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Somatosensory Impairment and Balance Dysfunction in Multiple Sclerosis

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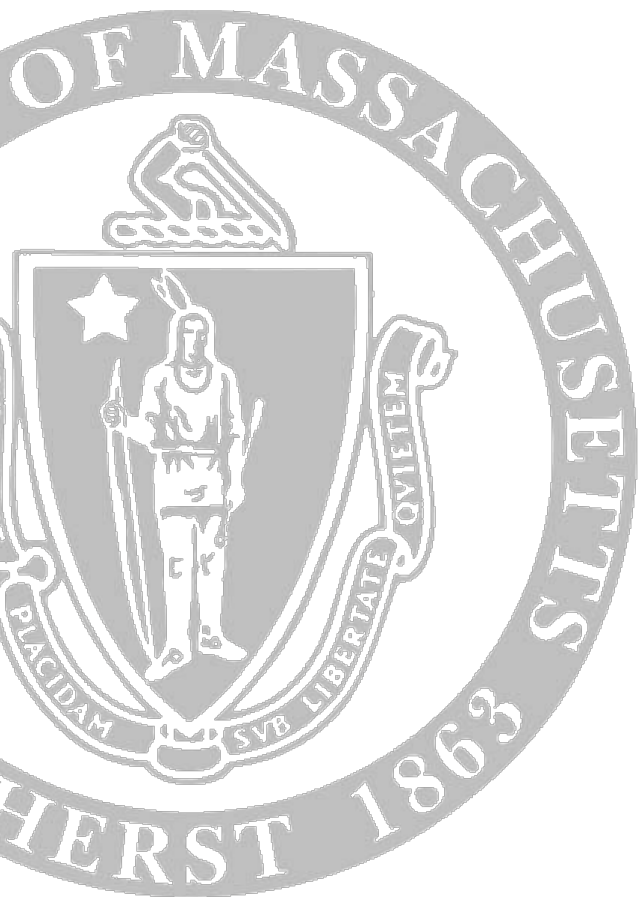
Jones S. (2014). Somatosensory Impairment and Balance Dysfunction in Multiple Sclerosis. UMass Center for Clinical and Translational Science Research Retreat. Retrieved from https://escholarship.umassmed.edu/cts_retreat/2014/presentations/11

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Somatosensory Impairment and Balance Dysfunction in Multiple Sclerosis

