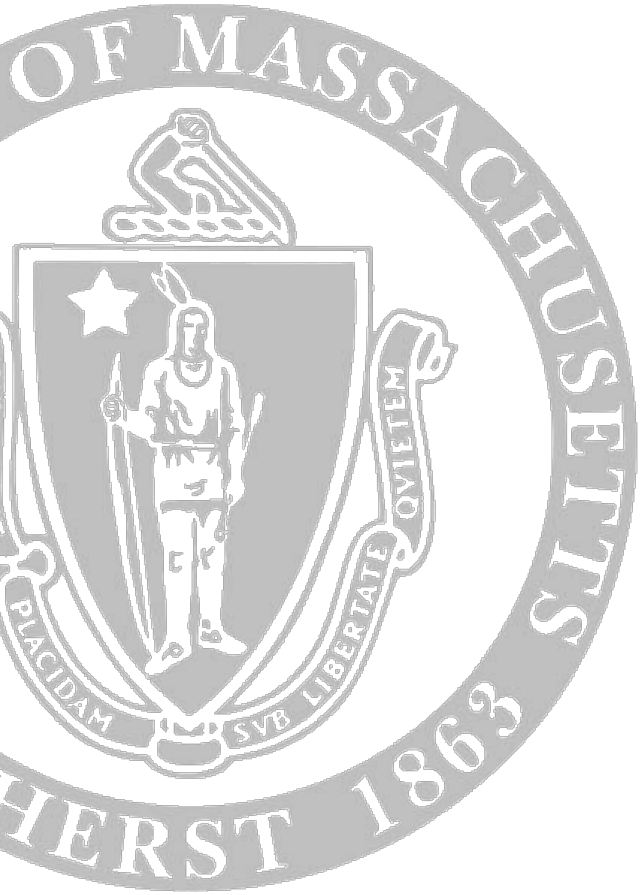
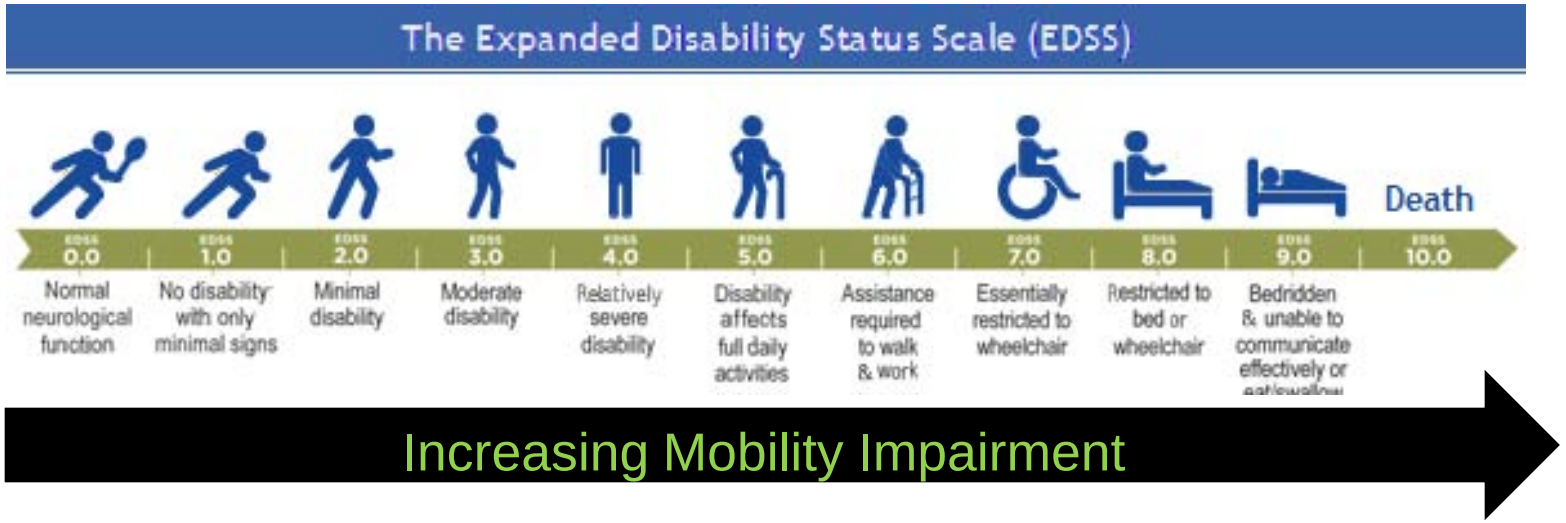


Somatosensory Impairment and Balance Dysfunction in Multiple Sclerosis

Stephanie Jones, PhD
MS Research Group
Sensory-Motor Control Laboratory
Department of Kinesiology

Multiple Sclerosis: Progressive Mobility Impairment



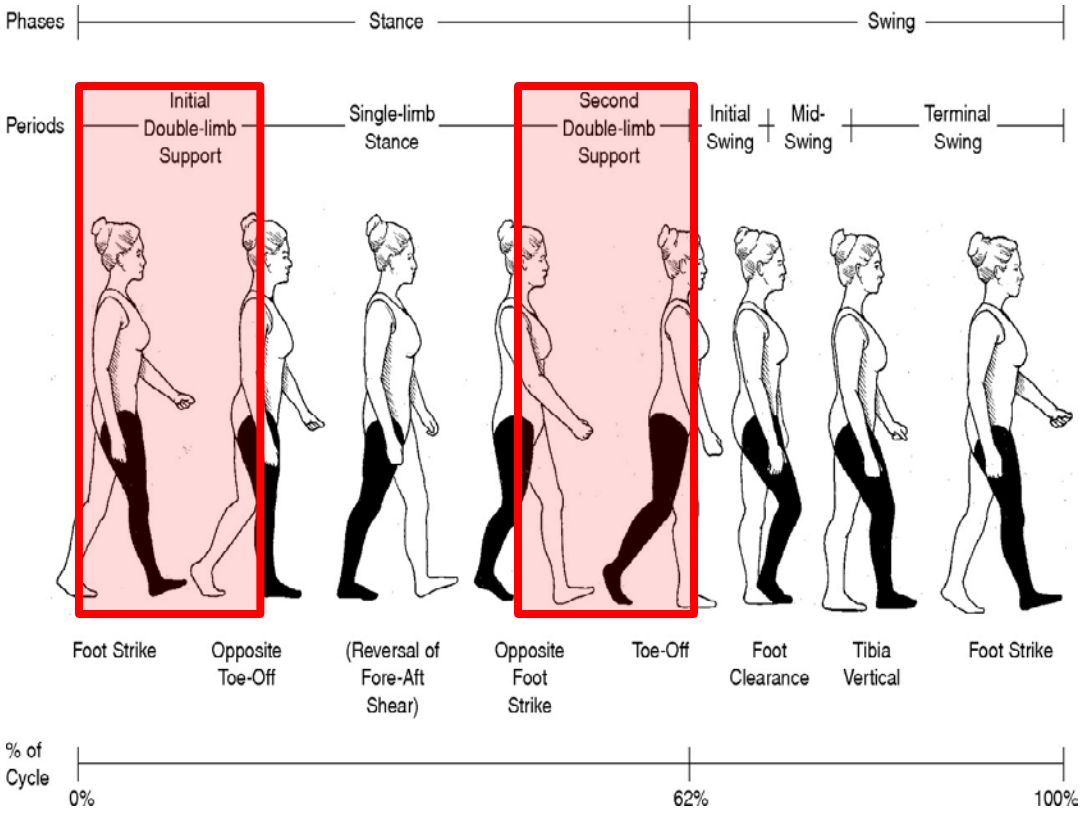
⇨ 80% will develop progressive form of MS within 20 years of Dx

