BAREFOOT SCIENCE™

Foot Strengthening Insole System.

A New Approach to an Age Old Concept…

EXERCISE IS GOOD!

The Role And Importance of the foot.

- Cushioning: To effectively reduce and dissipate harmful impact forces and energy.
- Support: To ensure balance and stability to the upper body while reducing unwanted motion.
- Guidance: To ensure to proper positioning of the body over the foot maximizing energy usage at propulsion.

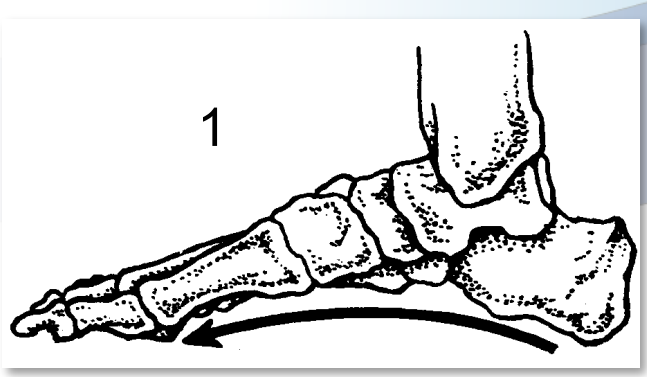
- Traditional insoles and orthotics, because of their brace and support philosophy, fall short in encouraging the foot's natural abilities and structures to fulfill these roles:

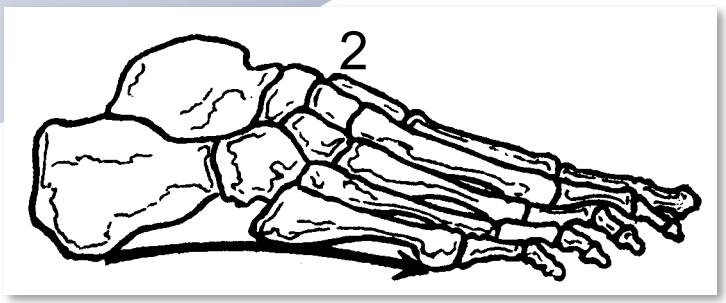
Keys to Ideal Foot Function.

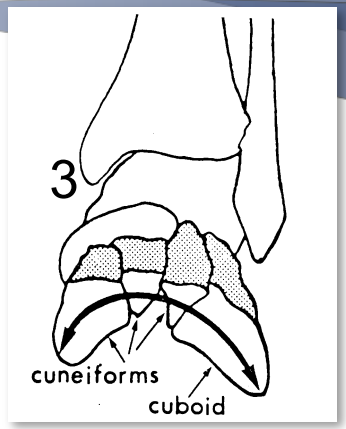
• Proprioceptive and Neuromuscular Considerations: - The instinctive manner our foot operates in an effort to function optimally. Barefoot Science simulates the neural response we would get from the ground.

• Foot Stability and Alignment / The Windlass Effect: - Evolutionary mechanical system that allows the foot to provide optimal stability. Barefoot Science strengthen the foot muscles to achieve this.

The Anatomy of the foot: Geometric Considerations.



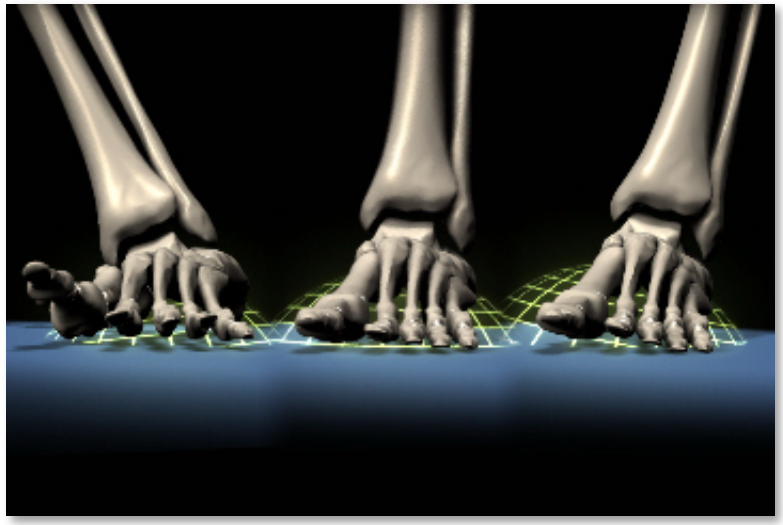




Traditional teaching shows three arches;
1) Medial , 2) lateral, 3) transverse (metatarsal)

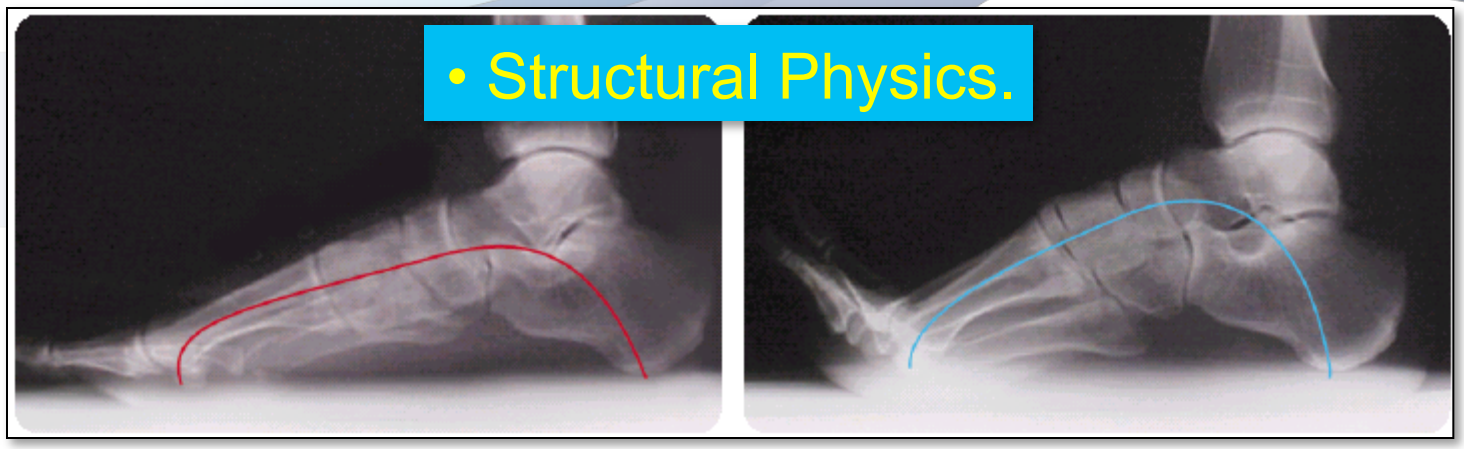
However.

