By Observing Horizontal Eye Correction.

- Have the patient close there for about 5 seconds
- Have the patient then open their eyes looking straight ahead.
- The examiner observes the direction of the saccade that re-fixates the eyes to center.
- Interpretation:
  - The direction from which eyes come from if contributory will be from the opposite side of yaw preference.

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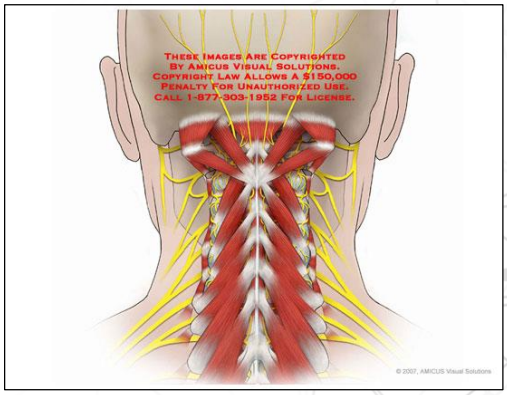
Determining Cervical Spine Contribution to Yaw Preferencing

- Primarily deals with the effects of:
  - The alterations in tone of the sub occipital musculature.
    - Such that increase in tone of the left sub-occipital group results in a preference for right eye deviation and or left head deviation. "Left Yaw" preference
  - The differences in tone of the intertransversarii and multifidus group and there linkage to the lateral rectus and medial recti muscle of the eye respectively.
    - Such that increased tone of the right intertransversarii and left multifidus will result in increased tone of the right lateral rectus and left medial rectus which will lead to right horizontal eye deviation and or left yaw of the head.
- To differentiate between the two use vertical saccade testing as described in the previous slide with combined head rotation:
  - If the amplitude of the refixation saccade increases with ipsilateral head rotation to the initial direction of the saccade it suggests yaw preferencing secondary to ipsilateral sub-occipital splinting.
  - If the amplitude of the refixation saccade increases with contralateral head rotation to the initial direction of the saccade it suggests yaw preferencing secondary to contralateral intertransversarii and ipsilateral multifidus muscle splinting.



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Correcting Yaw Preferencing

- If the Yaw preferencing is due to:
  - Sub occipital Muscle Splinting:
    - Adjust to fast stretch the sub occipitals on the side of the direction of the re-fixation saccade.
  - Intertransversarii and multifidus Muscle Splinting:
    - Adjust vertebra in the cervical spine that have lost z translation on the side opposite the direction of the refixation saccade.

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Alternate Method For Determining Yaw Preferencing

- One can use the presence of gaze evoked nystagmus in the extreme positions of gaze as a test for muscle tone asymmetry between the right and left lateral and medial recti muscles.
- Extreme Horizontal gaze normally produces nystagmus in the direction of the gaze which are commonly referred to as “Nystagmoid Jerks”
- These are considered to be normal.
- The clinician can utilize the difference in the amplitude of the gaze evoked nystagmus from side to side to determine tonus asymmetry in the eyes that may be due to a yaw preference of the head and or cervical spine.
- The general idea is that the amplitude of the gaze evoked nystagmus is in part due to the tone in the muscles that are stretched on horizontal gaze.
  - i.e. We are testing how much the eyes get pulled off of the fixation spot secondary to the elastic qualities of the eye muscles being stretched.
  - The degree to which the eyes drift off the target is partly related to the elastic qualities of the eye muscles being stretched which is in part due to there tone.

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Alternate Method For Determining Yaw Preferencing

- Eg:
  - There is an observed increased amplitude of gaze evoked nystagmus while looking to the right.
    - This suggests greater tone in the right medial rectus and left lateral recti muscles.
    - This can be secondary to:
      - Right sub-occipital muscle splinting
      - Left intertransversarii and right multifidus splinting.
    - To differentiate the two turn the head to the right and or left and check to see if either direction gives you an increase in the amplitude of the gaze evoked nystagmus to the right.
  - Interpretation:
    - If the degree of right beating gaze evoked nystagmus increases on right head turn then it suggests ipsilateral sub occipital muscle splinting.
    - If the degree of right beating gaze evoked nystagmus increases on left head turn then it suggests ipsilateral multifidus muscle splinting and contralateral intertransversarii muscle splinting.
  - Adjustments:
    - Same as stated earlier.

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Yaw Preference & its Relationship To The Postural Ellipse

- Imbalance in the pairing of the activity of the anterior and posterior canals as a result of yaw preferencing will result in a postural ellipse in the direction opposite of yaw preference:
- I.e.
  - Right yaw preference is observed.
  - This will result in plasticity in the activation of the left anterior and right posterior canals.
  - As a result of this the brain must compensate by increasing the tone of the muscles in the opposite paired canals: I.e. The right anterior and the left posterior
  - This results in a ellipse directed right anterior and left posterior.
- With regards to force closure failure the patient will most likely have a failure on the right in this example secondary to a failure of the right gluteus maximus to recruit.

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Yaw Preferencing & FPA

- This results secondary to postural disturbances in the neck and pelvic rotatory compensations.
- Example using Left Yaw preference:
  - Head is turned to the left and the eyes turn to the right to compensate.
  - The neck below C2 and the upper torso above T6 turn to the right.
  - The lumbar spine and lower torso turns to the left to compensate.
  - This creates a Left FPA:
    - Left Ilium rotated posterior: Short Leg
    - Right Ilium rotated anterior: Long leg
- Therefore FPA is often seen with ispilateral yaw preferencing in the neck.

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Lumbopelvic & Lower Extremity Adjustments For Left FPA

- Pelvis
  - Left SIJ Adjust into extension
  - Right SIJ adjust to flexion
- Lumbar Spine:
  - Left side up fast stretching right intertransversarii and right multifidus.
  - This will reduce the compression of the right sided facet joints.
- Lower Extremity:
  - Right Side: (Long Leg Side)
    - Fast stretch external hip rotators (for femur external rotation)
    - Adjust femur/tibia with femur in internal and tibia in external rotation with valgus stress
    - Ankle mortise A-P glide.
    - Calcaneus lateral –medial glide
  - Left Side: (Short leg side)
    - Fast Stretch Internal Hip Rotators (for femur internal rotation)
    - Adjust femur/tibia with femur in external and tibia in internal rotation with varus stress
    - Calcaneus medial to lateral glide

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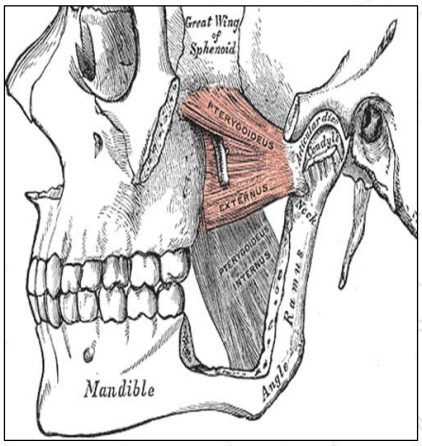
JAW DYSFUNCTION YAW PREFERENCE & FPA

Lateral Pterygoid Function

- Primary function of the lateral pterygoid muscle is to pull the head of the condyle out of the mandibular fossa to protrude the mandible.
- Unilateral action of a lateral pterygoid produces contralateral excursion
  - Usually performed in concert with the medial pterygoid.
- Unlike the other three muscles of mastication, the lateral pterygoid is the only muscle of mastication that assists in depressing the mandible.