Symptom	% occurrence
Fatigue	83.1%
Walking difficulties	67.2%
Stiffness and spasms	63.1%
Cognitive problems (memory)	55.8%
Bladder problems	55.8%
Pain	54.3%
Emotional and mood problems	37.5%
Vision problems	37.4%
Dizziness and vertigo	36.2%
Bowel problems	34.5%

From: Minden, S.L., et al., (2006). The Sonya Slifka longitudinal Multiple Sclerosis study: Methods and sample characteristics. Multiple Sclerosis, 12, 24-38.

Contributors? Can we intervene to maintain/improve mobility?

Impaired Mobility in People with MS



The Normal Gait Cycle, adapted from Sutherland et al., 1994

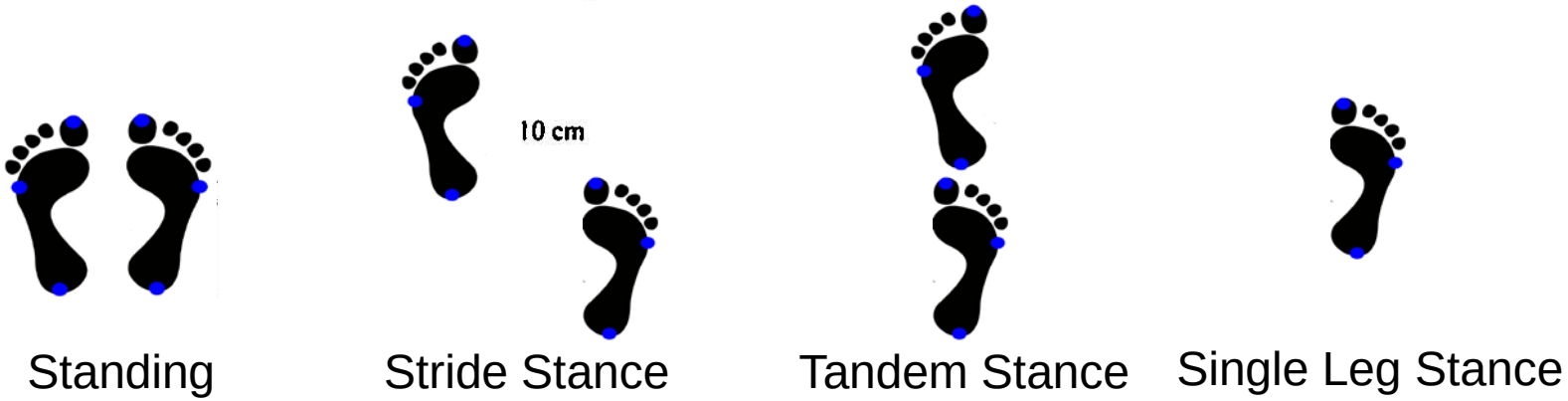
- ⇨ Slower preferred speed
- ⇨ Shorter stride length
- ⇨ Wider stride width
- ⇨ Longer double support time

(Benedetti 1999; Martin 2006; Kelleher 2010; Remelius 2012)

Adaptations to increase stability ???

Impaired Postural Control in People with MS: Clinical Balance Tests

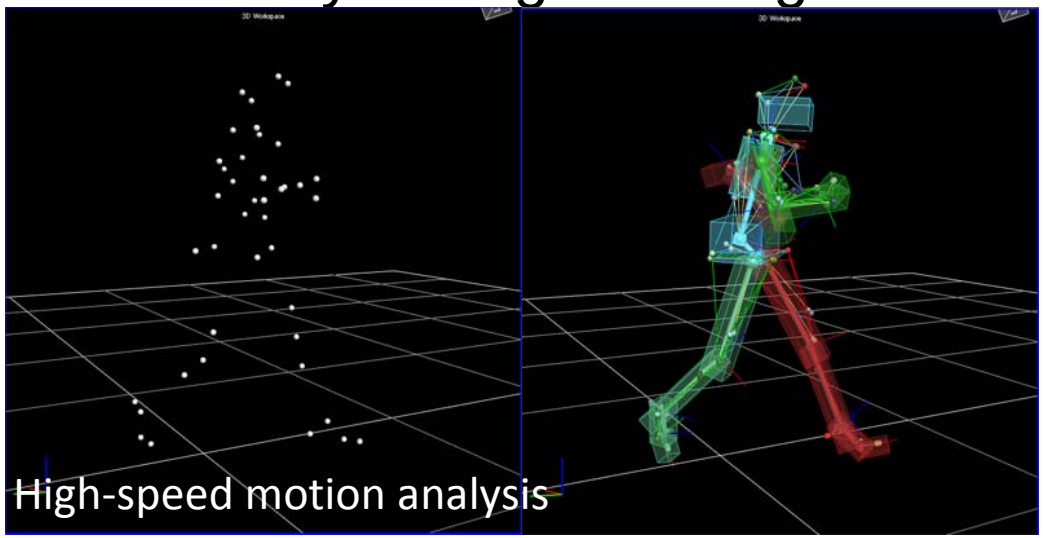
- ↓ performance on timed balance tasks (Frzovic 2000; Soyuer 2006)
  - altered base of support configurations

