

Walk small, walk tall

Walking across the lifespan

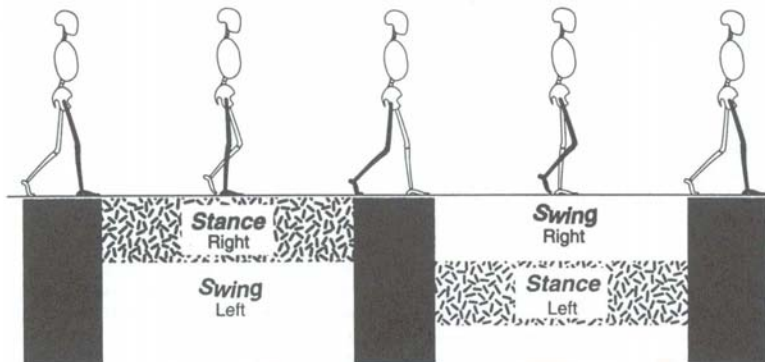
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RSRC

Human walking



Walking is a pattern of controlled falling
stance:swing ratio =60:40

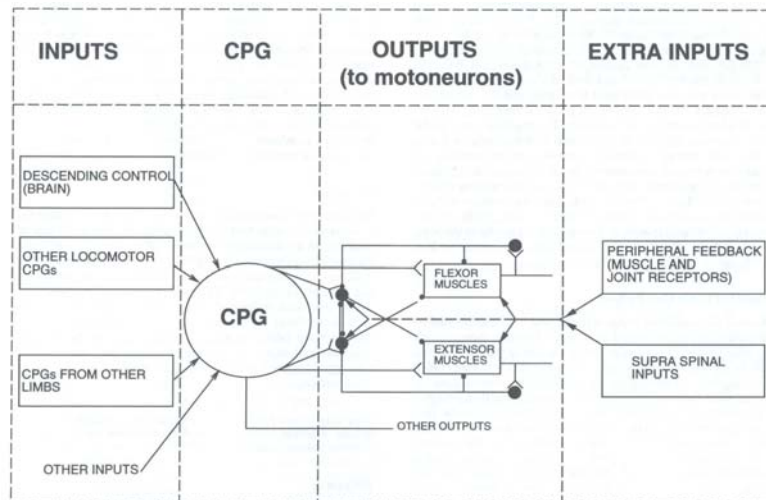


Control of locomotion

- **Static stability at slow speeds:** centre of mass remains within the base of support
- **Dynamic stability during motion** involves the summed support forces of the legs, momentum and inertial forces
- Energy expenditure associated with vertical motion of the body centre of gravity and forward propulsion
- Neural mechanisms are complex and widely distributed within nervous system
- Changing terrain or speed, negotiating obstacles pose motor control challenges



Neural control of walking



Gait maturation and decline

- Gait maturation is a major developmental milestone in early childhood
 - shaped by environmental experience
- Gait decline in the elderly often signals
 - difficulty in moving within the community
 - the need for a change of lifestyle and possibly supported living



Limitations of current measurement tools

- Provide limited knowledge about mechanisms of maturation and decline.
- Laboratory-based technology is labour-intensive and expensive.
- Lack of sophistication in standard clinical measures and inaccuracy of visual observation
- Impact on sample size, number of trials and the amount of information that can be collected
- Provenance of normative values associated with commercially available systems is unknown: small sample size, no demographic or anthropometric data
- Decisions about the quality or abnormality of gait are based on limited reference data that is unrepresentative of specific age groups.



Minimum gait data set

- Permits identification of the level of gait deviation resulting from
 - reduced physical activity levels
 - obesity
 - delayed motor development in children
 - disease, injury or the aging process
- Allows monitoring of restoration in lower limb function following exercise
- Permits informed decisions about the community-dwelling independence of an older person.



