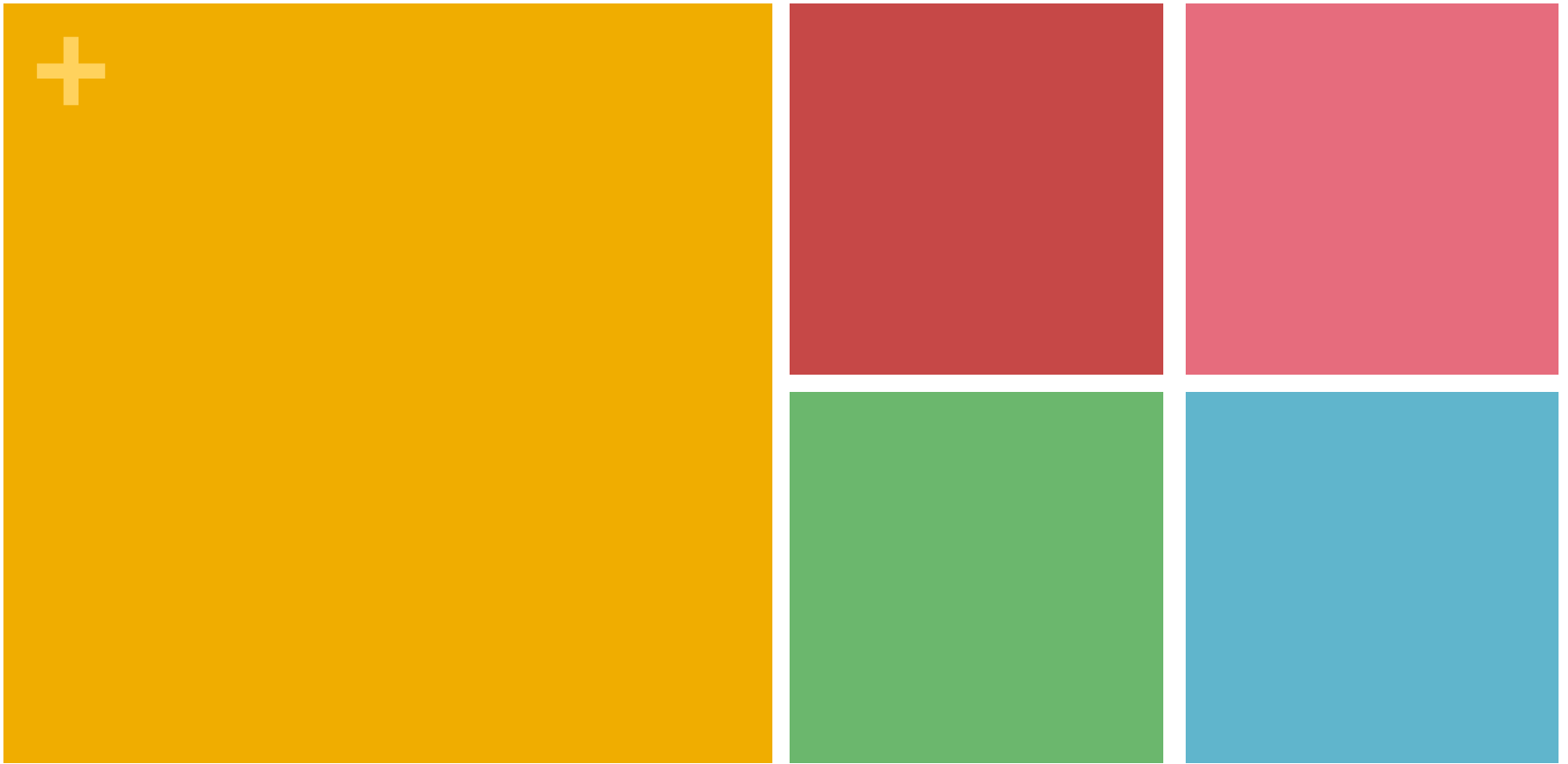
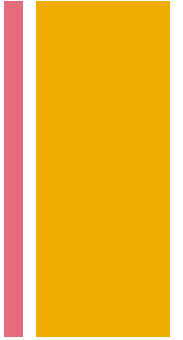