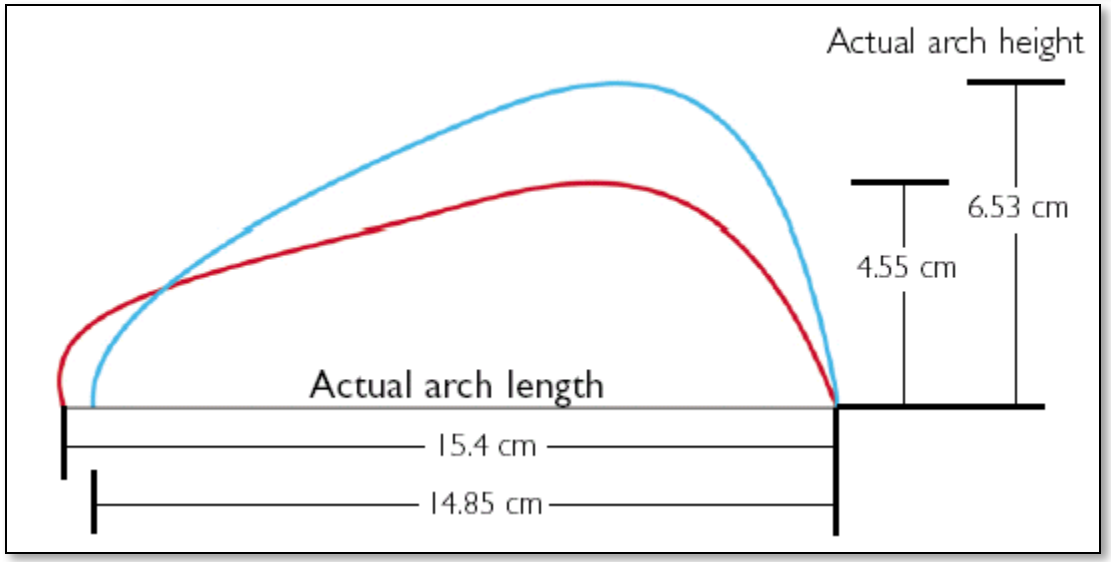
- Ideal biomechanics requires a 3D dome shape: necessary to provide support, cushioning and guidance throughout all degrees of motion.
- Multi-Directional needs: Hip = Ball & Socket, Knee = Hinge, Foot/Ground = Ball & Socket.



- Barefoot Science simulates that ball and socket relationship thereby enhancing ideal and efficient tri-planar motion.

Encouraging a self supporting structure has mechanical benefits.

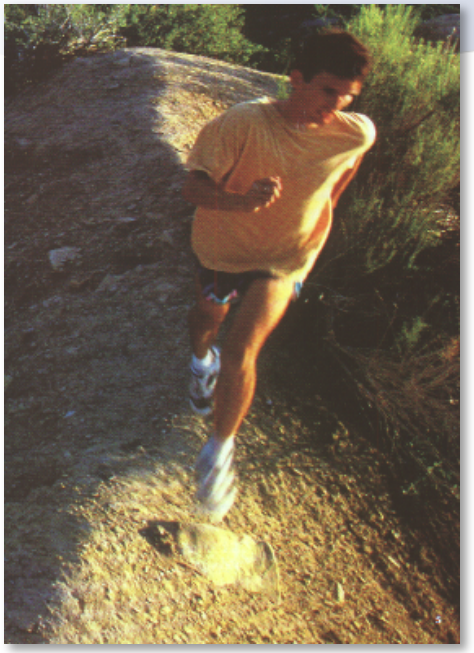




• Barefoot Science has been shown to create increases in arch height. An increased arch height results in more even force distribution across the joints of the foot and a decreased tension on the plantar connective tissue.

The Anatomy of the foot.
Soft Tissue:

Muscle contractions:



• Eccentric contractions control the arch deflection rate for natural cushioning and terrain adaptation. Require strong intrinsic muscles.

• Control and absorb energy.

• Concentric contractions provide energy and power for propulsion and pre-stabilize the foot for contact.

• Create energy and motion.

The morphological changes created through the use of Barefoot Science are a result of increased muscle contribution.