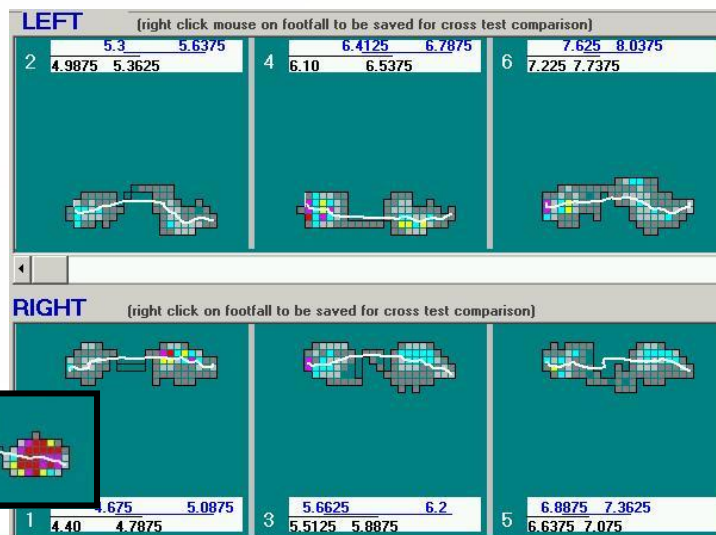
GAITRite: Spatiotemporal parameters

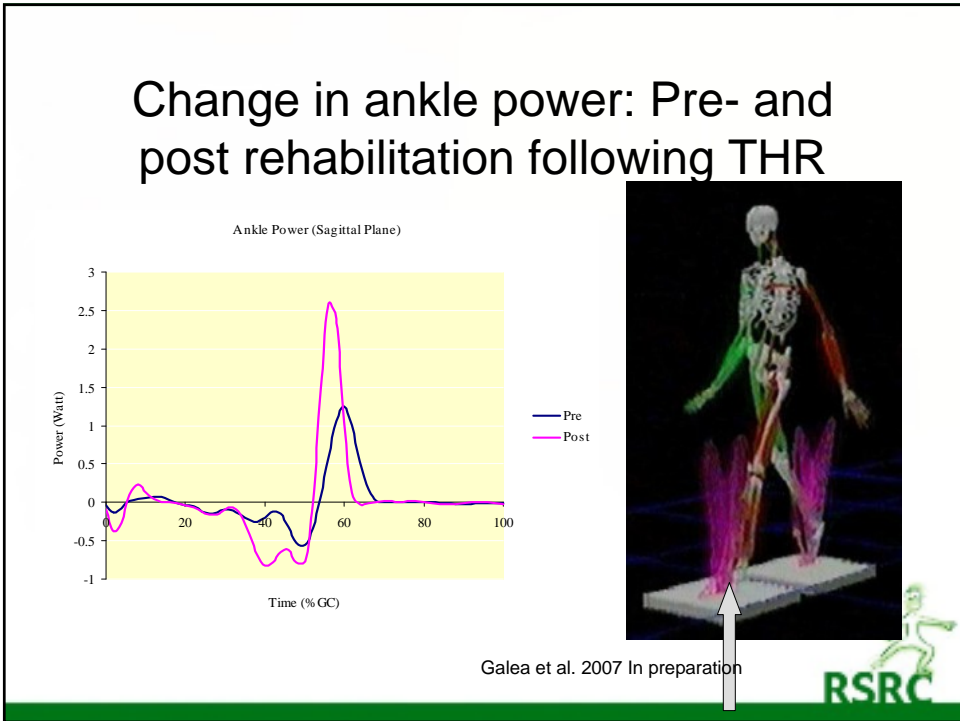
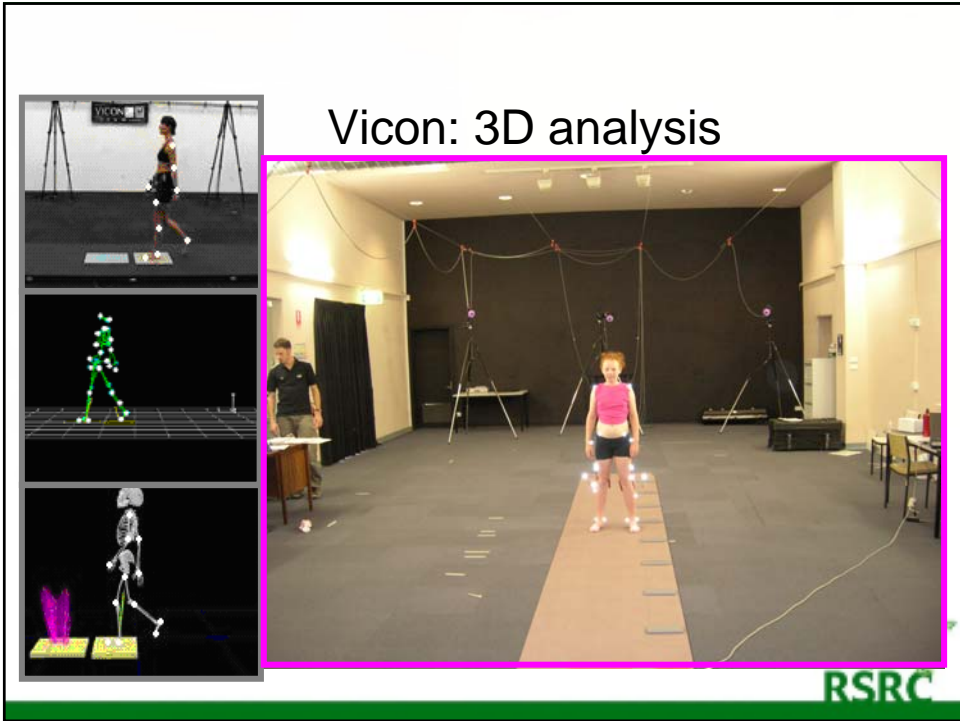