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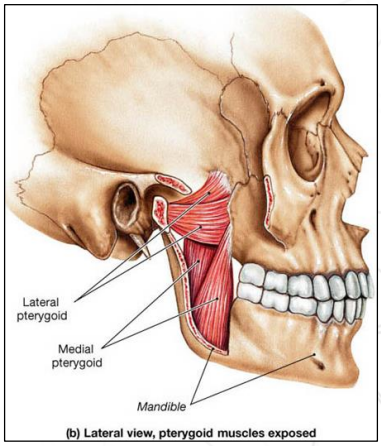
Medial Pterygoid

- Functions include:
  - Elevation of the mandible (closes the jaw)
  - Minor contribution to protrusion of the mandible
  - Assistance in mastication
  - Excursion of the mandible:
    - Contralateral excursion occurs with unilateral contraction.
    - Works in concert to the action of the lateral Pterygoids.



(b) Lateral view, pterygoid muscles exposed

Anatomy

- All muscles are supplied by the trigeminal nerve.
- *Bilateral* cortical representation is seen
- Thus a central lesion no matter how large, is unlikely to produce any observable deficit.
- Thus Jaw deviation will occur in conditions that facilitate asymmetry in the motor nuclear output from one side to another.
- As a rule the Jaw will deviate to the side of weakness in output.

Practicum
Central Mediated Jaw Deviation

- Have the patient lie supine
- Examiner observes the lateral deviation of the jaw on initial opening.
- The examiner then instructs the patient to hold right and left lateral gaze while having the patient open their mouth.
- Each time observing any changes in the degree and or direction of lateral jaw deviation.
- Interpretation:
  - No change:
    - Suggests biomechanical fixation on the side of deviation.
  - Decreased deviation with contralateral gaze:
    - Suggests ipsilateral cortical axis of influence
  - Decreased deviation with ipsilateral gaze:
    - Suggests ipsilateral cerebellar axis of influence

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Practicum
Cervical Mediated Jaw Deviation

- This mechanism is based on the principle that the *intertransversarii* muscles are linked to the ipsilateral PMRF and the multifidus to the ipsilateral mesencephalon
- Have patient sit and open jaw.
  - Observe initial lateral deviation.
  - Observe changes in jaw deviation upon right and left head rotation
- Interpretation
  - Changes in jaw deviation upon head rotation suggest cervical influence
- Example:
  - If one sees left jaw deviation that is increased with right head rotation and decreased with left.
    - This suggests dominance in the right *intertransversarii* and left multifidus.
    - To correct the examiner will manipulate the vertebra in the cervical spine with a loss of right z-translation. Or a coupled reduction on the side of Jaw deviation.
  - If one sees left Jaw deviation that is increased with left head turn:
    - This suggests a mechanism influenced through the lateral rectus and medial rectus muscle s and their linkage to the left sub occipital muscles
    - To correct for this the examiner will fast stretch the sub occipital on the right.
- Note:
  - Most times the examiner will also have to manipulate the Jaw on the side of deviation to reduce the spindle influence on promoting the muscular asymmetry.

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Jaw Deviation Influences on FPA Left FPA

- The jaw will most likely deviate opposite the yaw preferencing in the neck regardless if it is due to:
  - Ipsilateral Intertransversarii splinting or contralateral sub occipital muscle splinting.
- The following will bee seen:
  - Right jaw deviation
  - Left Upper cervical spine rotation
  - Right torso rotation—right lower cervical rotation
  - Left lower torso rotation
    - Left posterior ilium rotation (Short Leg)
    - Right anterior ilium rotation (Long Leg)
- Results in a left FPA

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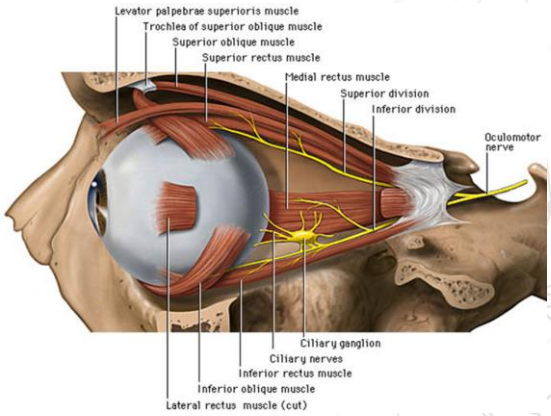
Ocular Motility & Reflexes

Ocular Movement

- 3 cranial nerves are responsible for the eye movements we observe.
  - CN III, IV, and VI
- They innervate 6 Ocular Muscles
- There exists mechanical advantages for specific movements of the extrocular muscles in Abduction and Adduction



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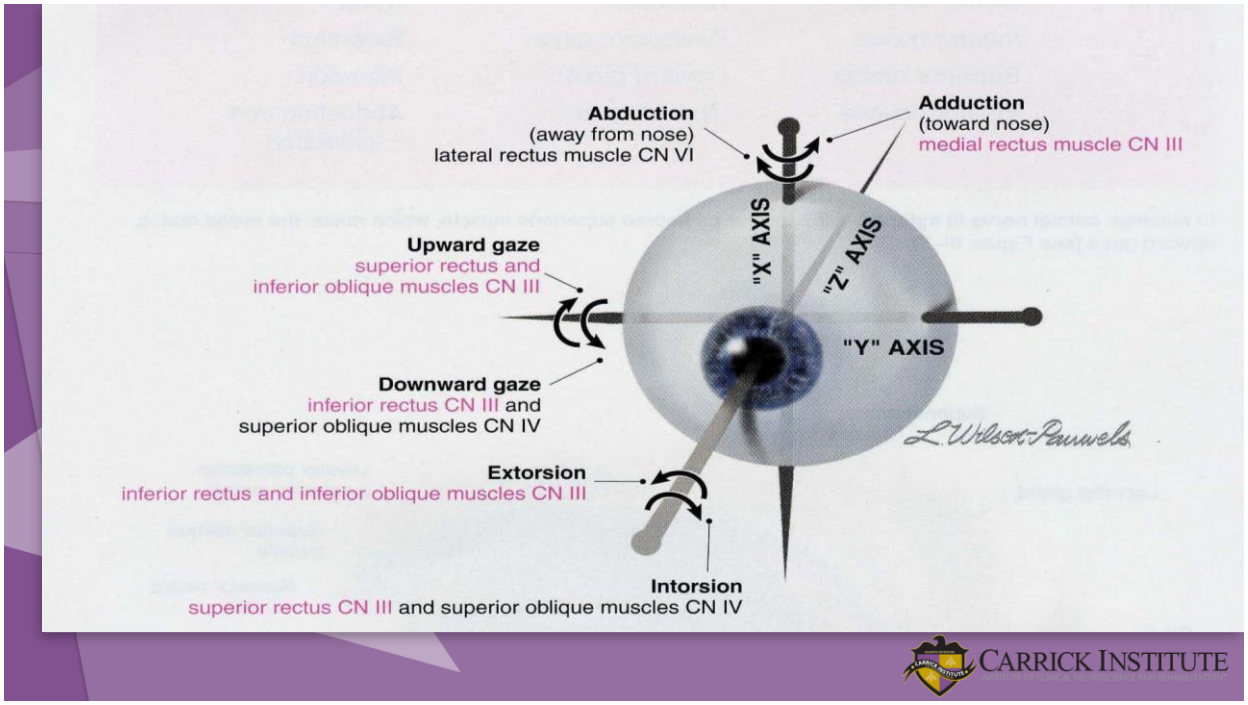