Biomechanical Assessment of Performance and Injury

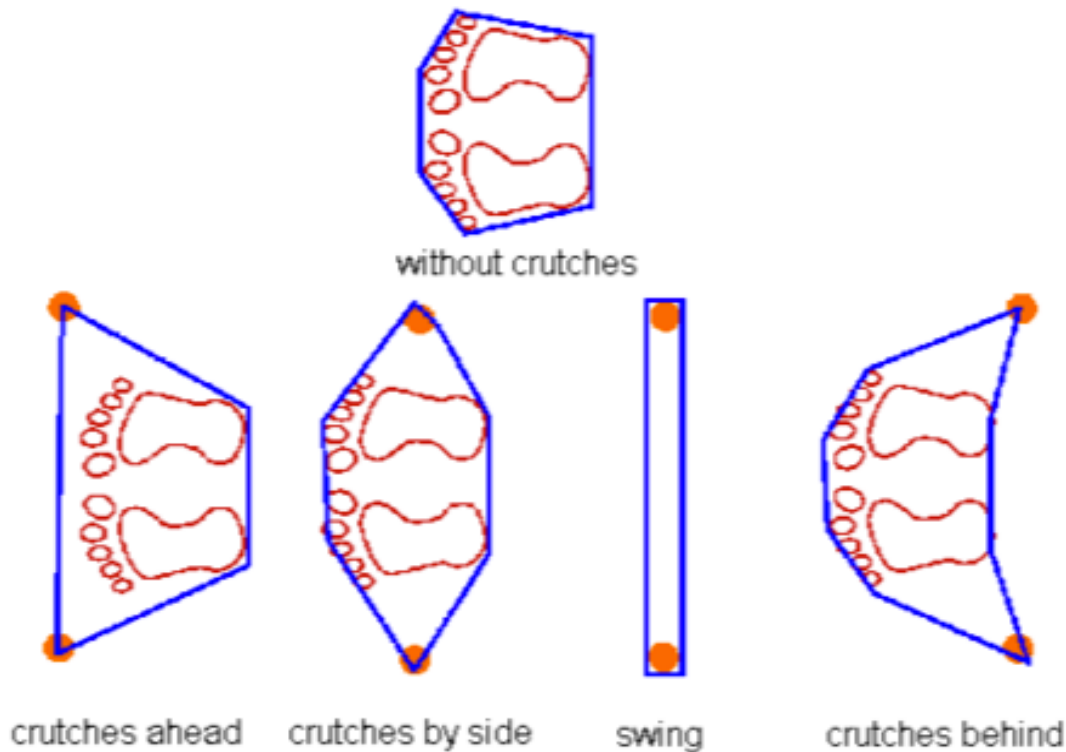
+ Content - Gait Analysis



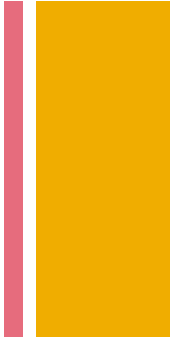
- Base of Support
- Normal Phases of Gait
- Abnormalities
- Measurement of Gait

+ Base of Support - BOS

- BOS is formed by the area created from the points of contact between the body and ground.

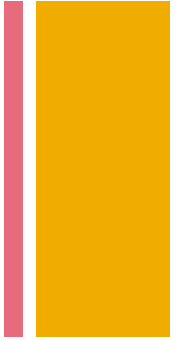


+ Base of Support - BOS



- Increase in BOS is normally associated with increase in stability
- Line of gravity
- Centre of gravity
- Principles that effect stability in a given individual

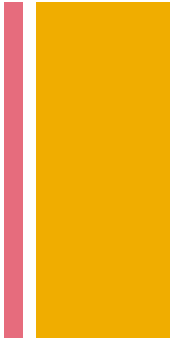
+ Gait Analysis



- Walking is a series of gait cycles
- Study of human locomotion
- Involves walking and running



Main Tasks of Gait Cycle



■ Weight Acceptance

- Most demanding task in gait cycle
- Transfer of body weight on to the limb that has just finished swinging forward in poor anatomical alignment
- Shock absorption and maintenance of forward body progression

■ Single Limb Support

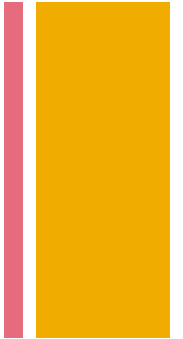
- One limb must provide support for entire body
- Stability around trunk is preserved whilst opposite limb continues motion

■ Limb advancement

- Foot clearance required
- Swings through three positions as it travels towards another heel strike



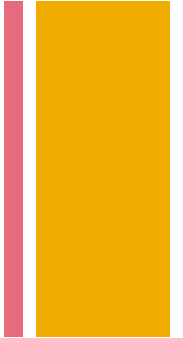
Why study normal gait?



- One of the most important functional movements
- Loss of ability to walk can result in significant health issues
- Pain/ Injury/ Pathology can alter gait and lead to:
 - Musculoskeletal compensatory strategies
 - CV and pulmonary issues
 - Psychosocial issues including depression
- Health and Fitness professionals have to knowledge to restore pain free movement in individuals with altered gait mechanics
- What are the normal variations in gait?