Proprioceptive and Neuromuscular Considerations of How Barefoot Science Works

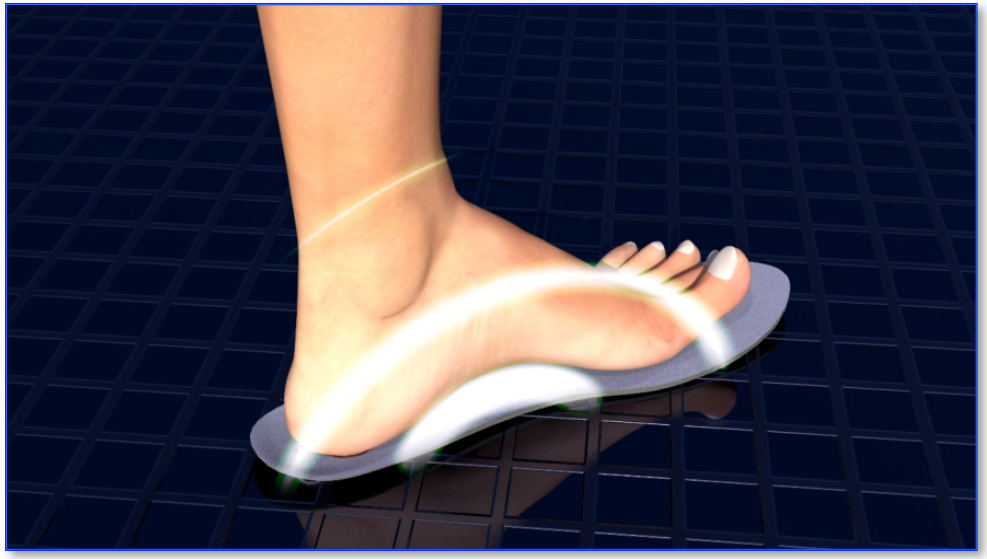
- Plantar aspect of the foot is heavily engorged with mechanoreceptors providing avoidance and reflex responses.
- Sensory feedback of terrain and activity level in preparation for foot contact.
- Altered gait characteristics in an effort to improve biomechanical efficiency and reduce predisposition to injury.
- Traditional insoles etc.. insulate this key region of the foot, leading to sensory deprivation of the foot.
- Barefoot Science capitalizes on both the mechanical properties of this key area of the foot as well as the neuromuscular properties of the sole.

Mechanoreceptors provide important information about the surrounding environment. As people interact with objects, their receptors adapt to offer useful feedback allowing people to do everything from controlling a pencil to adapting their gait. Adaptation provides a high degree of sensitivity on body parts like the hands and feet. These structures are also involved in the body's sense of balance, helping the brain find the body's place in space and the environment.

As a defence mechanism the body desires to maintain homeostasis and reduce external, potentially harmful stresses stresses.

Key Neuromuscular Componenets used by Barefoot Science

- **Merkel's Discs and Pacinian corpuscles .**
  - provide texture and pressure information to the brain
- **Ruffini Cells and Muscle Spindles**
  - provides tension information to the brain
- **Nociceptors** are sensory receptors of the peripheral nervous system.



• **Merkel's Discs and Pacinian corpuscle .**

- Provide texture and pressure information to the brain.
- Changes in pressure create action potentials and muscle fibre firing in response to the pressure.

• **Ruffini Cells and Muscle Spindles**

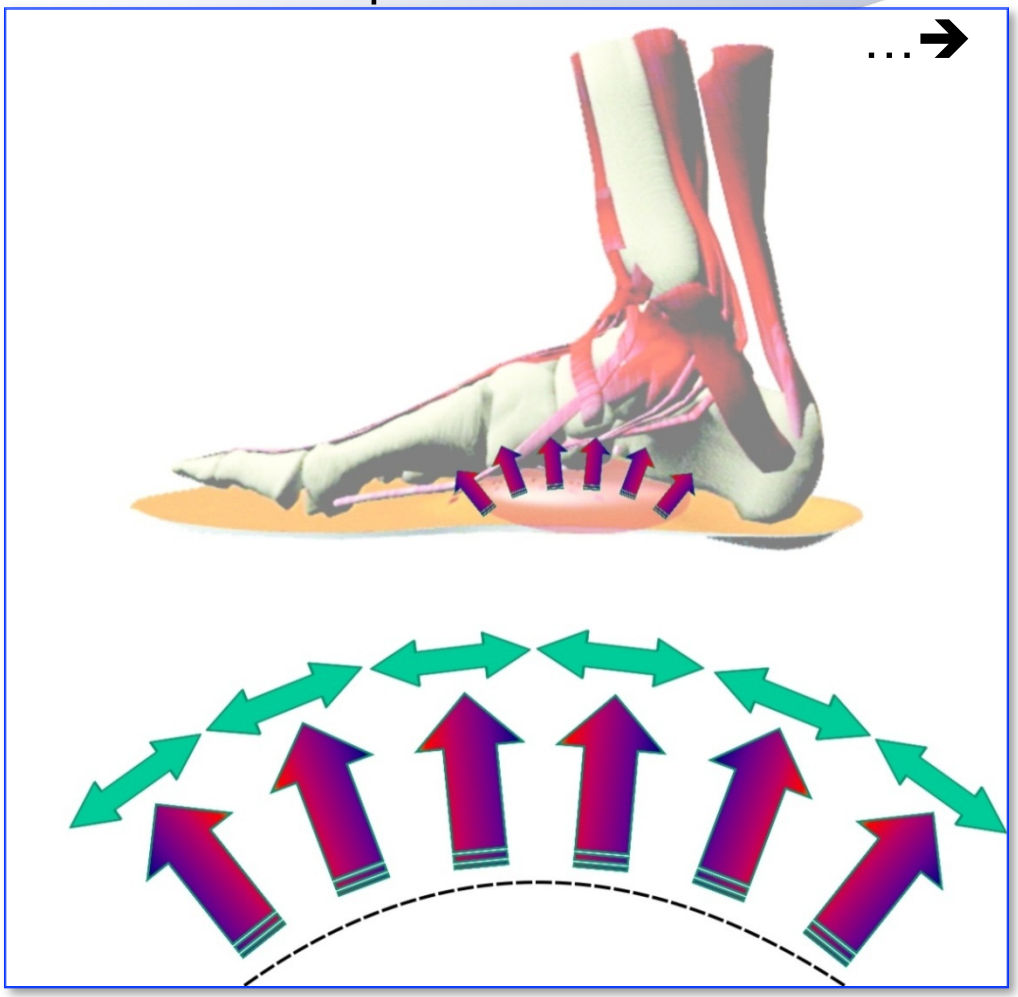
- Provides tension information to the brain
- Increases in tension are sensed and muscle contractions are created to control and manage the source of the tension.