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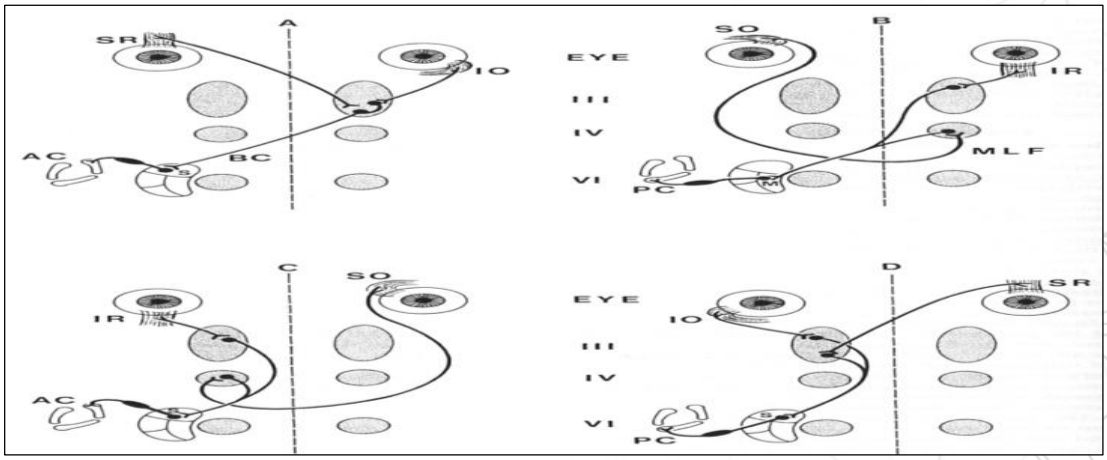
The Vertical Canals



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Types of Eye Movements

Types of Eye Movements

- Saccades:
  - Fastest of eye movements, enable us to rapidly redirect our line of sight.
- Pursuit:
  - Eye movements evoked by following of moving object in order to stabilize the image on the fovea.
- Optokinetic Nystagmus:
  - Eye movements evoked by following moving fields.
- Fixation:
  - Eye movements associated with effort to keep the eyes completely still

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Ocular Examination Procedure

- Steps:
  - Saccades
    - Velocity, Latency, Accuracy
    - Gaze Holding
  - Pursuits:
    - Catch up saccades
    - Saccadic Intrusions
    - Depth perception/OKN contamination
  - Pursuits with Head Movement
- OKN
- VOR

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Saccades

Assessment & Related Disorders

Saccades

- Derived from the French word "Saquer", which means to pull.
- Have an extremely high acceleration (up to 30,000 degrees/sec.
- Typically have a latency of 200ms
- Produced and controlled by multiple areas:
  - Occipital Parietal Cortex
  - Frontal Lobes
  - Basal Ganglia
  - Cerebellum
  - Brainstem

- Leigh RJ, Zee DS 1991

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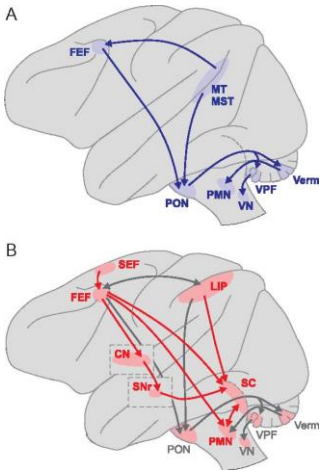
Saccade Pathway



- The primary circuit emphasizes several additional routes not imparted to the pursuit system
  - Munoz 2002; Sparks 2002.
- These include direct projections from:
  - Frontal eye fields project to eye-movement related structures in the brain stem such as:
    - The superior colliculus (SC)
    - Premotor including nuclei in the reticular formation (PMN)
    - The basal ganglia
      - Including the
        - » Caudate nucleus (CN)
        - » Substantia nigra pars reticulata (SNr).

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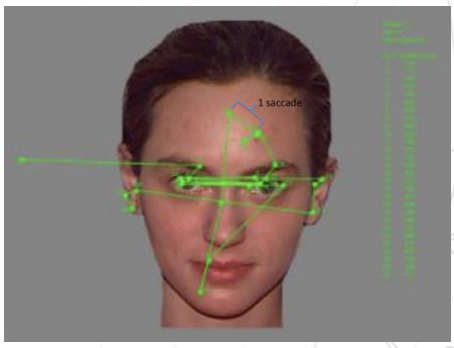
Methods For Eliciting Saccades

- Calibration Test
- ENG Methods
  - Random Paradigm
  - Gap Paradigm
  - Remembered Target
  - Anti-Saccade Paradigm.



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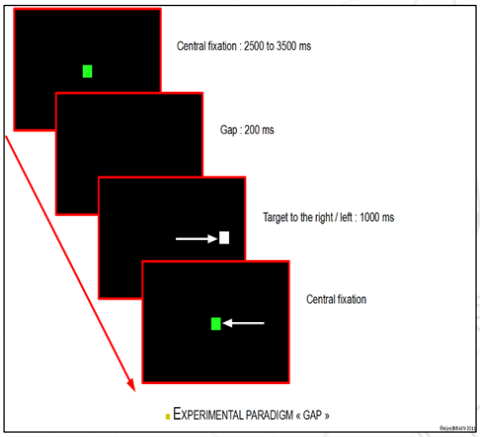
Gap Paradigm

- Can be use to elicit saccades of extremely short latency (90-130ms).
- These are often called “Express Saccades”.
- Target is briefly extinguished when stepping from one position to another.
- Helps to differentiate between frontal lesions and superior collicular lesions:
  - Lesions of the Superior Colliculus:
    - Loose ability to generate express saccades:
  - Lesions of the Frontal Lobes:
    - Ability to generate express saccades is preserved.



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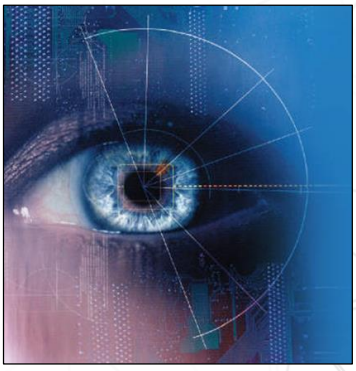
Remembered Saccades & Anti Saccade Paradigms

- Both aimed at eliciting and evaluating volitional saccades.
- Saccades to remembered targets are formulated in the Frontal Lobes and are released to proceed by way of the basal ganglia.
- In Anti-Saccadic methods patients are asked to make saccades in the direction opposite the target displacement.
- Clinical Notes:
  - Patients with basal ganglionic lesions characteristically have more difficulty producing volitional saccades than reflexive ones.
  - Patients with frontal lobe lesions have difficulties making saccades in the direction opposite the target displacement.