Normal gait requirements

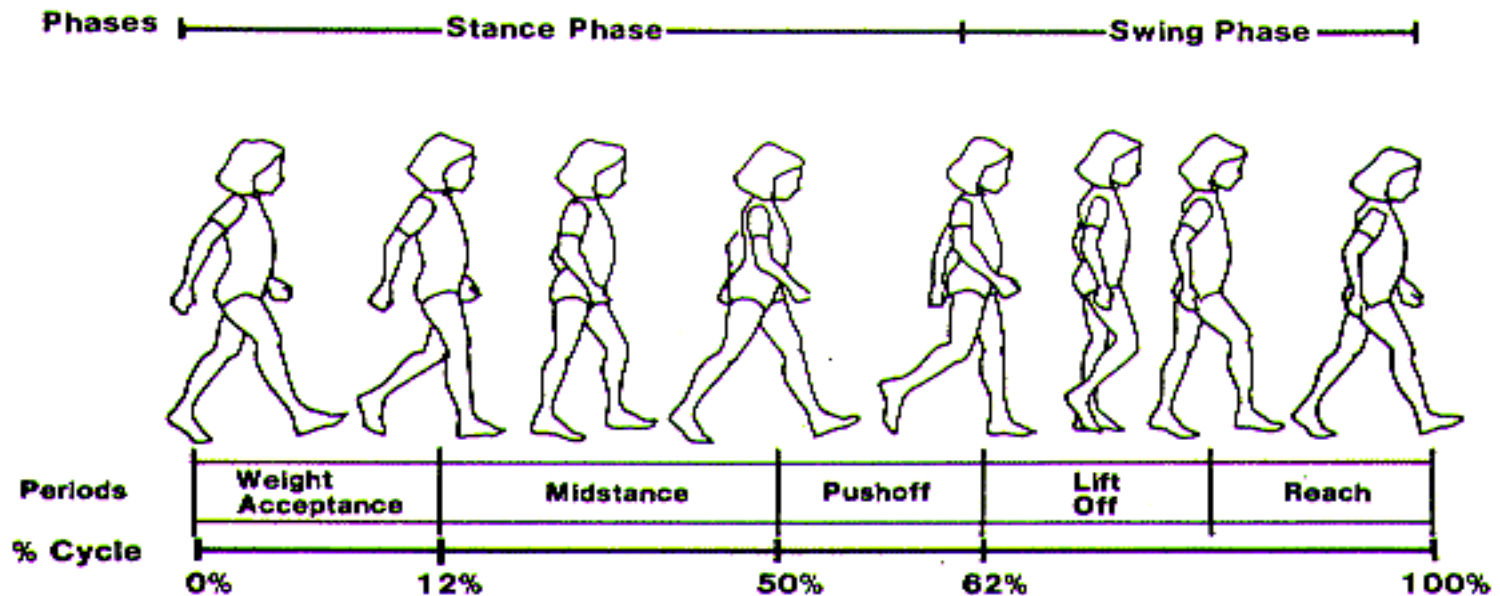


- Locomotion
 - Rhythmic mobilisation
- Equilibrium
 - Ability of assume upright balance and posture
- Integrity of MSK system
 - Normal ST and Bone condition
- Neurological control
 - Afferent and efferent messages from receptors contributing to the ability of body to respond to movement