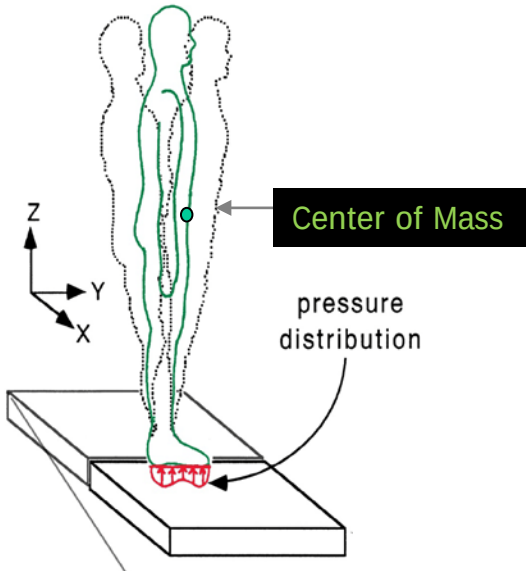


Standing | Stride Stance | Tandem Stance | Single Leg Stance

Impaired Postural Control in People with MS: Posturography

- ↑ Center of Pressure (COP) and trunk sway
- ↑ COP velocity during standing





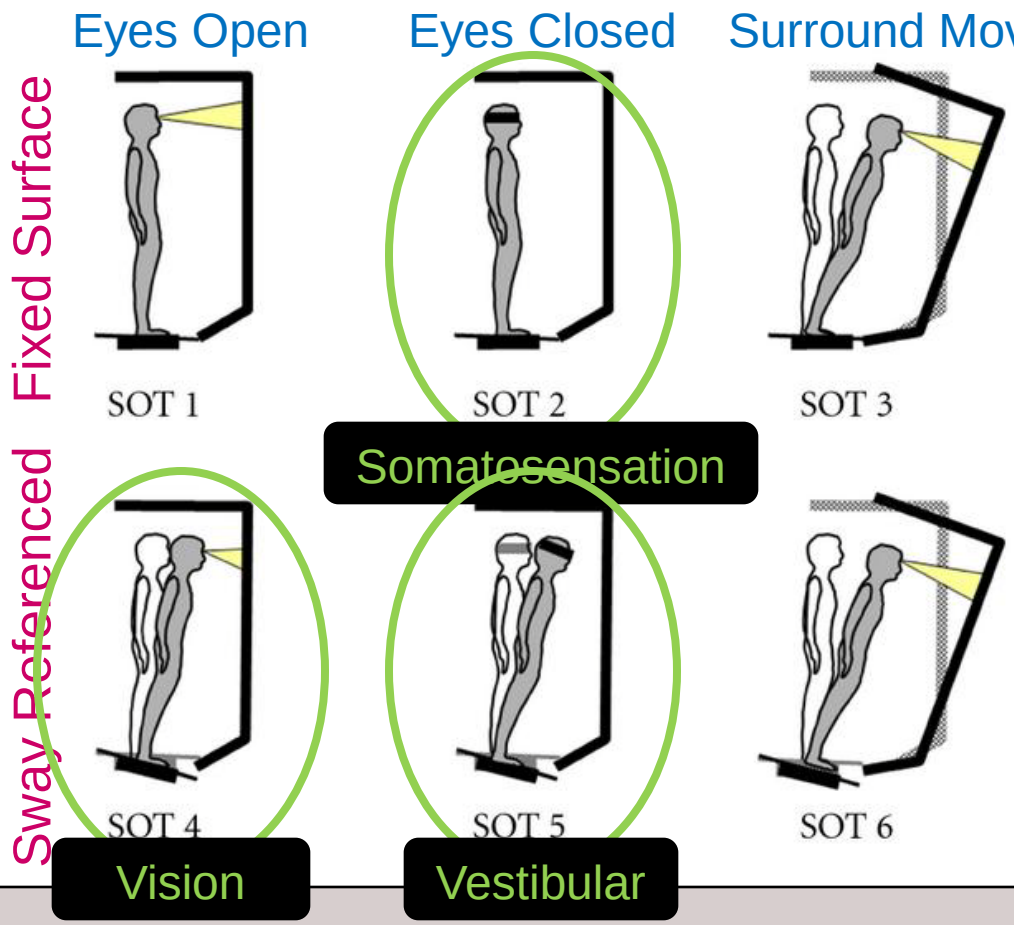


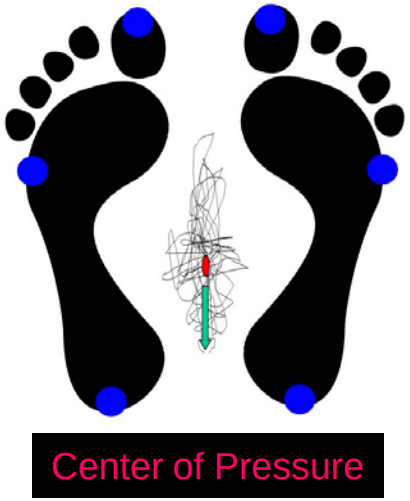
- worsened with increased task difficulty
  - ⇨ BOS restrictions
  - ⇨ self-generated perturbations *(Van Emmerik 2010)*
  - ⇨ dual task *(Boes 2012; Negahban 2011)*
  - ⇨ altered sensory conditions *(Findling 2011; Porosinksa 2010; Spain 2012; Fjeldstad 2009; Cattaneo 2009)*

Consistent with decreased stability

Impaired Postural Control in People with MS: Posturography

- Sensory Organization Test
  - ⇨ Manipulate sensory conditions
  - ⇨ Understand contribution of different sensory modalities