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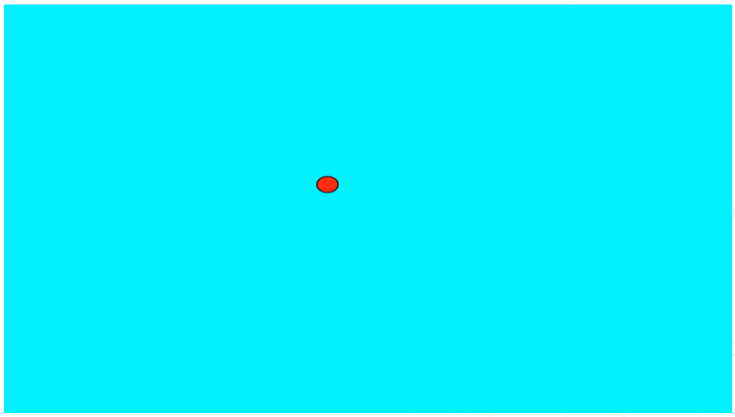
Applications for Training Saccades

Right Brain Saccaidic Eye Exercises



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Left Brain Saccadic Eye Exercises

Sit in a comfortable position with your eyes at the level of this text. Don't look up or down to read it. When you see a red ball you should look at it and keep your eyes on it. If it moves you should follow it. Do not stare at the ball but keep it in your gaze, relaxing your eyes. Do this exercise every hour during the day.

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Horizontal Gap Saccades

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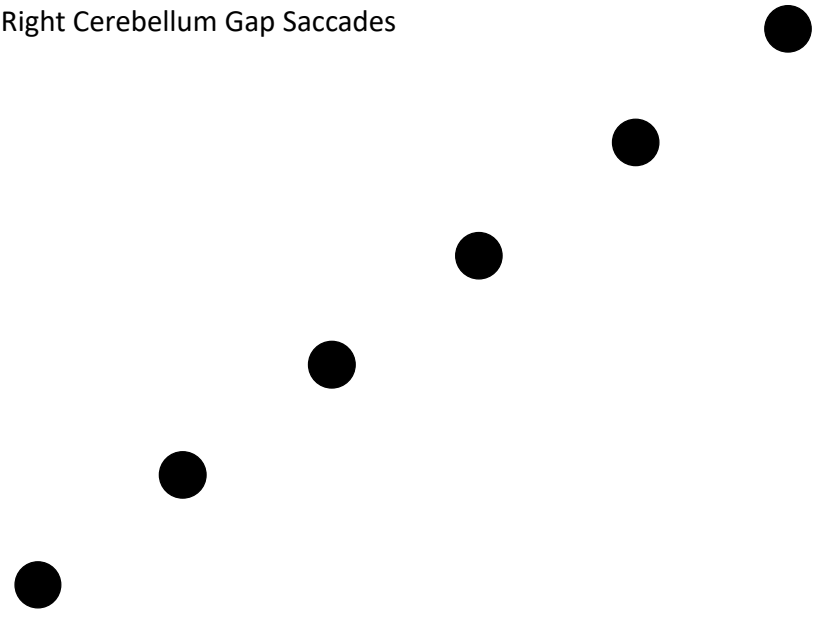
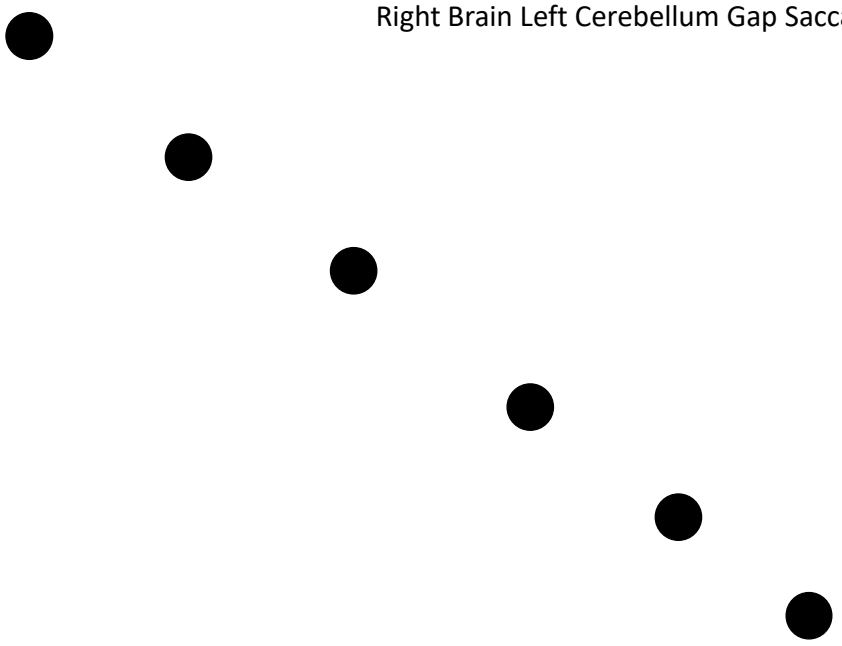
Left Brain Right Cerebellum Gap Saccades



Right Brain Left Cerebellum Gap Saccades



Anti-Saccades

- A good App to use for these is “Focus Builder”
- Great way to exercise the prefrontal cortex and to bias the activation of the “Indirect Pathway” through the basal ganglia.
- Preferred Settings:
  - Repetitions: 10
  - Go/NoGo: Shapes
  - Left Right Blinks: 5/5
  - Number of Dots: 3
  - Time Interval:3
  - Distance: 4

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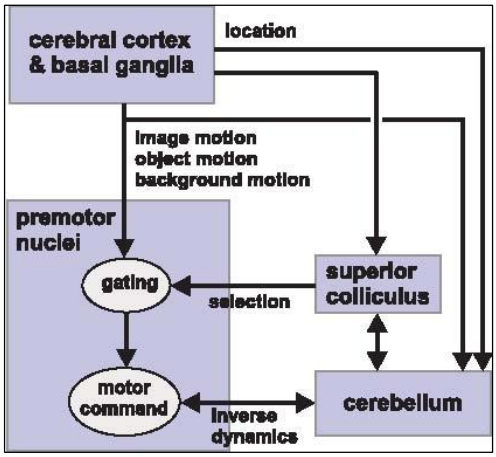
Ocular Pursuits

Pursuit Pathway



- To track a slowly moving object accurately during whole body rotation, target-velocity-in-space signals must first be reconstructed in the brain by retinal image-slip-velocity of the target, eye velocity and head velocity
  - Robinson 1981
- Consists of a simple circuit connecting areas in the temporal and frontal lobes of the cerebral cortex with pursuit-related motor regions of the cerebellum
- Two parallel pathways exist contributing to pursuits
  - Lee1997; Keller and Heinen 1991; Lisberger et al. 1987