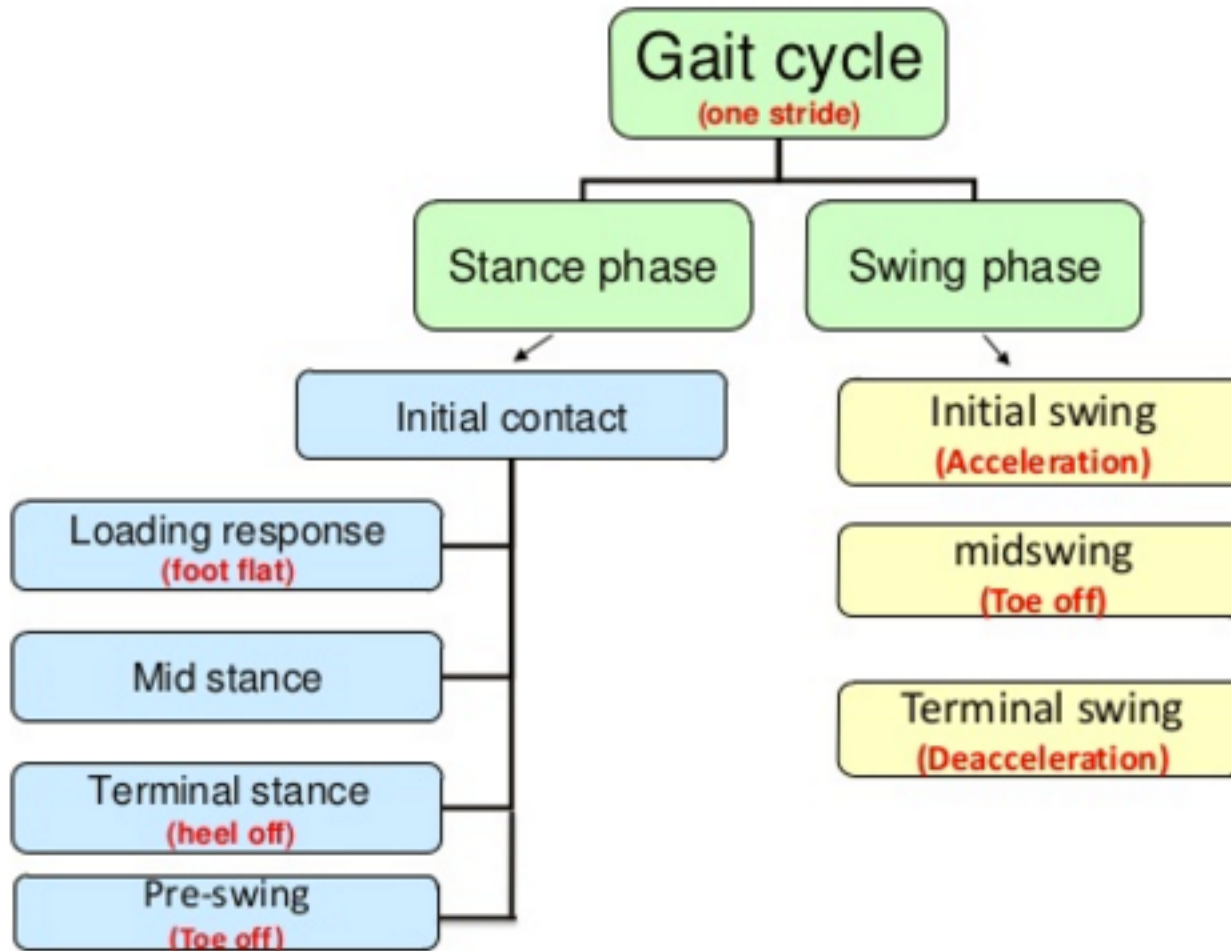


Gait Cycle

- Single gait cycle or 'Stride' is defined:
 - Period of one foot contact the ground til when that same foot contacts the ground again
 - Each stride has two phases
 - Stance Phase
 - Swing Phase



+ Phases of Gait



+ Phases of Gait - Stance

When the foot is contact with the ground only

Propulsion phase

Stance phase has 5 parts:

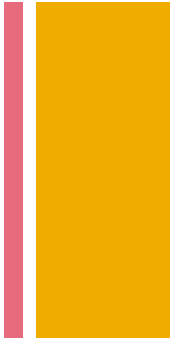
- Initial Contact (Heel Strike) (1)
- Loading Response (Foot Flat) (2)
- Midstance (2)
- Terminal Stance (3)
- Toe Off (Pre-Swing) (4)



(Missing Loading Response in picture)

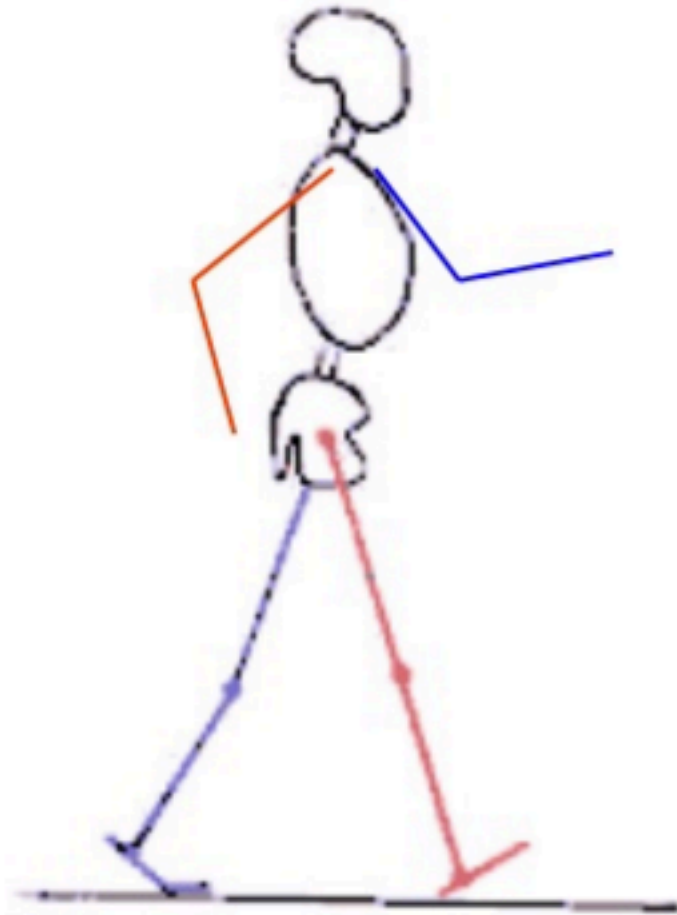
+ Motions during Stance

- Shoulder flexs
- Pelvis rotates in transverse plane
- Opposite rotation of spine
- Hip extends and Irs
- Knee flexs and extends
- Ankle PF/DF/PF
- SubTalar Pro/Sup
- Toes PF/DF/PF



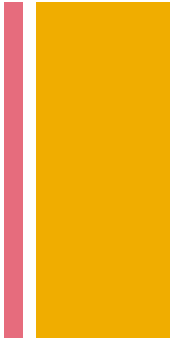
+ Initial Contact

- **Phase 1**
- The moment when the **red** foot just touches the floor.
- The heel (calcaneus) is the first bone of the foot to touch the ground.
- Meanwhile, the blue leg is at the end of terminal stance.