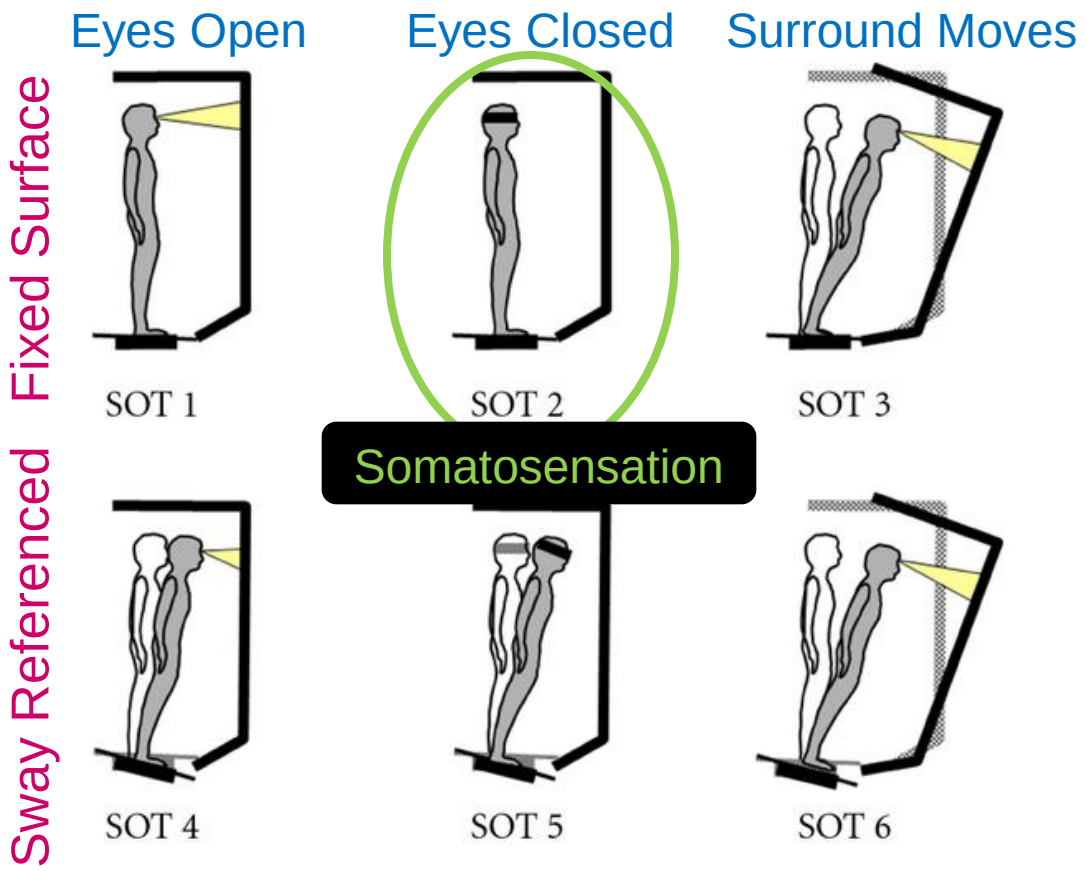


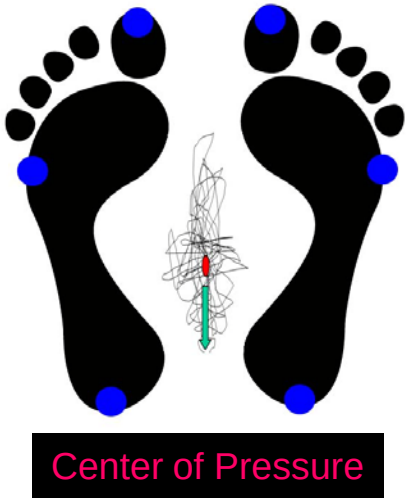


Impaired Postural Control in People with MS: Posturography

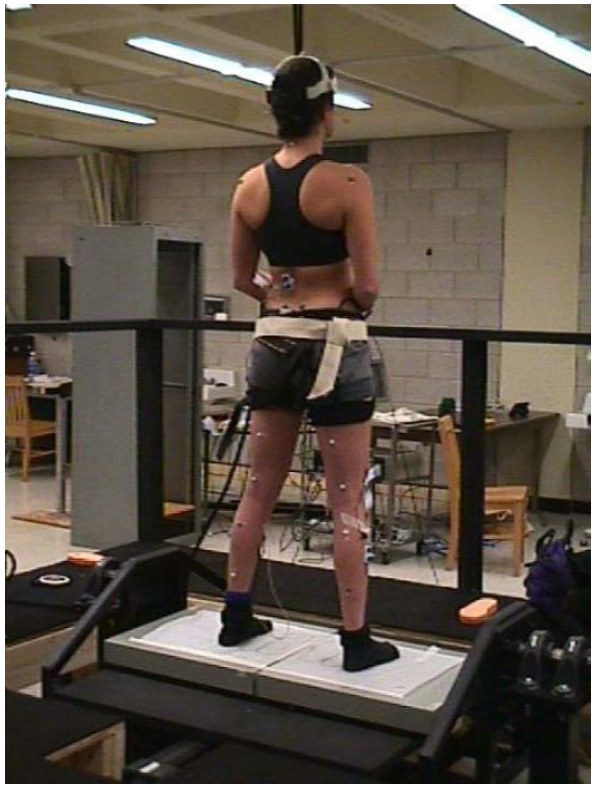
Tasks that rely on somatosensation greatly impacted in MS

(Fjeldstad 2009)

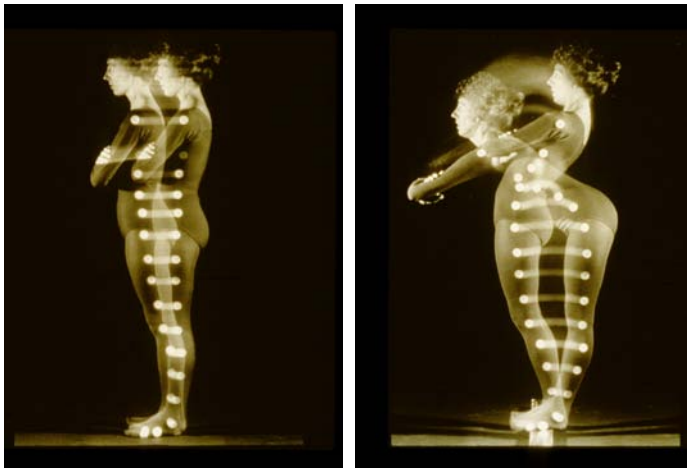




Impaired Postural Control in People with MS: Postural Responses



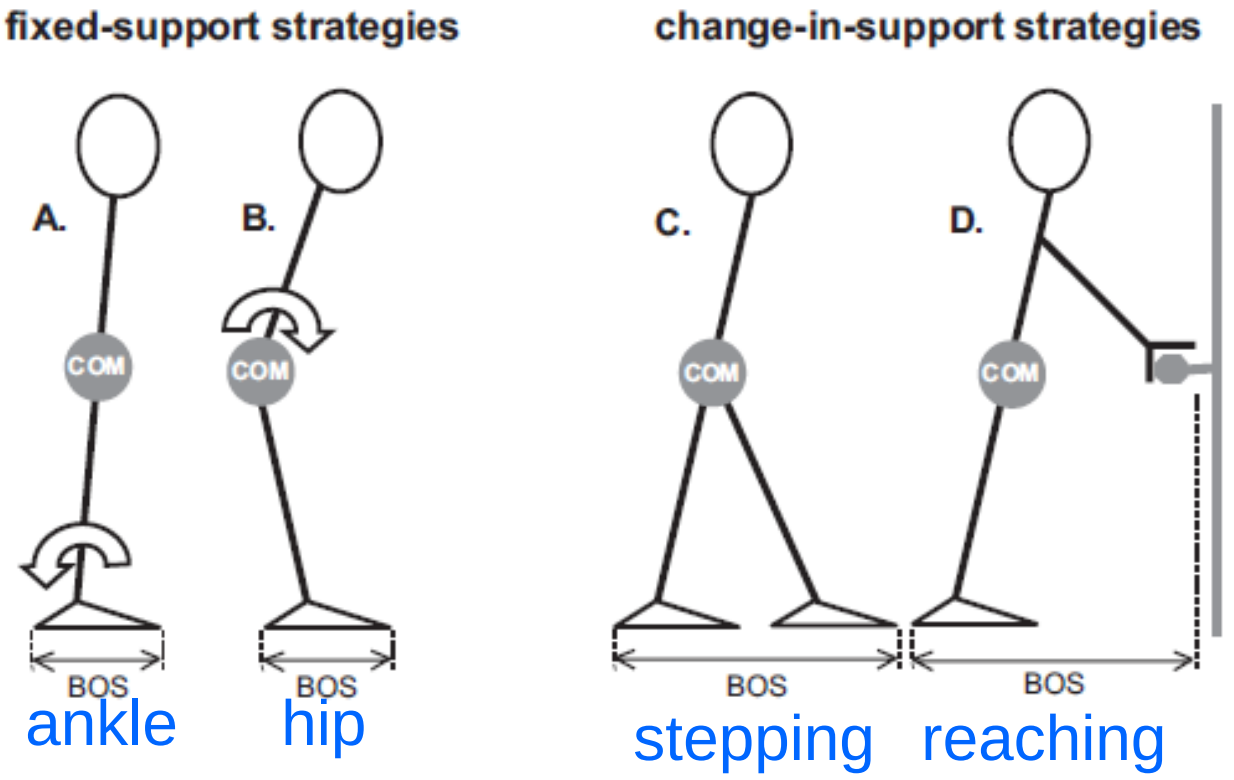
Automatic postural responses



70-100ms latency

Impaired Postural Control in People with MS: Postural Responses

- A range of strategies can be used depending on many factors
  - ⇨ Environmental context, constraints/impairments, behavioural goals