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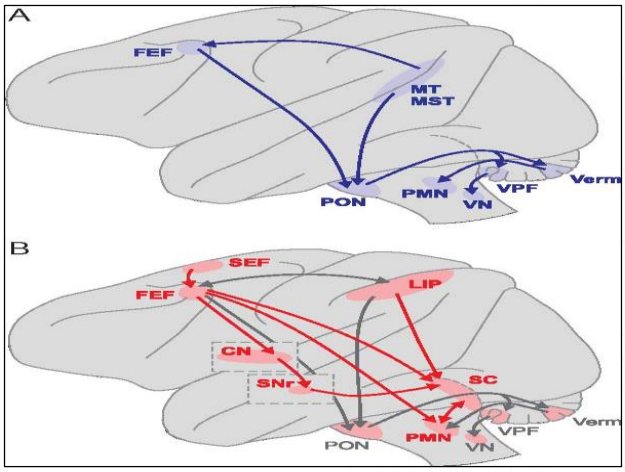
Pursuit Pathway



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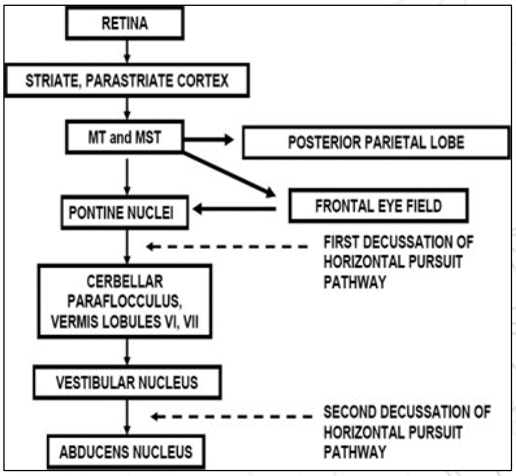
Pursuits Deficits

- Deficits can be seen in lesions that affect peripheral vision (retinal pigmentary degenerations).
- Measured by utilizing a sinusoidal stimulus of approximately .5 Hz, +/- 20 degrees in amplitude
- Symmetry and gain are the major features measured.
  - Gain:
    - The ratio of eye velocity to target velocity.
- Clinical Classification:
  - Perfect:
    - Pursuit gains of >.8
  - Moderately Impaired:
    - Pursuit gains of .2-.8
  - Severely Impaired:
    - Pursuit gains of <.2



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Pursuit Exercises

- Easiest to use the "Focus Builder App"
- Want to consider the following parameters:
  - Dot Color:
    - Red: Left Brain
    - Blue: Right Brain
  - Back Ground Color:
    - Reds/Yellows: Left Brain Effect
    - Blues/greens: Right Brain Effect
  - Direction
    - Horizontal VS Oblique
  - Speed
    - Slower: Parietal
    - Faster Colliculi

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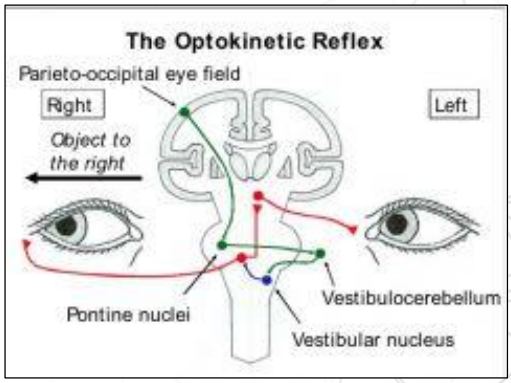
OKN Contamination

Optokinetic Contamination Pursuit Breakdown

- Occurs when the brain uses the optokinetic system to compensate for a break down in pursuits gain or a reduction in the VOR
- Also seen with depth perception issues as a result of otolithic imbalances causing hypertropia and resultant hyperopia.
- As an example upon left pursuits:
  - Catch up saccades to the left are visualized.
  - This can be due to:
    - Failure of the left parietal lobe
    - Optokinetic contamination from the resultant right OKN response created by the left pursuit.
    - Breakdown in the Right VOR
  - To differentiate due the following:
    - Have the person turn their head to the opposite side of the pursuit in this case to the right while pursuing a target
    - Interpretation:
      - Continued catch up saccades suggest parietal based lesion or breakdown in the right VOR.
      - A decrease in the degree of the catch up saccades indicates OKN contamination.



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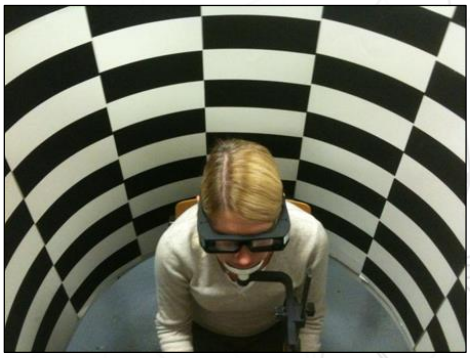
Alternate Method For Analyzing OKN Contamination in Pursuit Breakdown

- As an example upon left pursuits:
  - Catch up saccades to the left are visualized
  - This can be due to:
    - Failure of the left parietal lobe
    - Optokinetic contamination from the resultant right OKN response created by the left pursuit.
  - To differentiate between the two due the following:
    - Run an OKN stimulation to the same side of the pursuit breakdown and observe any changes in the pursuit mechanism
  - Interpretation:
    - If the OKN reduces the degree of the left catch up saccades or the direction of the saccades changes then the individual most likely has OKN contamination.
    - If there is no change in the degree of the catch up saccades then they are most likely due to parietal failure and of a failure of the VOR.



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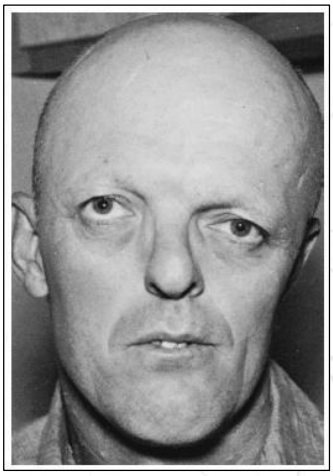
Alternate Method For Analyzing OKN Contamination in Pursuit Breakdown

- OKN contamination often occurs in individuals who have skew deviation of the eyes.
- It is caused secondarily to the hypertropic eye in skew being hyperopic.
- To differentiate the breakdown in the pursuit from other causes the following procedure can be helpful:
  - Check pursuits with both eyes open and asses the directionality of the pursuit breakdown.
  - Have the patient cover the hypertropic eye and pursue in the direction of the initial breakdown observed.
- Interpretation:
  - If the examiner notices an improvement in the pursuits upon covering the hypertropic eye then it is most likely the initial pursuit breakdown was secondary to OKN contamination involving the hypertropic eye



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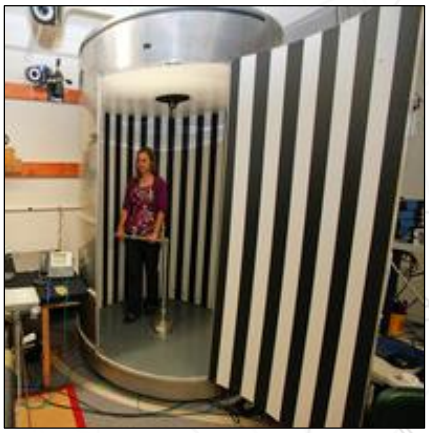
Rehab for OKN Contamination

- Overall employs the integration of various techniques involing the production of an OKN stimulation in the opposite direction to that which is being created.
- For example right head turns will be facilitateted by left OKN which can be broken if you provide and opposite OKN stimulation during the head movement.
- This is often accomplished by using what are called 2X gaze stability exercises.