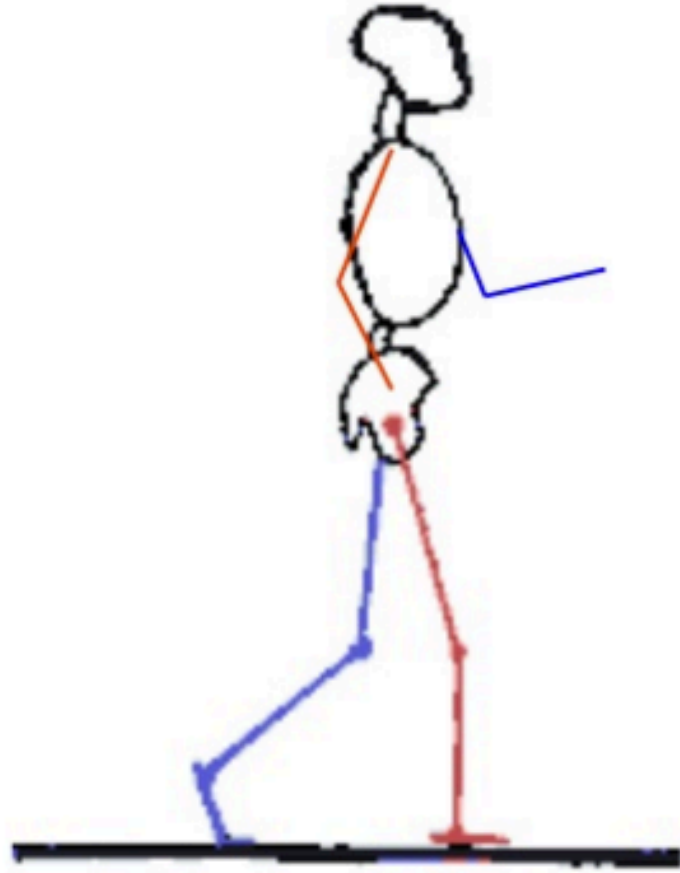
Static positions held with Initial Contact



- FREEZE FRAME positions
- Shoulder Extended
- Pelvis rotated
- Hip flexed and ER
- Knee fully extended
- Ankle dorsiflexed
- SubTalar is supinated
- Toes are dorsiflexed

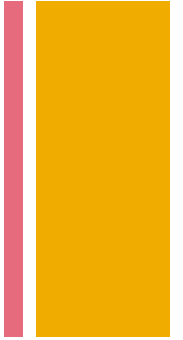
+ Loading Response

- **Phase 2**
- The double stance period beginning
- Body weight is transferred onto the **red** leg.
- Phase 2 is important for shock absorption, weight-bearing, and forward progression.
- The blue leg is in the pre-swing phase.





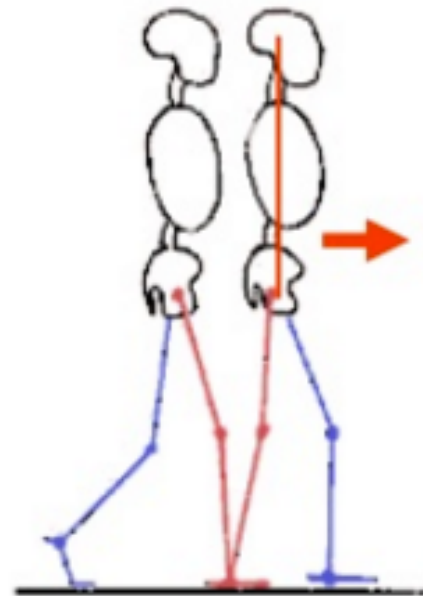
Static positions held in Loading response



- FREEZE FRAME positions
- Shoulder sl.Extended
- Pelvis rotated
- Hip flexed and sl.ER
- Knee slightly flexed
- Ankle PFing to neutral
- SubTalar is neutral
- Toes neutral

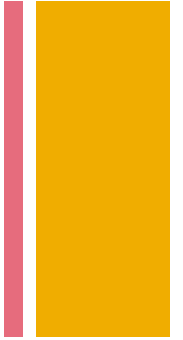
+ Midstance

- **Phase 3**
- **single limb support** interval.
- Begins with the lifting of the blue foot and continues until body weight is aligned over the **red** (supporting) foot.
- The red leg advances over the red foot. The blue leg is in its mid-swing phase.