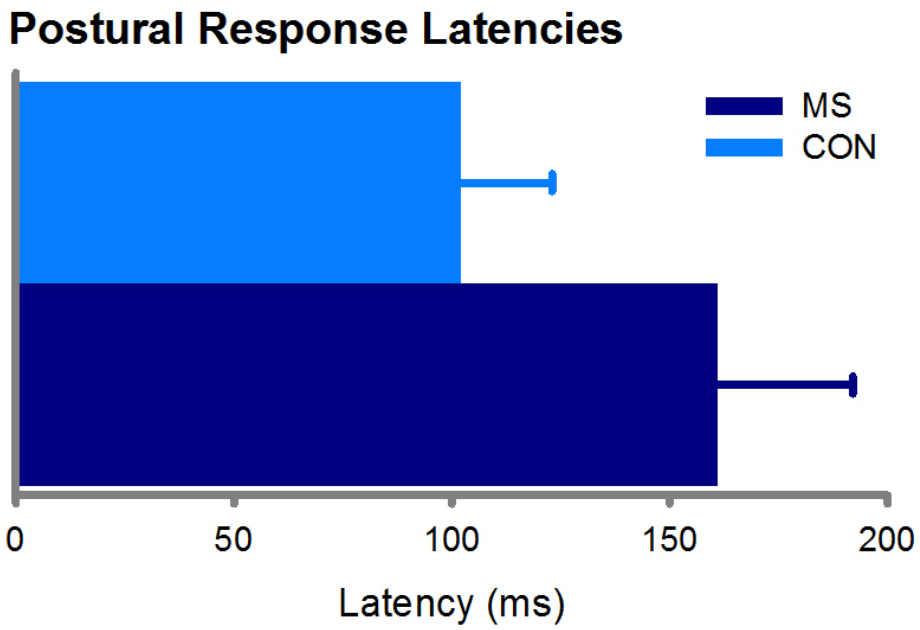


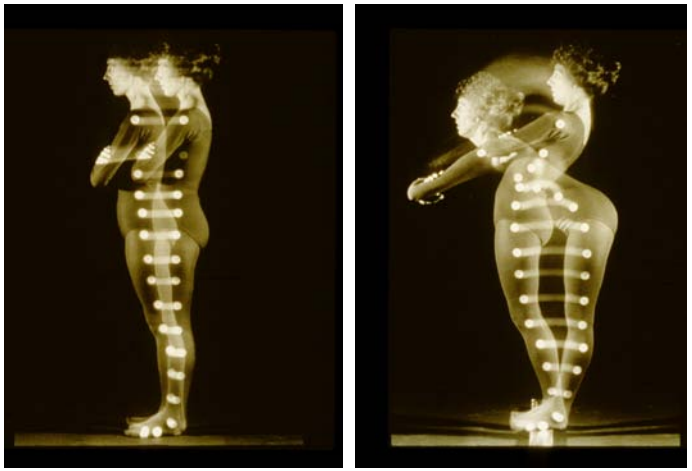
Initiated by feedback from the Somatosensory System

Impaired Postural Control in People with MS: Postural Responses

- Significantly delayed automatic postural responses

(Cameron et al., 2008)

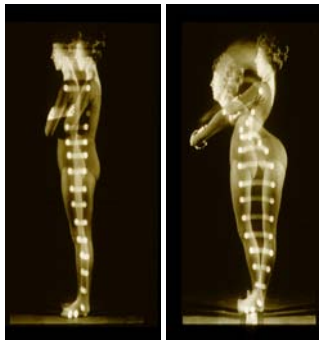


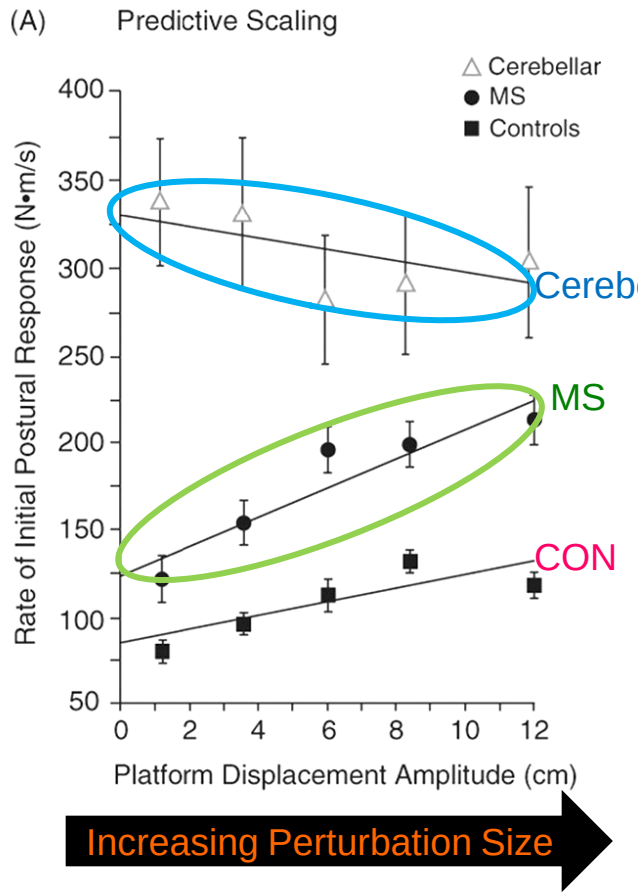


Impaired Postural Control in People with MS: Postural Responses

- Reduced reactive scaling but enhanced predictive scaling

(Cameron et al., 2008)