• **Nociceptors** are sensory receptors of the peripheral nervous system.

- Nociceptors are responsible for sending signals to the spinal cord and the brain when potentially damaging stimuli is detected in the skin, mucous membranes, muscles, joints, and organs. They are also known as pain receptors because they produce the sensation of pain and discomfort.

• Barefoot Science Dome Interface.

- the introduction of the patented BFS dome to the plantar surface of the foot …➔



1) introduces a mild pressure sensed by the Merkel's Discs and Pacinian corpuscles thus initiating reactions at the neuromuscular level.

2) creates a mild discomfort initiating a pain avoidance and related muscle contractions response initiated by the nociceptors .

3) creates an infinite number of tensile force vectors sensed by the Ruffini Cells and Muscle Spindles which initiate muscular contraction response in an avoidance reaction.

PROPRIOCEPTION IS THE BODY'S BUILT- IN INJURY AVOIDANCE SYSTEM!

Definition: Proprioceptors are specialized sensory receptors on nerve endings found in muscles, tendons, joints, and the inner ear. These receptors relay information about motion or position and make us aware of our own body position and movement in space. Proprioceptors detect subtle changes in movement, position, tension, and force, within the body.

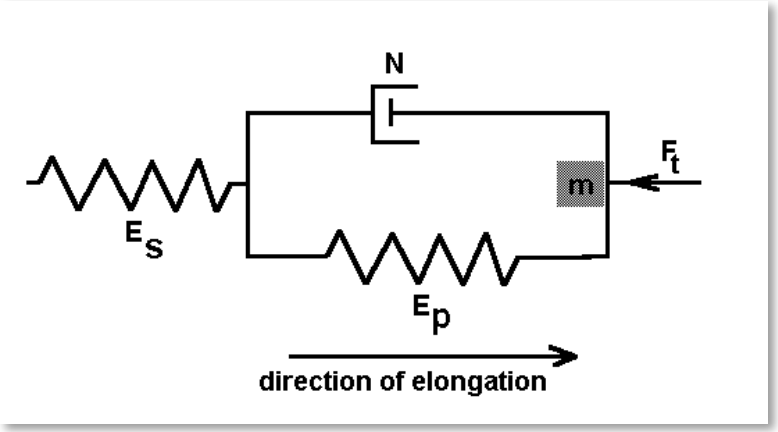
How Proprioceptors Protect Us From Injury?

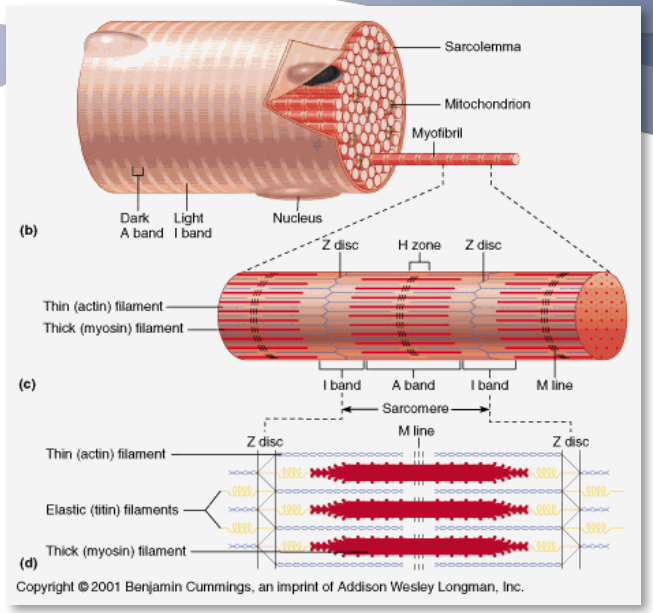
In addition to providing information about the movement and positioning of our body, head, arms and legs, the proprioceptors can trigger certain protective reflexes. The "stretch reflex," for example, is activated when the proprioceptors sense too much stretch or force on a muscle or tendon. To resist an unsafe change in muscle length that may lead to a torn muscle or tendon, the reflex causes the stretched muscle to contract, shorten and protect the muscle or tendon from injury.

The insulative effect from even the thinnest of shoes results in injury due to the fact that brain has not had a chance to activate the "stretch reflex" and subconsciously initiate muscle firing to compensate for the "unsafe change" .

Benefits of Increased Muscle Strength:
- Spring Effect of Muscles

- Energy Storage capabilities of soft tissues.
  - Series and Parallel Spring properties.
  - Stored energy contributed to motion.
  - Stronger muscles & stronger connective tissue produce stronger spring effect.





- Implications:
  - The ability to store and reuse energy reduces the energy dissipated within the system.
  - Excess energy leads to micro-trauma in bone and soft tissue.
  - Common injury sites are the plantar fascia and Achilles tendon because of excess tension on the connective tissue.