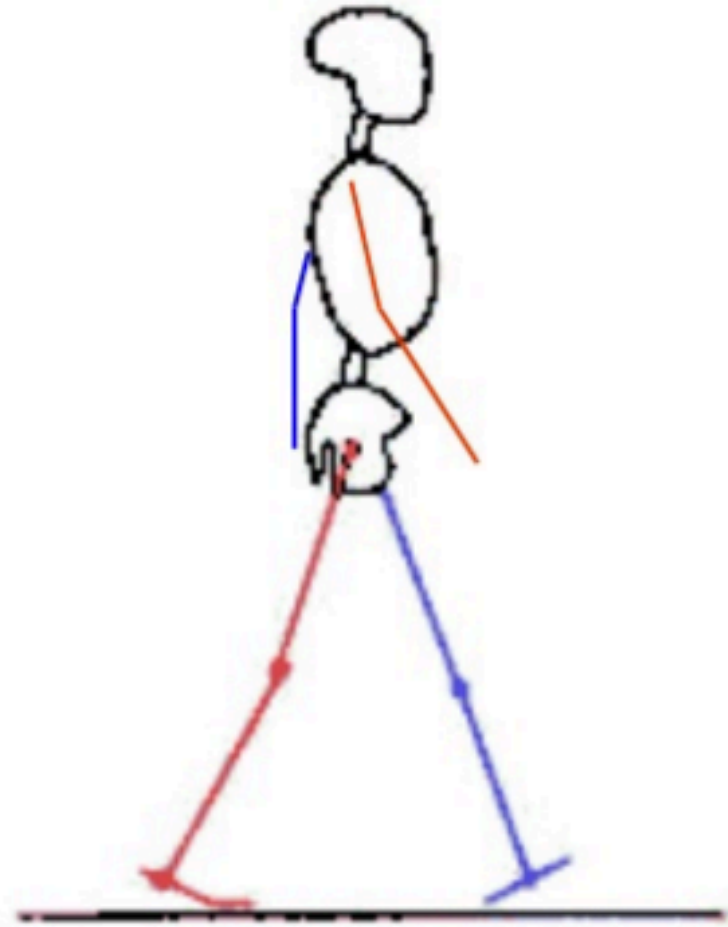
Static positions held in Midstance



- Shoulder in neutral
- Pelvis in neutral
- Hip in neutral
- Knee extended
- Ankle in neutral
- SubTalar pronated
- Toes in neutral

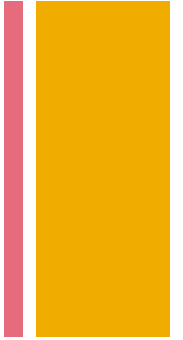
+ Terminal Stance

- **Phase 4**
- Begins when the **red** heel rises and continues until the heel of the blue foot hits the ground.
- Body weight progresses beyond the red foot





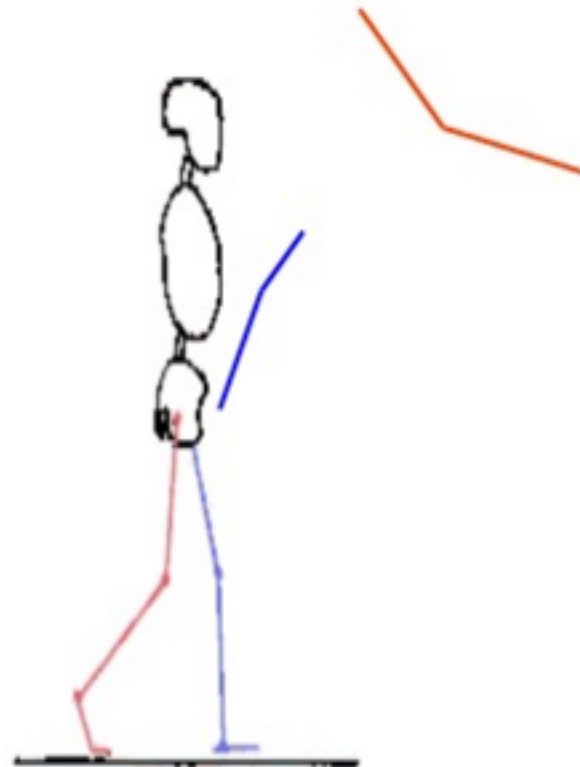
Static positions held in Terminal Stance



- Shoulder in sl flexion
- Pelvis in rotated
- Hip in extended and internally rotated
- Knee extended
- Ankle in DF
- SubTalar sl supination
- Toes in neutral

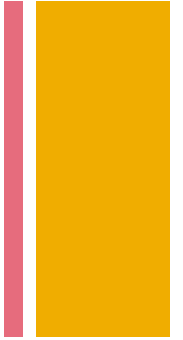
+ Toe Off

- **Phase 5**
- The second double stance interval in the gait cycle.
- Begins with the initial contact of the blue foot and ends with **red** toe-off.
- Transfer of body weight from ipsilateral to opposite limb takes place.





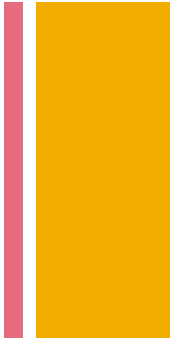
Static positions held in Toe Off



- Shoulder in flexion
- Pelvis in rotation opposite
- Hip in extended and internally rotated
- Knee extended
- Ankle in full PF
- SubTalar full supination
- Toes in plantar flexion