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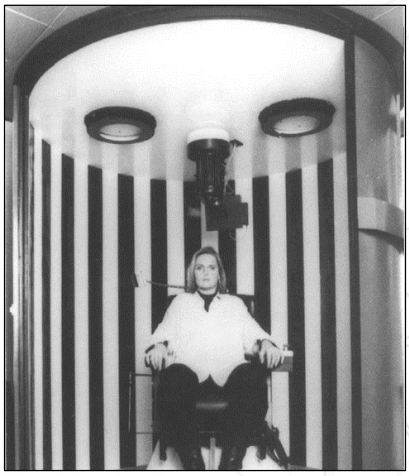
Optokinetic Nystagmus

Optokinetic Nystagmus

- Consists of the combination of two tracking mechanisms:
  - Smooth Pursuit System:
    - Involves foveal vision
  - Alternate Pursuit System:
    - Involves both foveal and extrafoveal vision
- Normal Gains are similar to those seen on Pursuit testing
  - Perfect: >.8
  - Moderately Impaired: .2-.8
  - Severely Impaired: <.2
- Two major Deficits Seen:
  - Symmetrical Reduction
  - Asymmetrical Reduction.



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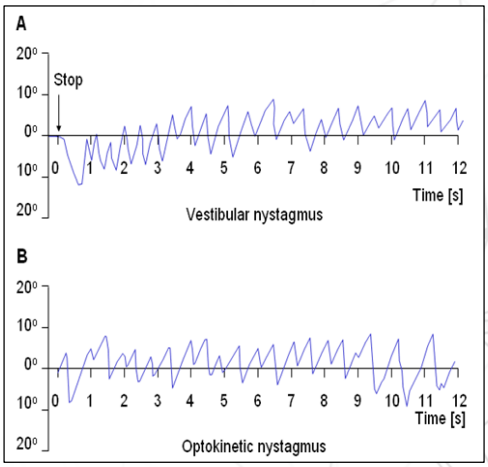
Symmetrically Reduced OKN

- Occurs primarily in three main disorders:
  - Visual Disorders
  - Pursuit System Disorders
  - Fast Phase Disorders
    - Seen with PSP:
      - Characteristic saccadic slowing and difficulty in saccadic initialization is seen.
      - These individuals characteristically also have normal pursuit gains but decreased OKN gains due to fast phase weakness.
        - » Eyes often get "Hung Up" in the orbit.



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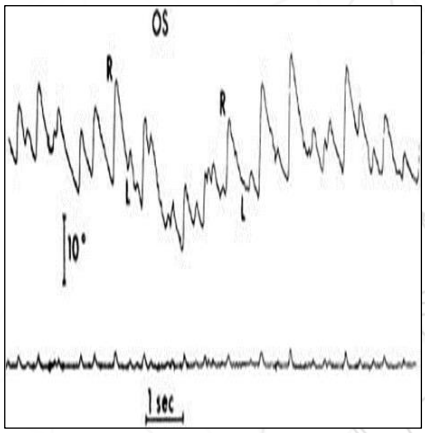
Symmetrically Reduced OKN

- Visual Disorders:
  - Note: Pursuits are based on foveal vision while OKN is based on foveal and extra-foveal vision.
  - Thus OKN may persist even is visual acuity is poor.
  - Clinically one compares pursuit gain to OKN gain:
    - Decreased Pursuit Gain & Intact OKN Gain:
      - Seen in lesions that selectively affect foveal vision. Often see a slow build-up of OKN will occur to a constant velocity stimulus.
    - Intact Pursuit Gain & Decreased OKN Gain
      - Also seen in Fast Phase disorders. Often see the eyes getting "Hung Up" in the orbit upon OKN and Caloric stimulations:



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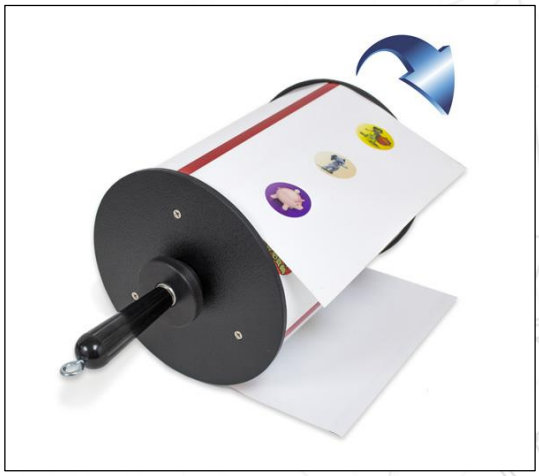
Asymmetrical OKN Gain

- Seen in the following lesions:
  - Vestibular
  - Cerebellar
  - Parieto-occipital
  - Frontal



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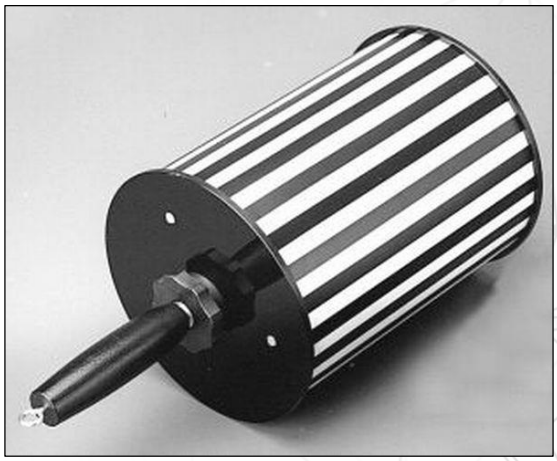
OPK Clinical Application

- Note:
  - Upward saccades have more of a temporal summative effect.
  - Downward saccades have more of a parietal summative.
- OPK Utilization
  - Upward movement has more of a parietal effect.
  - Downward movement has more of a temporal effect.
- Note:
  - Upward gaze, head neck extension and inspiration are all coupled neurologically.



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OKN Application

- You can also use OKN therapy to alter ones perception of their subjective vertigo.
- For Instance:
  - If on closing the eyes a patient falls to the left you can reduce this by giving them OKN stimulation to the left which will offset the subjective leftward vertigo.