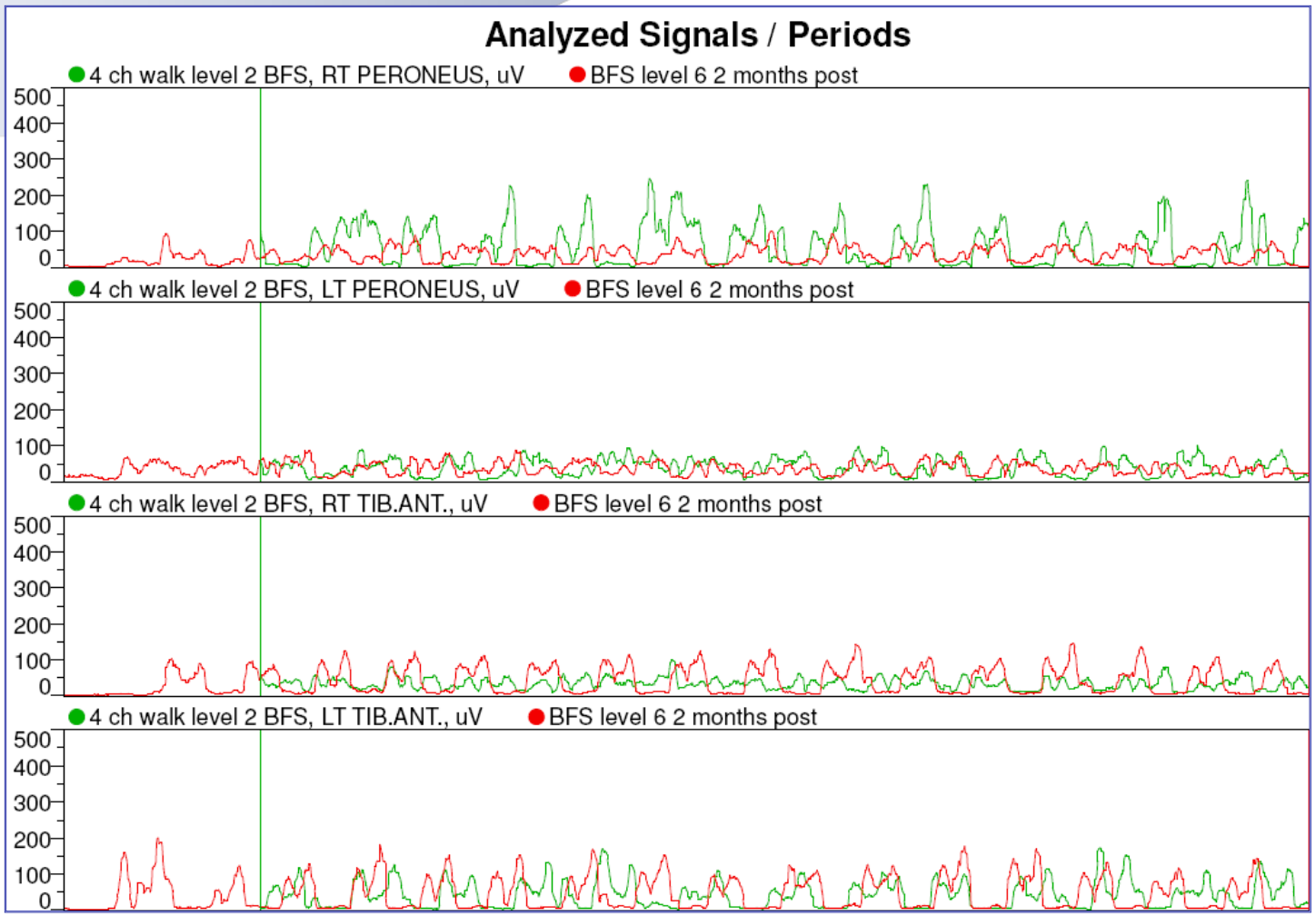
- The Foot: Stronger arch muscles can control arch deflection more effectively, reduce strain on the plantar fascia and help re-establish the arch integrity during push off enhancing propulsion.

SMEG: Data Collection and Observations

- Efficiency and strength in co-contractions of Tib. Ant and Per Long help to stabilize the foot/ankle prior to HS in the frontal plane.

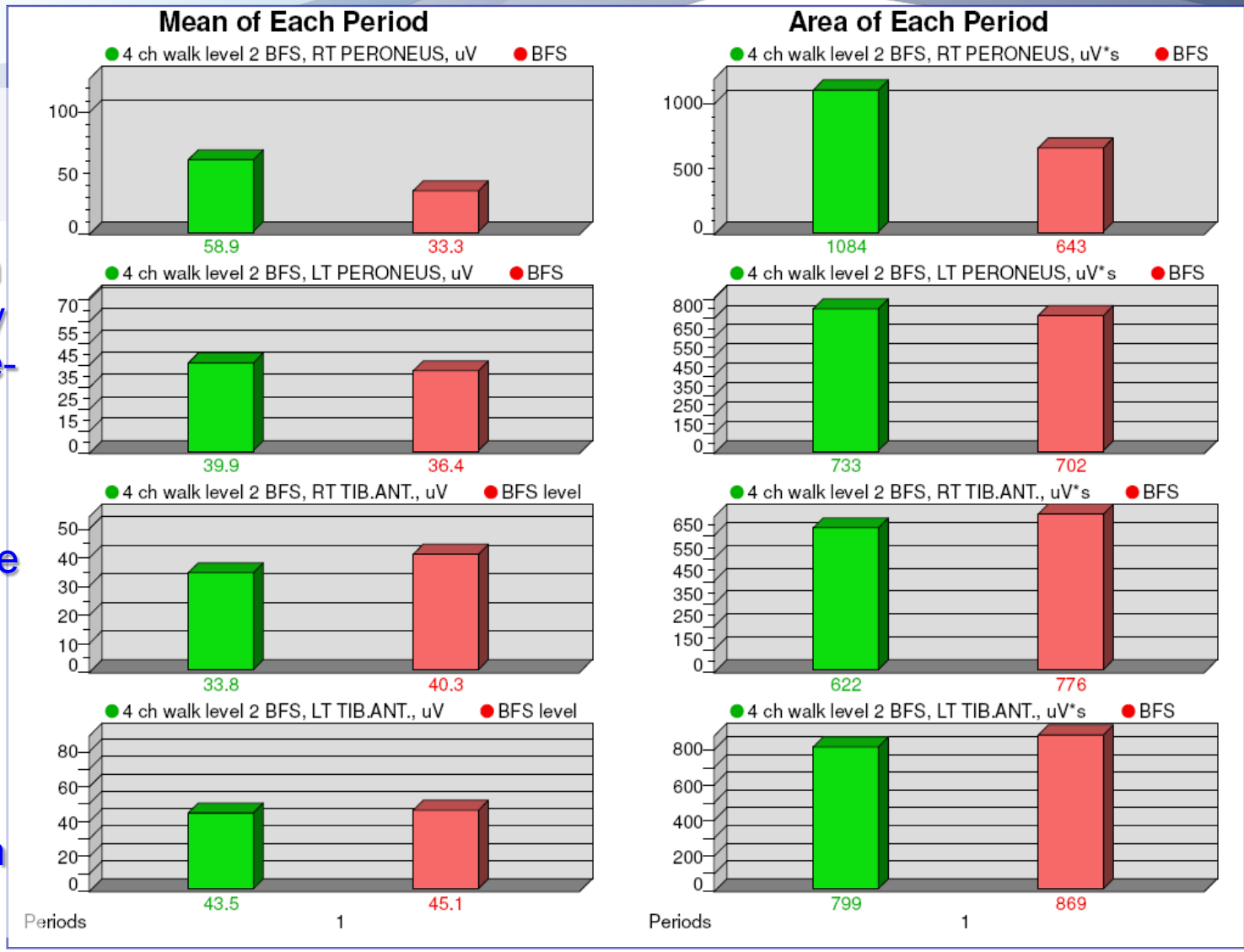
- After a **2 month** introduction of a proprioceptive catalyst. (Barefoot Science) Positive changes were seen in the SEMG in Tib. Ant. and Per. Long. Activity