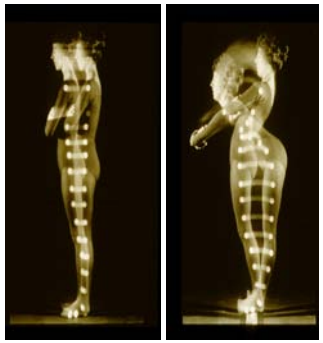
↓ ability to predictively scale

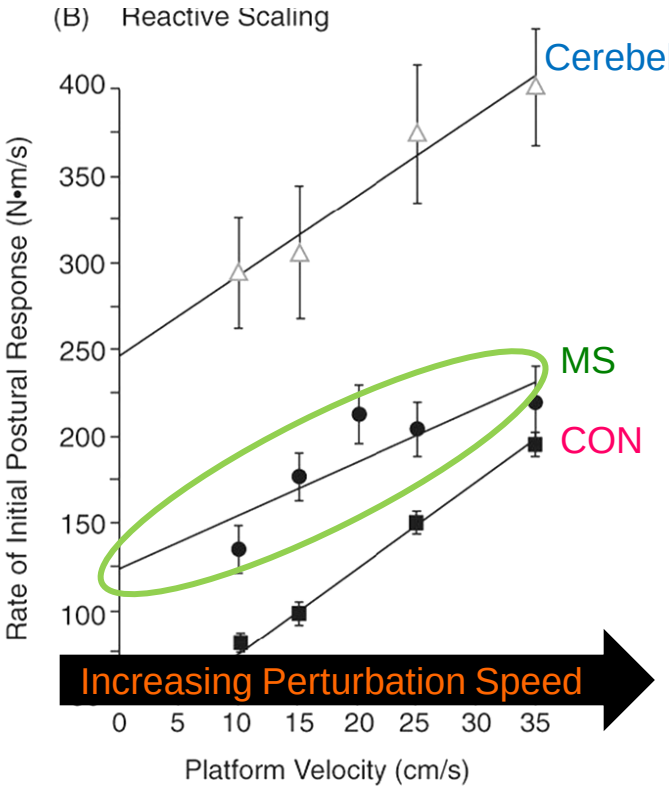
↑ ability to predictively scale

Impaired Postural Control in People with MS: Postural Responses

- Reduced reactive scaling but enhanced predictive scaling

(Cameron et al., 2008)





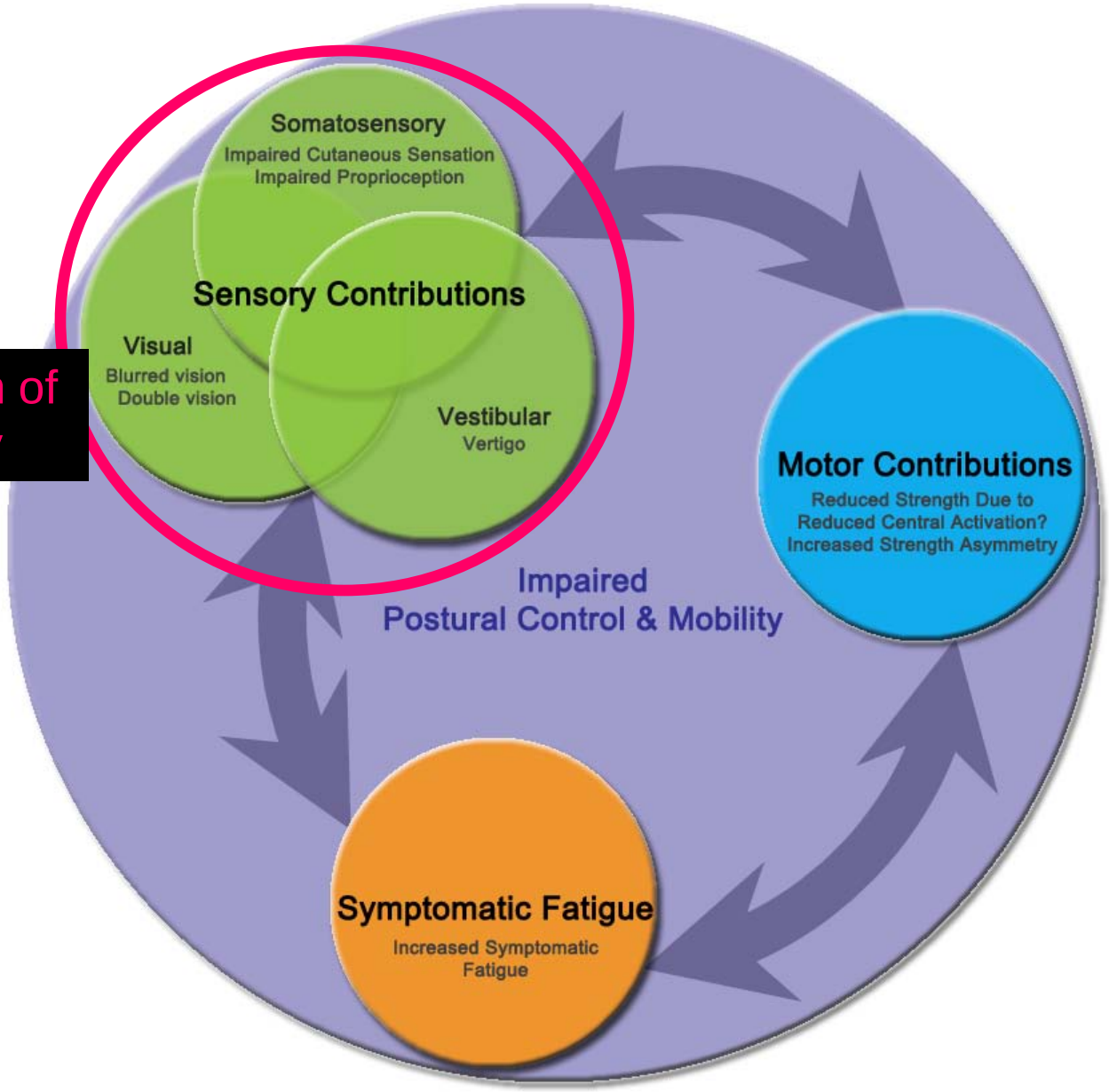
↓ ability to reactively scale

Appropriate timing and scaling of postural responses thought to depend on proprioceptive feedback