Gorgon, Said, Galea 1997 *Physio Res Int* 12:72-81



Patient with OA hip





Demonstration



Questions for e-research - 1

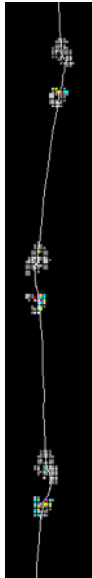
When is gait mature?

- Indicators:
 - presence of a heel strike
 - reciprocal arm swing
 - generation of a knee-flexion wave
 - pelvic-span-over-ankle-spread ratio of 2.5
- New findings - Children have:
 - reduced peak plantarflexor moments
 - less peak power absorption and generation at the ankle during late stance

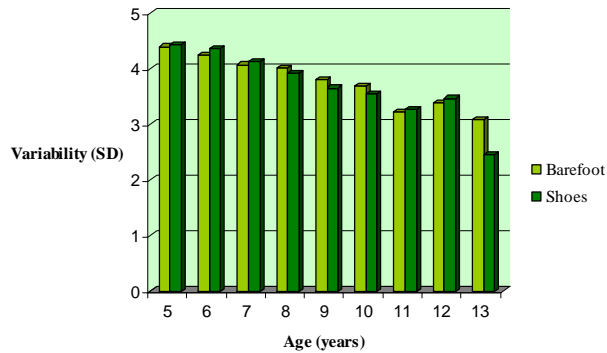
Do children grow out of early abnormalities e.g. intoeing, knock knees?