- Reduced Per.Long. activity and improved synchronization of complimentary muscle co-contractions indicating increases in muscular efficiencies.



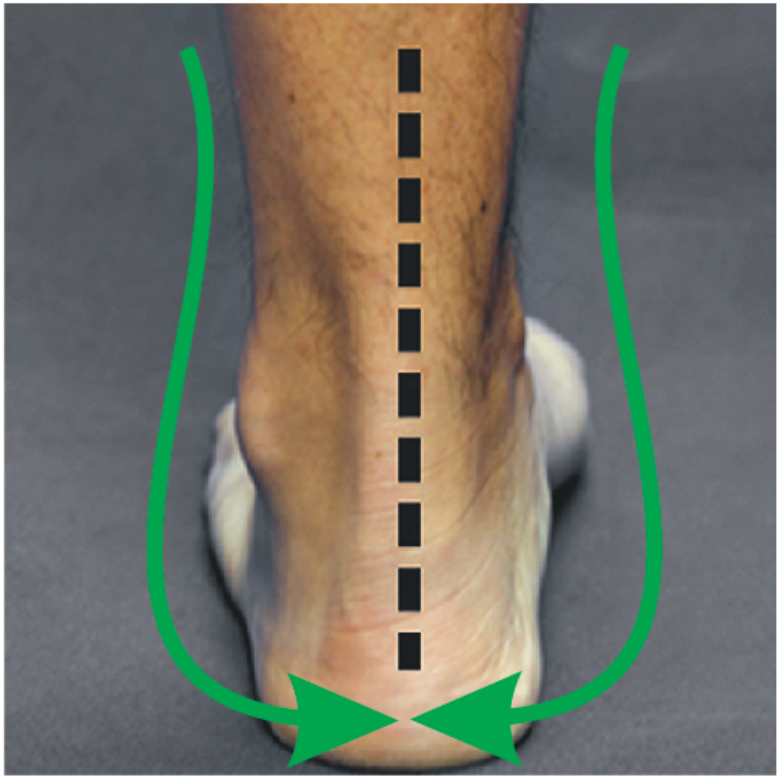
SMEG: Data Collection and Observations

Keys:
- 1) increased efficiency in firing and synchronization requires less activity of Per. Long. for Pre-HS stabilization.
- 2) Increased Tib. Ant. Activity indicative of increase in reported muscle strength
- 3) after fourteen weeks muscle asymmetry was reduced to less than 1%.