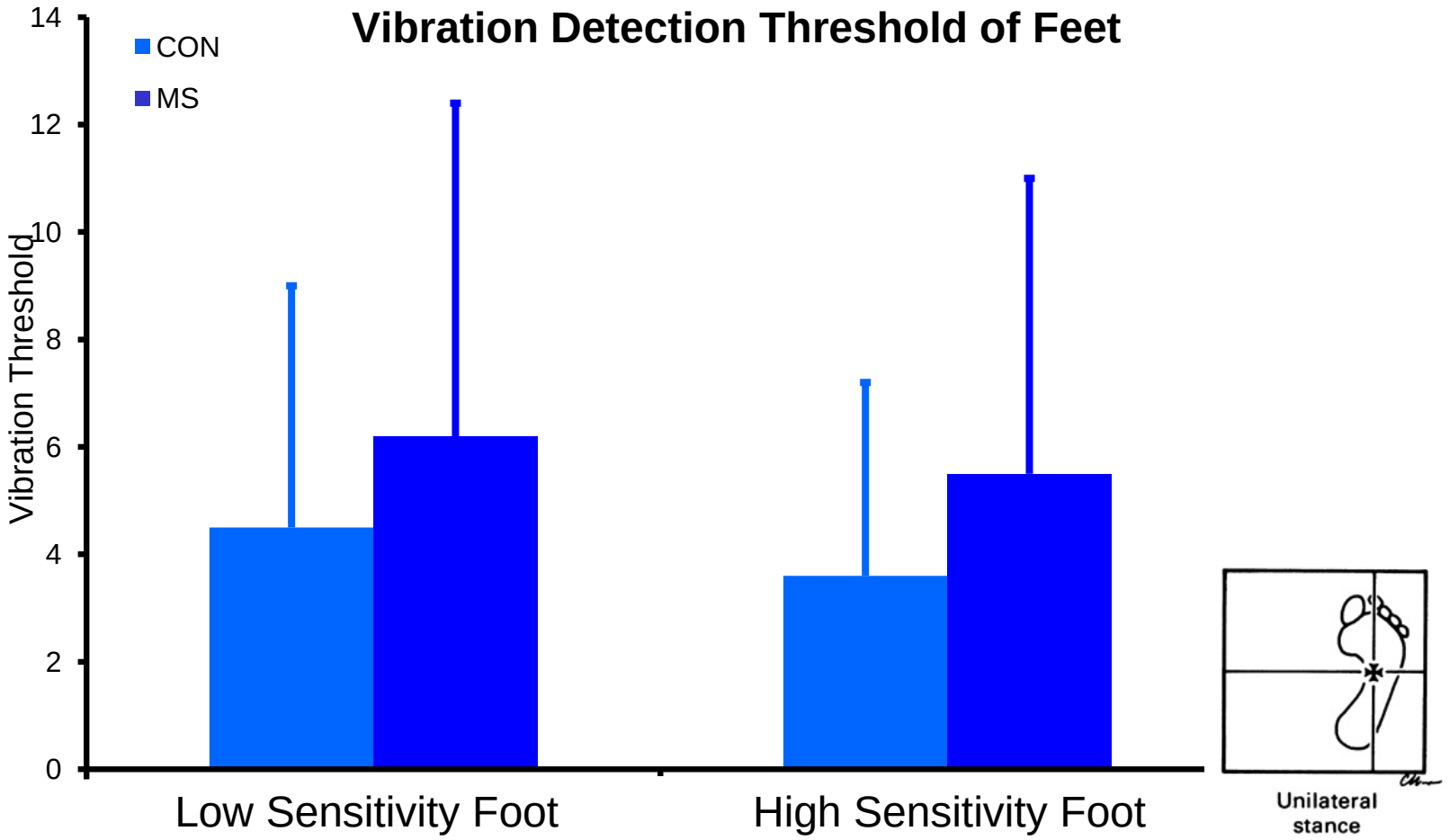
(Stapley 2002)

Suggests somatosensory rather than cerebellar impairment

↓ Detection of Instability



Somatosensory loss and balance in MS



- Impaired sensation explained variance in single leg stance time

(Citaker et al., 2011)

Novel Functional Assessment of Cutaneous Sensation

- Traditional sensation testing performed in supine

  ∴ Unloaded

Are sensory thresholds the same in functional (loaded) positions?

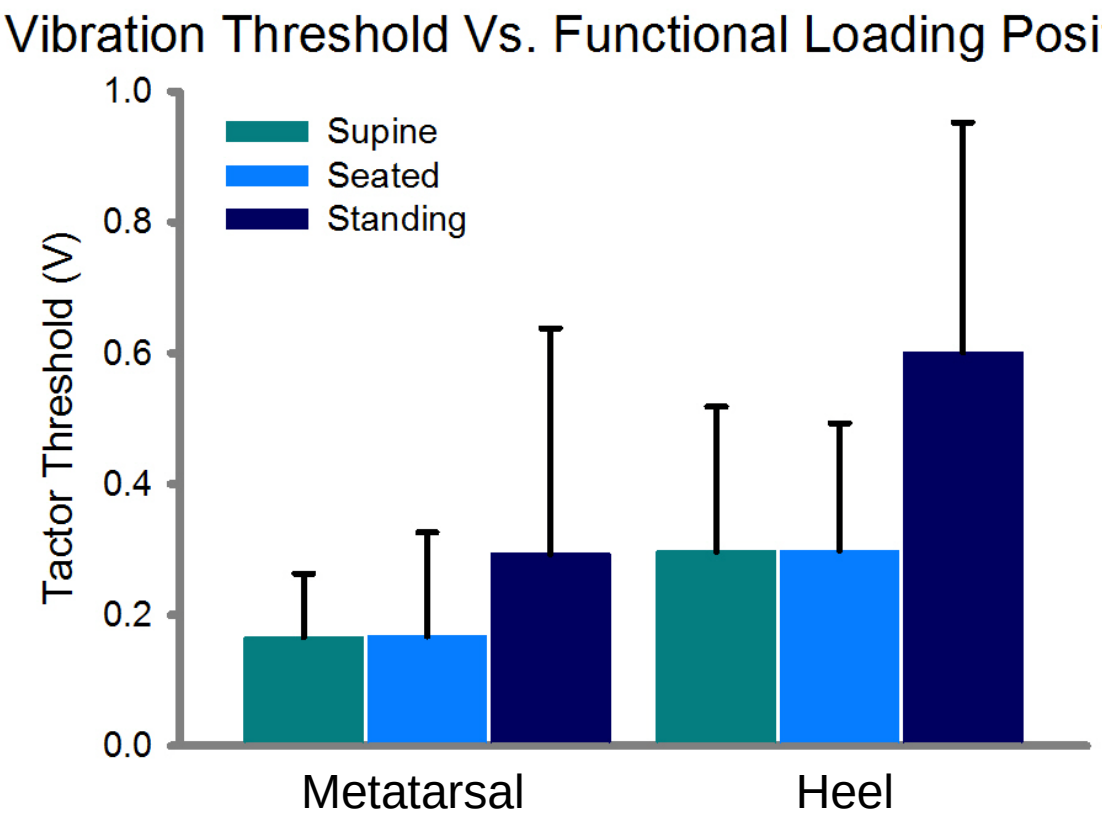
Tactors Embedded in Shoes



- Detect vibration thresholds while standing

Novel Functional Assessment of Cutaneous Sensation

- Vibration threshold increased with increasing load





On-going Project: Will these thresholds differ in those with MS?

Enhancement of Cutaneous Sensation in MS

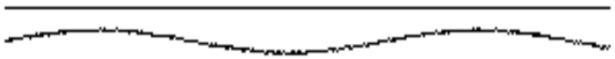
- Direct manipulation of cutaneous sensation to impact balance

Use tactors to enhance sensation



Priplata, 2006

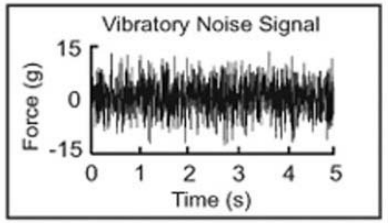
A



Threshold

Signal + Noise (too Low)