Zigzag variability in children reduces with age



Zig Zag Variability

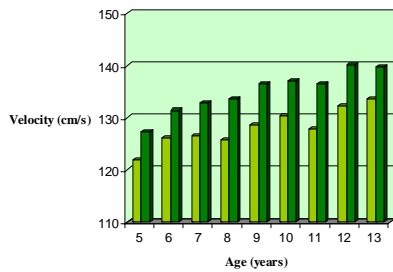


Lythgo & Galea 2007 In preparation

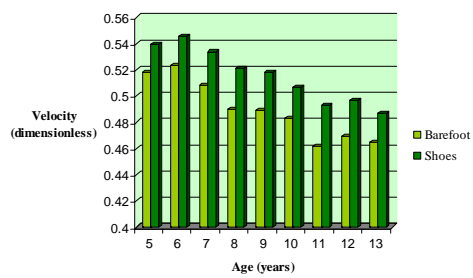


Changes in gait velocity in children

Gait Velocity



Gait Velocity (normalised to leg length)



Lythgo & Galea 2007 In preparation



Questions for e-research - 2

How does obesity affect gait?

- Obese children exhibit
 - lower cadence and velocity
 - longer stance period
 - greater asymmetry in step length
 - longer time in double support
 - larger base of support

Is obesity associated with motor impairment or developmental delay?



Questions for e-research - 3

Age-related decline

- Consistent changes:
 - reductions in step length, cadence and walking speed
 - increase in step width
 - reductions in range of motion
 - Reduced foot-ground/obstacle clearance
 - Reduced ankle plantar-flexor power at push-off

When does gait start to deteriorate?

How do older adults deal with perturbations, e.g. walking faster, negotiating obstacles?



Questions for e-research - 4

What is the relationship between gait variability/symmetry and falling behaviour?

- Fallers are found to have
 - reduced step width variability
 - increased step width
 - significant gait asymmetry

Is there functional gait asymmetry? (one limb propulsive and the other supporting or stabilising)



Questions for e-research - 5

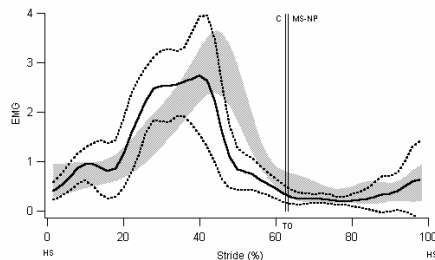
Gait as an early marker of disease:

- Nervous system disease e.g. multiple sclerosis, Parkinson's disease
- Dementia
- Development of lower limb osteoarthritis

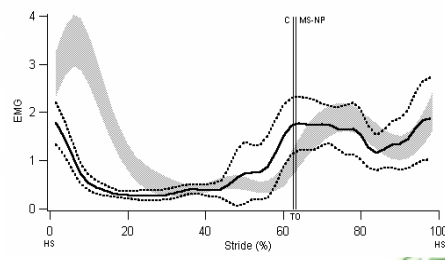


Motor impairments in people with recently diagnosed Multiple Sclerosis

- Reduced ankle motion throughout the gait cycle
- Alterations in the timing of activity in muscles controlling the ankle



Medial gastrocnemius



Tibialis anterior

Martin et al. 2006 *Multiple Sclerosis*. 12: 620-628.



What is needed?

- **Standardised protocols**
 - GAITRite and Vicon systems
 - Minimum dataset incl. anthropometric measures
 - Standard and perturbed trials, barefoot and shod
- **Appropriate interface**
 - Organization of data
 - Uploading of data
 - Interrogation of database
- **Security and access rights**
- **Privacy considerations**



National benefit

- Lifespan reference data will permit:
 - assessment of gait deviations resulting from reduced physical activity levels, obesity, delayed motor development in children, disease, injury or the aging process.
 - monitoring of the effects of public health initiatives designed to promote the benefits of exercise
 - making informed decisions about the community-dwelling independence of an older person.
 - re-assessment of community environment: e.g. settings for control of pedestrian crossings
 - development and assessment of computer models to explore the musculo-skeletal determinants of gait.



Acknowledgements

- RSRC staff and students
 - Noel Lythgo
 - Pazit Levinger
 - Cameron Wilson
 - Ian Anderson
 - Clarissa Martin
 - David McKenzie
- VeRSI staff
 - Paul Davis
 - ABM Russel