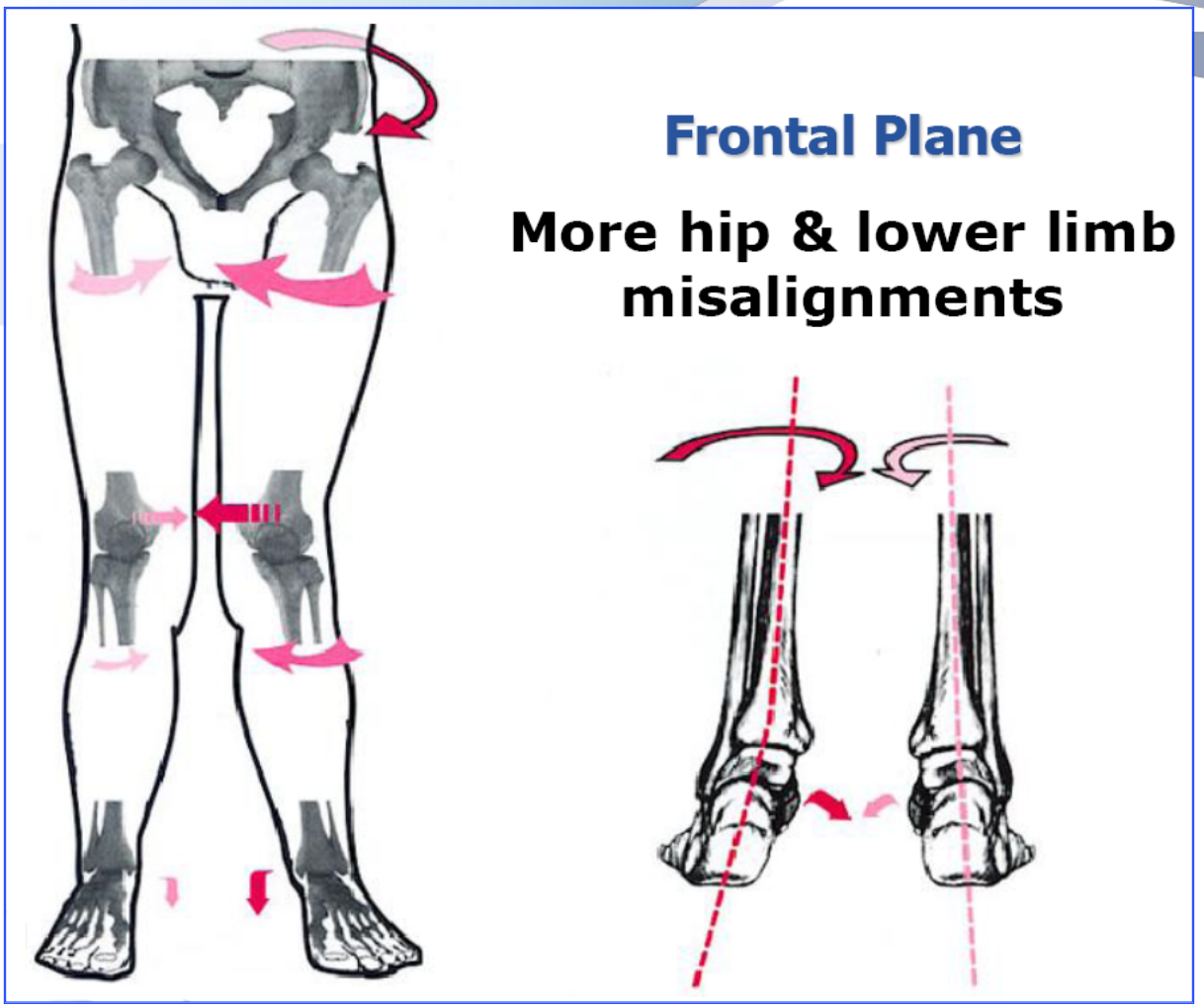
Significance of Ideal Co-Contractions during Gait

Non Symmetric firing and synchronization produces misalignment issues in joints.



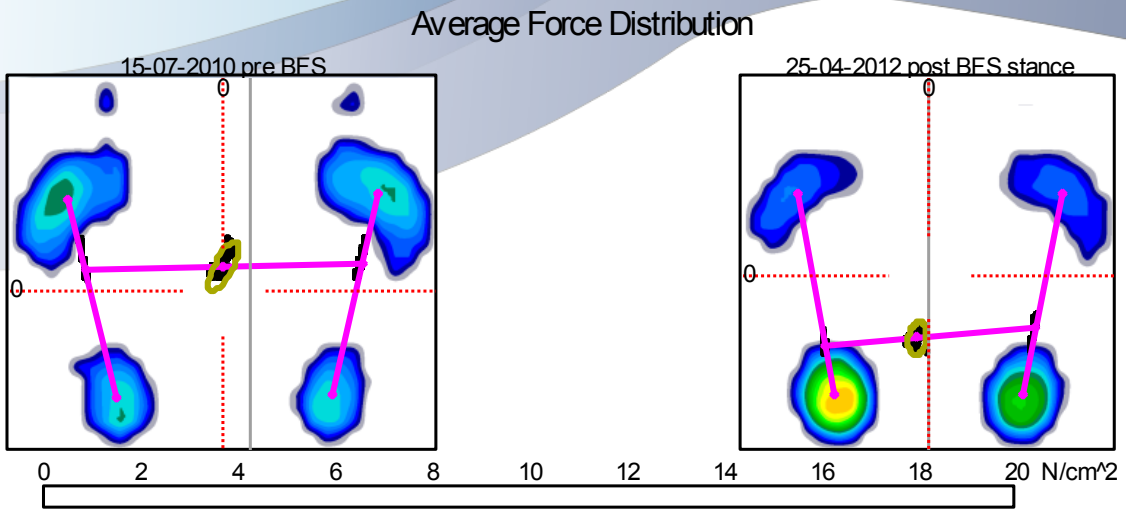
Synchronized firing of key co-contractions across joints produces stabilization and ideal alignment..

Significance of Inefficiencies in the base of Support



Inability to stabilize the foot due to muscular inefficiencies effects the kinetic chain. Excess foot pronation and eversion linked to mortise joint orientation directly link internal tibial and femoral rotation to excess pronation and arch collapse.