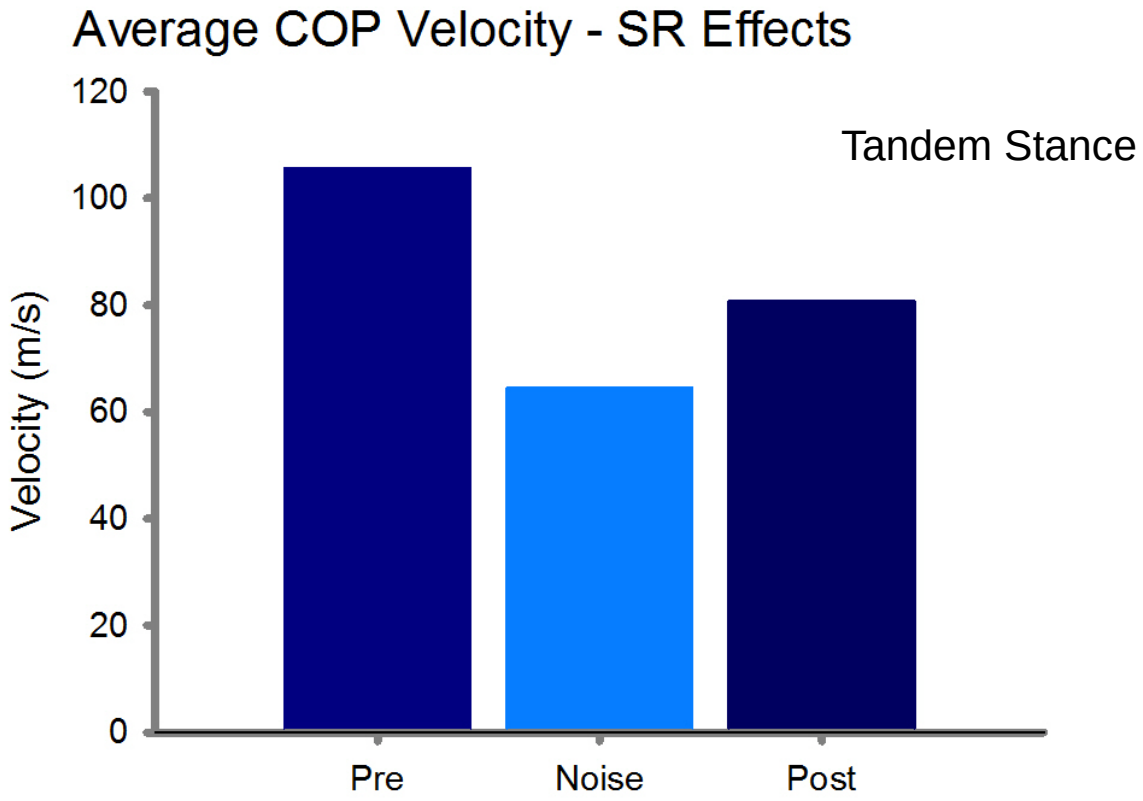


Increase likelihood of detecting signal

Demonstrated increases in sensation and reduced sway in older adults, stroke, diabetic neuropathy

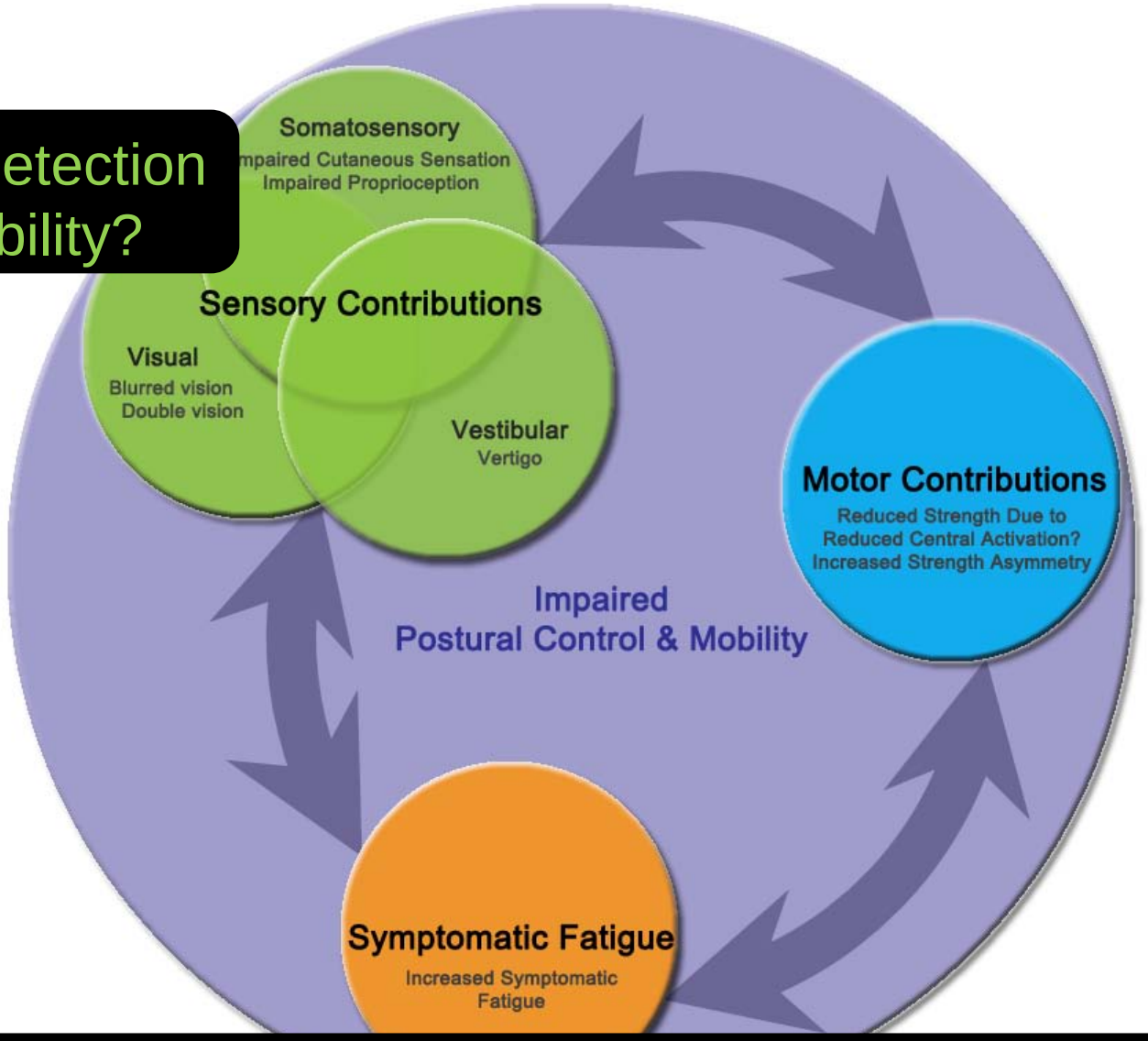
Improvement of Balance using Stochastic Resonance (SR)

- Reduced COP velocity may indicate greater stability



Potential use as an ambulatory aid? Increase mobility ??

Improve detection of instability?



Future Work - SR to improve mobility??

Thank you!

UMass Motor Control Lab Website:

http://www.umass.edu/motorcontrol/

National MS Society Website:

http://www.nationalmssociety.org

http://www.nationalmssociety.org/about-multiple-sclerosis/symptoms/walking-gait-problems/index.aspx