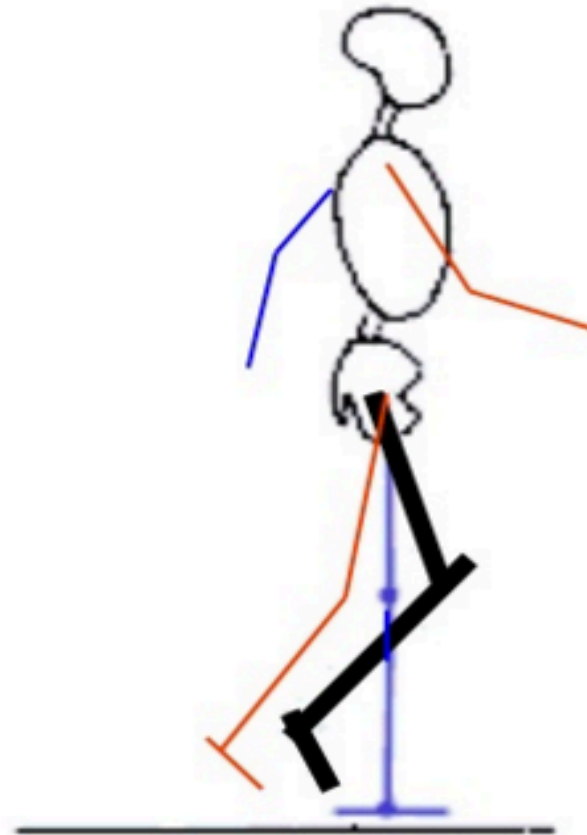
Stance phase characteristics



- During single stride, there are two periods of double limb support.
 - Loading response and opposite Toe off
 - Loading response and opposite Toe off

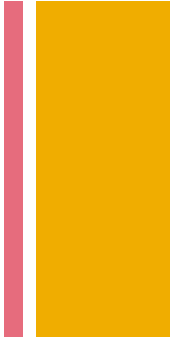
+ Initial Swing Phase

- **Phase 6**
- Begins when the red foot is lifted from the floor and ends when the red swinging foot is opposite the blue stance foot.
- It is during this phase that a footdrop gait is most apparent.
- The blue leg is in mid-stance.





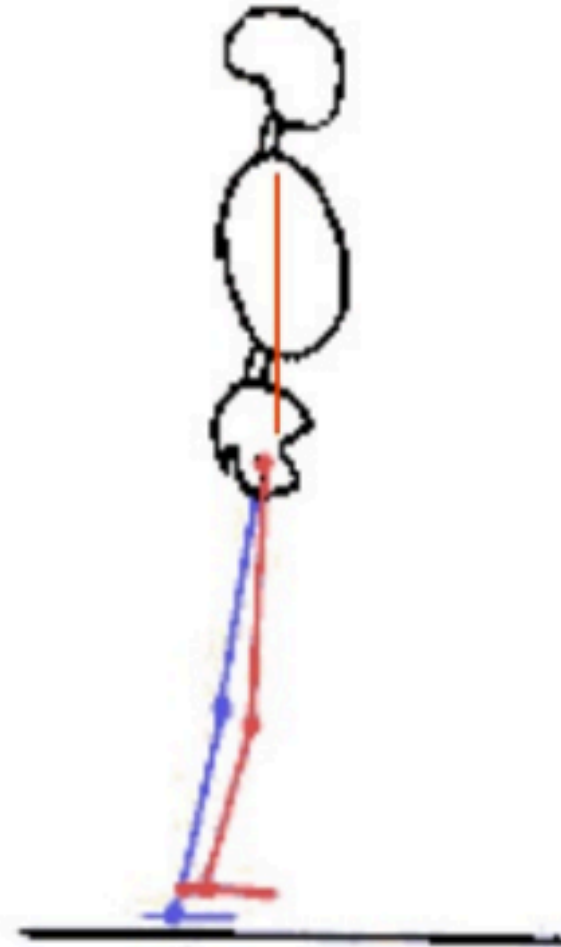
Static positions held in Initial Swing phase



- Shoulder in flexion
- Spine is rotated
- Pelvis in rotation opposite
- Hip in extended and internally rotated
- Knee sl flexed
- Ankle in full PF
- SubTalar full supination
- Toes in sl plantar flexion

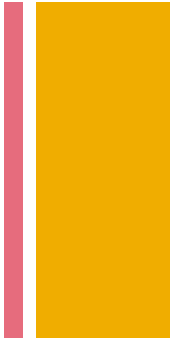
+ Midstance

- **Phase 7**
- Starts at the end of the initial swing and continues until the red swinging limb is in front of the body
- Advancement of the red leg
- The blue leg is in late mid-stance.