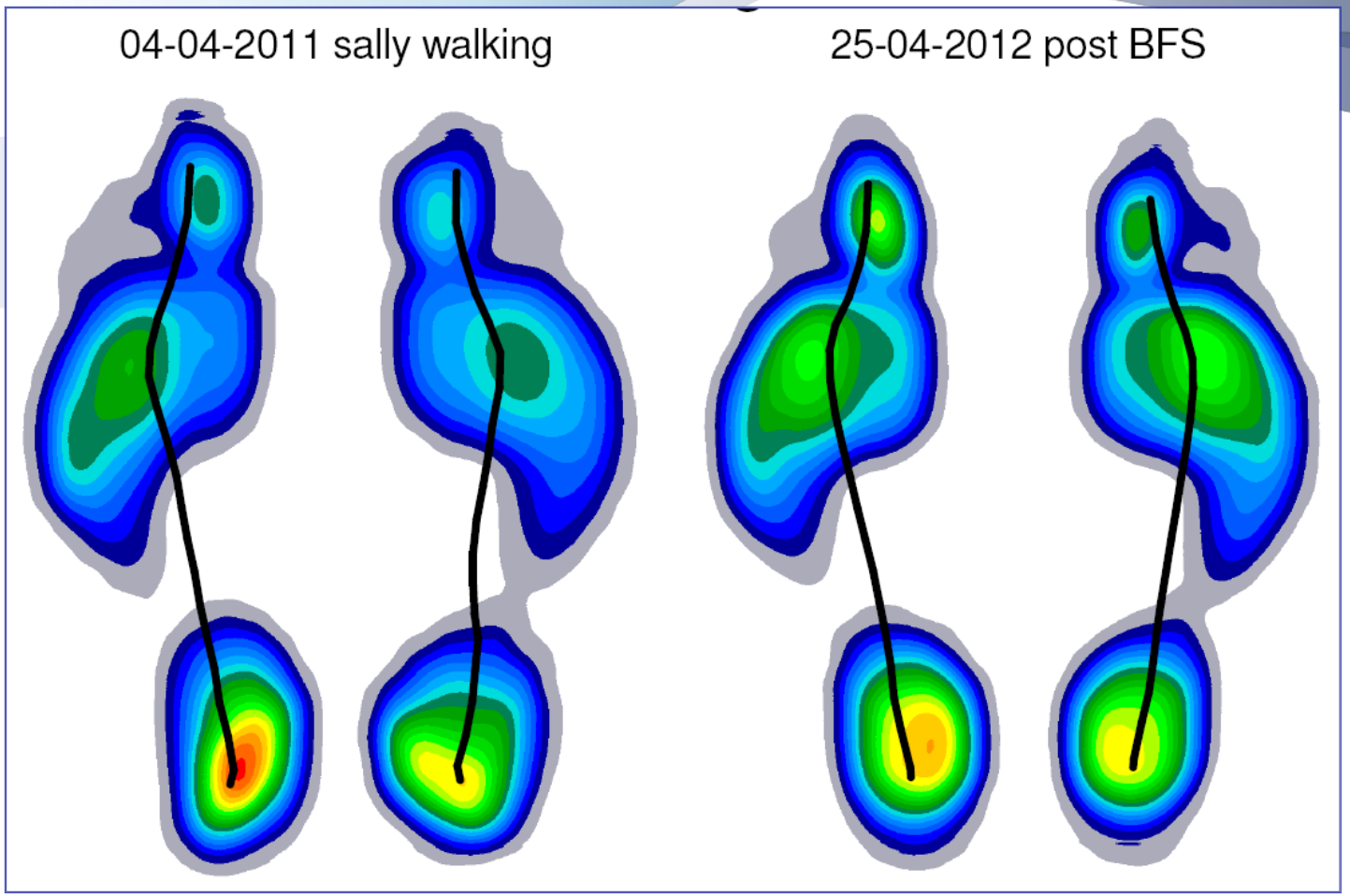
Evidence of Balance and Stability Change.



Parameters	15-07-2010 pre BFS	25-04-2012 post BFS stance
95% Confidence Ellipse		
Length of minor axis, mm	5.7	5.5
Length of major axis, mm	16.9	10.0
Angle betw. Y and major axis, deg	28.0 right	8.6 right
Area, mm*mm	75.1	43.1
COP Measures		
Path length, mm	114.1	54.0
Average Velocity, mm/sec	11.6	10.4
Standard Deviation X, mm	0.3 right	7.1 left
Standard Deviation Y, mm	14.9 top	37.6 bottom

Of particular interest is the reduction in the minor axis, the reduction in the major axis length and the reduction in the C of M area of movement. All indicative of increased stability and balance.

Evidence of Pressure Distribution, Posture and Gait Change.



Retraining of muscle firing sequences may lead to increased gait efficiencies *(better use of hallux at TO),* reduction of localized pressure *(note balanced weight distribution between rear and forefoot)* and improved posture/balance.

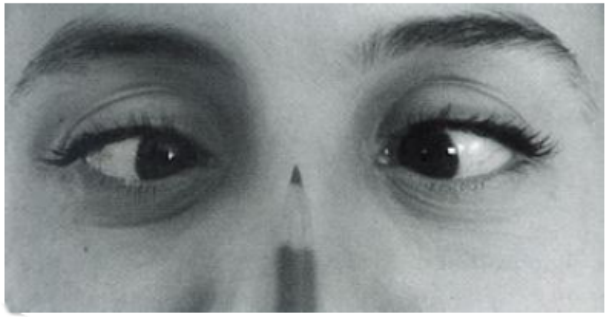
Other Issues relating to Gait, Posture and Balance.

There are four (4) primary proprioreceptors responsible for postural alignment.

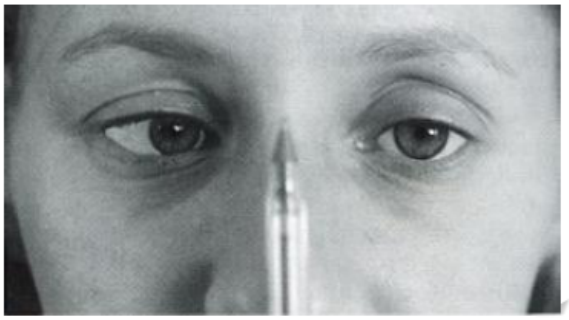
These include:

The Eyes: **Convergence & divergence**
(due to muscle strength, control & coordination)

Normal convergence



Asymmetrical convergence



Other Issues relating to Gait, Posture and Balance.

The Mandible: **Position & occlusion**
(due to skeletal orientation, muscle strength, control & coordination, and galvanic currents)

Skin Scars: **Body bend & torsion**
(due to stitching, and skin stretch & in tension)

The Feet: **Position and center of force (CoF) location**

(due to tactile pressure, skeletal orientation and muscle strength control & coordination)