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Fixation

The Maintenance of Ocular Stability

Fixation

- Testing is used to identify CNS disorders.
- Five abnormalities of fixation are often examined
  - Failed Fixation Suppression
  - Gaze-Evoked Nystagmus
  - Rebound Nystagmus
  - Congenital Nystagmus
  - Square Wave Jerks

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Rehab Involving Ocular Fixation Problems

- Most commonly used are what are referred to as 1X/Viewing exercises.
- Work on the principle of retinal slip and correction by the cerebellar cortex:
- Considerations:
  - Lying, sitting, standing
  - Passive VS Active
  - Speed
  - Symmetrical VS Assymetrical

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Gaze Stabilization Exercises: Clinical Notes

- Exercising in the direction of gaze stability along with the direction of gaze instability will not yield the desired results as the patient will maintain the imbalance:
- For the most part it is suggested that the person use gaze stabilization exercises of the yes/yes & no/no variety in the direction of greatest gaze holding failure first.
- Patient may use a saccade to target and or a pursuit to target depending on which one improves gaze holding the most.
  - I.e. If the patient is more stable in gaze using a saccade to target you will have them do saccades as appose to pursuit to target.

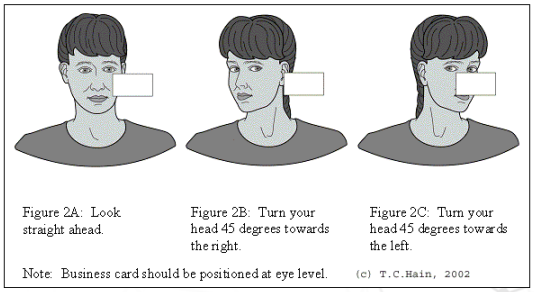

Figure 2A: Look straight ahead.

Figure 2B: Turn your head 45 degrees towards the right.

Figure 2C: Turn your head 45 degrees towards the left.

Note: Business card should be positioned at eye level. (c) T.C.Hain, 2002

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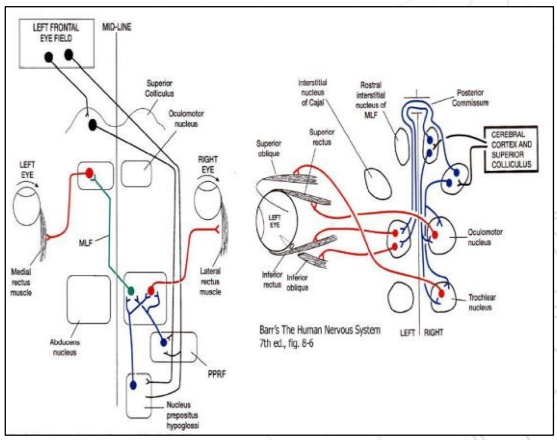
More Clinical Applications

Lesions of the PPRF

- Associated with decreased ipsilateral saccades to the side of the lesion.
- VOR Responses:
  - Normally the eyes will deviate initially to the side of rotation as the quick phase amplitude is larger then the slow phase amplitude
    - Lesions: Eyes will deviate away from the side of rotation as the slow phase amplitude becomes larger then the quick phase amplitude
- Directional Preponderance:
  - Seen towards the opposite side of the lesion.



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Cervical Manipulation

- Mechanoreceptors have direct projections to the vestibular nuclei.
- Projection are contralateral for rotation
- I.E.
  - Left side stimulation is produced by left head rotation.
    - Right sided joint receptors are activated.
  - The resultant input is increased firing of the Left medial vestibular nucleus and right lateral gaze deviation.

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Head Tilt Analysis:

- Patients will often produce head tilts contralateral to their subjective vertigo or most often towards to the side of their cerebellar lesion.
- Patients may also produce head tilts opposite of their cerebellar lesion based on a decrease in extensor muscle tone ipsilateral.

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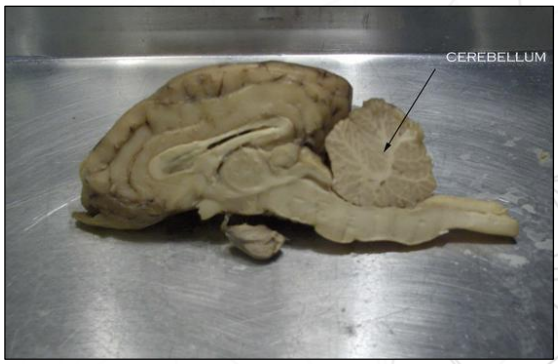
Muscle Tone Imbalance Testing:

- Cerebellar lesions classically produce weakness of proximal extensor muscles and weakness of the ipsilateral tibialis anterior muscle.
- Also see weakness of ipsilateral shoulder/elbow flexion.



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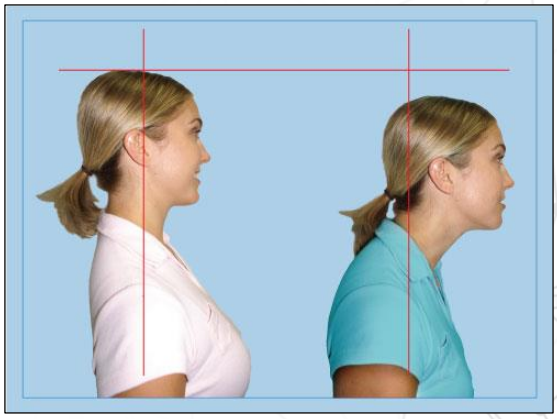
Postural Alignment:

- Patients will most often align themselves opposite their subjective vertigo.
- Thus a patient with a right cerebellar deficit in the horizontal canal will align the trunk with rotation towards the right side to compensate for the subjective leftwards rotational vertigo.



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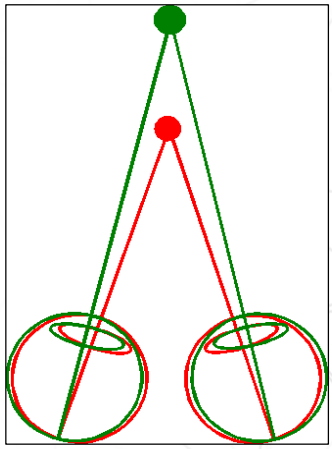
Testing Patients Subjective Visual Straight Ahead

- Otolithic and pontine lesions cause ipsiversive deviations.
- Mesencephalic lesions produce contraversive tilts.



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Fukuda's Step Test:

- Patients will most often deviate to the side of the lesion.

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Observe Sway Frequency:

- High sway frequency (3hz) commonly observed with :
  - Labyrinthine lesions
  - Anterior lobe lesions.
    - Note: With anterior lobe lesions one commonly finds lower limb ataxia.
- Low sway frequency (1hz) commonly observed
  - Sensory lesions.
  - Lesions of the FNL.
  - Visual lesions
- Ataxia upon limb trunk pursuit tasks is often seen with Basal Ganglionic disorders.