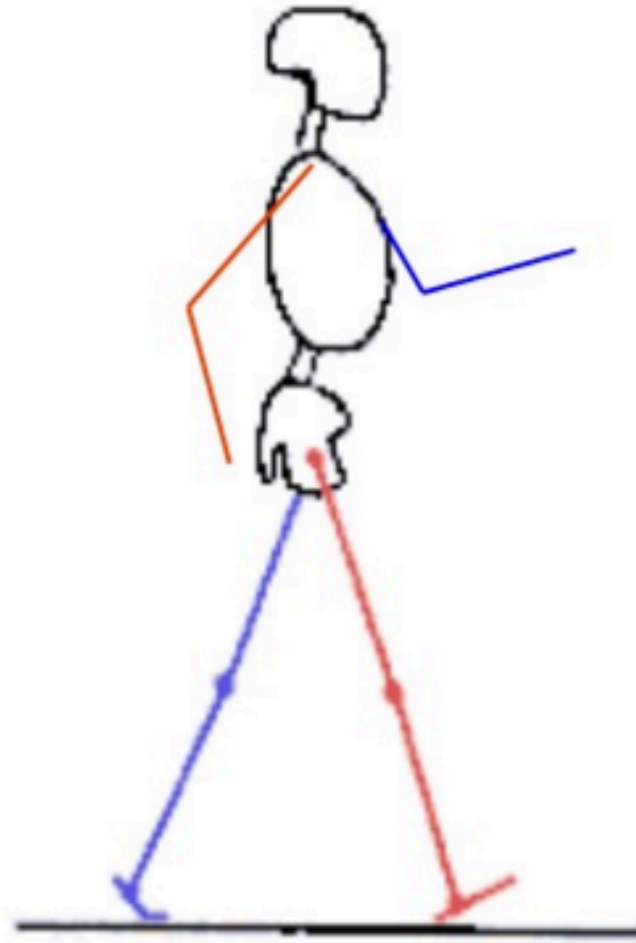
Static positions held in Midstance



- Shoulder in flexion
- Spine is neutral
- Pelvis in neutral
- Hip in neutral
- Knee flexed 60-90
- Ankle in PF to neutral
- SubTalar neutral
- Toes in dorsi flexion

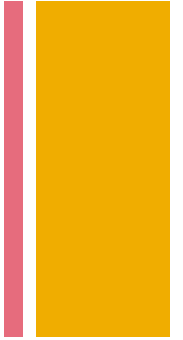
+ Terminal Swing

- **Phase 8**
- Begins at the end of midswing and ends when the foot touches the floor.
- Limb advancement is completed at the end of this phase.



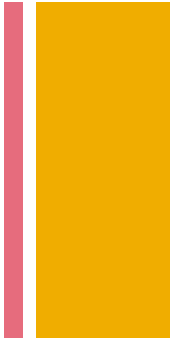


Static positions held in Terminal stance



- Shoulder Extended
- Pelvis rotated
- Hip flexed and ER
- Knee fully extended
- Ankle dorsiflexed
- SubTalar is neutral
- Toes are sl dorsiflexed

+ Gait Abnormalities



■ Antalgic Gait

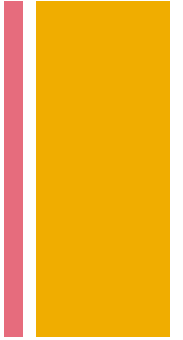
- Reduced time in stance phase
- Reduces weight bearing to 20-30% compared to the usual 50%
- Reduced stride length, leading to potential over stride on opposite leg

■ High Stepping Gait

- Seen in peripheral neuropathy
- Loss of motor function of the anterior compartment
- Leads to foot drop
- Patients excessively flex the knee to gain the sufficient clearance for the requirement



Gait analysis



- Viewing gait should be performed in sagittal and coronal planes, although pelvic rotation can only fully be seen from a transverse plane.
- Straight visual observation can be limited due to ability to determine anomalies.
- Video is a key way in which observation of these movements can prove beneficial.

+ Videos



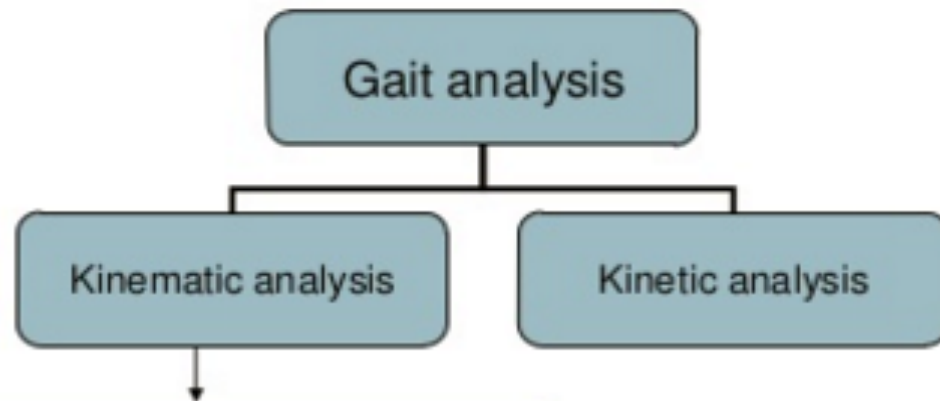
+ Videos



+ Videos



+ Measurement of Gait



1) Distance (**spatial**) & time (**temporal**) variables.

2) Measurement of joint angles of lower and upper extremities.

3) Descriptive components of gait (determinants of gait).

+ Measurement of Gait

■ Distance (Spatial)

- Step Length
- Stride Length
- Walking Base – distance between left and right feet
- Degree of Toe Out (Normal for men 7°, but decreases with increased cadence)

■ Time (Temporal)

- Step Time – time between steps
- Stride Time – time to complete single stride
- Stance Time – time for one extremity in contact during gait cycle
- Swing Time – time for one limb not in contact during gait cycle
- Cadence – steps per unit of time
- Speed – distance/time
- Double/ Single limb time –