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Testing for Lateropulsion:

- Represents position offset of the limb/body towards the side of the lesion.
  - Brany Past Pointing Test
  - Fukuda Vertical Writing Test
  - Unterberg's Stepping Test

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Observation of Body Tilts on Rocker Board:

- Patients with eyes closed will fall towards the side of their vestibular lesion when the rocker board is tilted towards that side.
- Normal patients will correct and align the head to gravitational vertical

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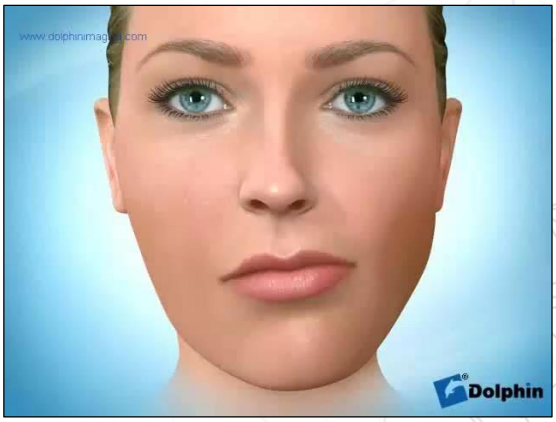
Yaw plane signs:

- Horizontal Nystagmus beating away from the side of the lesion
- Past pointing to the side of the lesion
- Rotational/lateral body falls towards the side of the lesion
- Horizontal deviation of the perceived straight ahead towards the side of the lesion.



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Roll Plane Signs:

- Torsional Nystagmus
- OTR/Skew deviation
- Ocular Torsion
- Tilts:
  - Head
  - Body
  - Perceived Vertical:
    - All tilts are
      - Ipsiversive in otolithic/pontine lesions
      - Contraversive in pontomesencephalic lesions.

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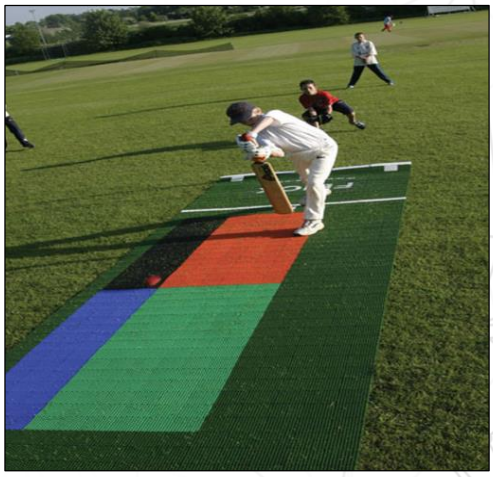
Pitch Plane Signs:

- Most often seen with bilateral paramedian pontine lesions and or flocculus lesions
- Vertical beating nystagmus
  - Upbeat:
    - Not very common
    - Often transient/reversible
      - Suggests lesions in the pontomesencephalic junction
      - Typical of MS
  - Downbeat:
    - More Common
    - Often permanent
    - Suggests a lesion in the craniocervical region



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Pitch Planes Signs Cont'd

- Patients often complain of backward falls this is thought to be secondary to the down beat nystagmus that most patients experience.
- The downbeat nystagmus is misinterpreted as forward motion which the patient compensates with backward posturing/falls.
- Forward/Backwards tilts and falls at 3Hz.
- Vertical deviation of the perceived horizontal straight ahead towards the side of the lesion (towards the slow phase)
- Oscillopsia:
  - Illusory oscillation of the visual field with results in visual blurring with head movement.

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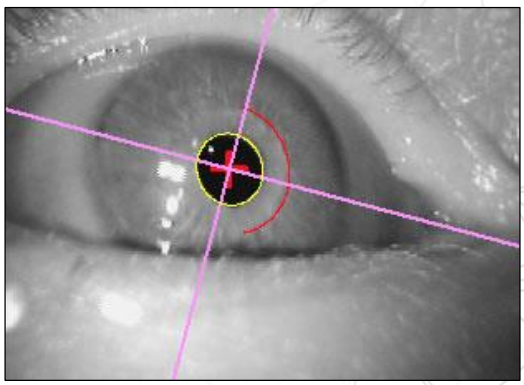
Observation of Torsional Nystagmus:

- Fast phase contraversive in pontomedullary lesions
- Ipsiversive in pontomesencephalic lesions (INC)
- Exception is that riMLF lesions produce contraversive beating torsional nystagmus:
- To differentiate one compares
  - OTR
    - Seen with INC lesions
  - Slowing of ipsilateral downward saccades:
    - Seen with riMLF lesions.



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Observation of Head Tilts to Head Rotations:

- **Posterior Vermis Lesions:**
  - Produce ipsiversive head rotations and head tilts
  - Produce marked ipsilateral saccadic hypometria and mild contralateral hypermetria
- **Fastigial Lesions:**
  - Produce ipsilateral head tilts and contralateral head rotations.
  - Produce marked ipsilateral hypermetria and mild contralateral hypometria.
- **INC Lesions**:
  - Produce OTR's
- **Central Mesencephalic RF Lesions**
  - Produce contralateral oblique saccadic hypermetria and ipsilateral oblique hypometria.
- **RiMLF Lesions**
  - Produce a slowing of ipsilateral downward and torsional saccades
  - Utilize OPK strip to visualize the quality of downward saccades on the right and left sides.

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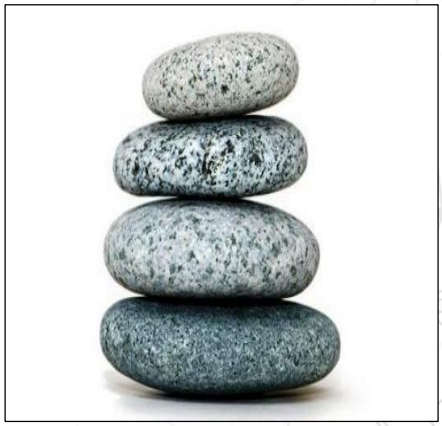
Exercises to Improve Visual Stability:

- All exercise performed at 30 sec to 1 min to start up to 2 min 5X daily for 6 weeks.
  - 1X Viewing (Patient focuses on stationary object while moving their head in the plane of the lesions canal
  - 2X Viewing (Patient focuses on object that moves in the opposite direction with respect to head rotation). Used more in later stages of rehabilitation.
  - Using moving object and or OPK stimulation
    - To increase VOR Gain have the head and the OPK strip move in opposite directions
    - To decrease VOR gain have the head and the OPK Strip move in the same direction



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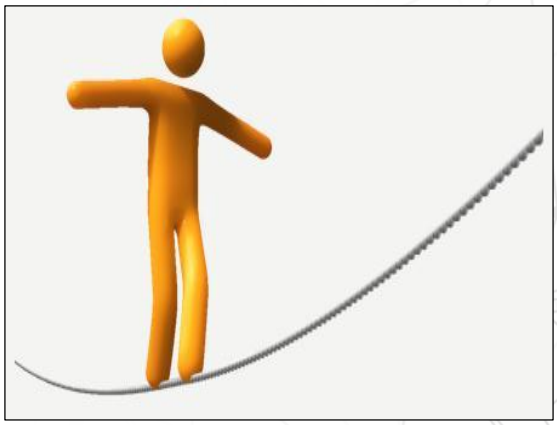
Exercise to Improve Postural Stability

- Patient Stand in front of wall with feet as close together as possible and rotates head back and forth while looking straight ahead at the wall for 1 minute.
- At First with support and then later without.
- Patient turns their head while walking.



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