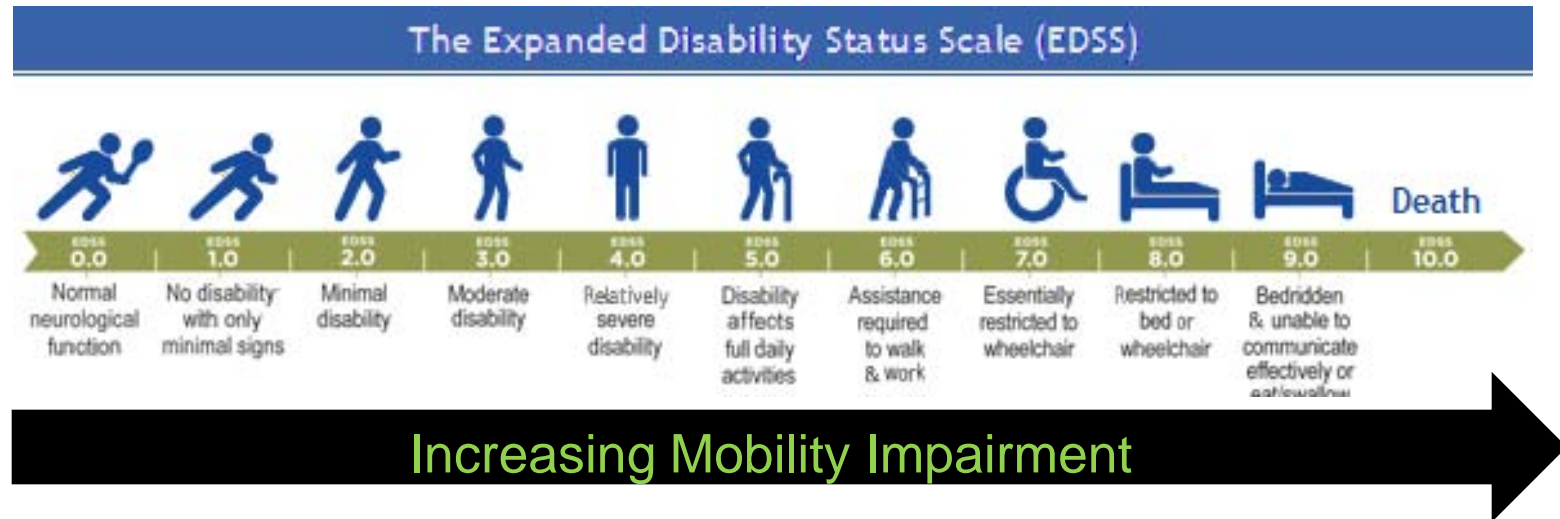
Stephanie Jones, PhD

MS Research Group

Sensory-Motor Control Laboratory

Department of Kinesiology

Multiple Sclerosis: Progressive Mobility Impairment



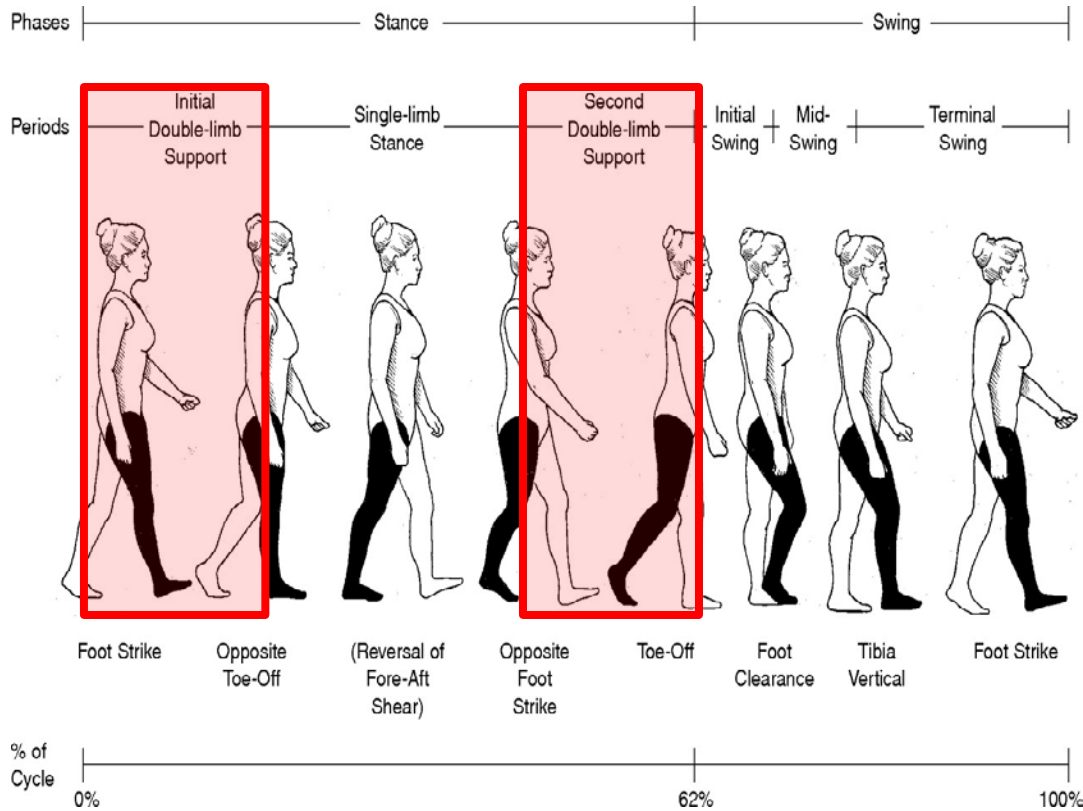
⇒ 80% will develop progressive form of MS within 20 years of Dx

| 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 ???

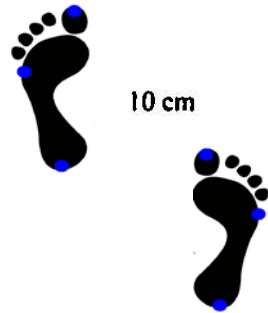
Impaired Postural Control in People with MS: Clinical Balance Tests

- ↓ performance on timed balance tasks
 - altered base of support configurations

(Frzovic 2000; Soyuer 2006)



Standing



Stride Stance



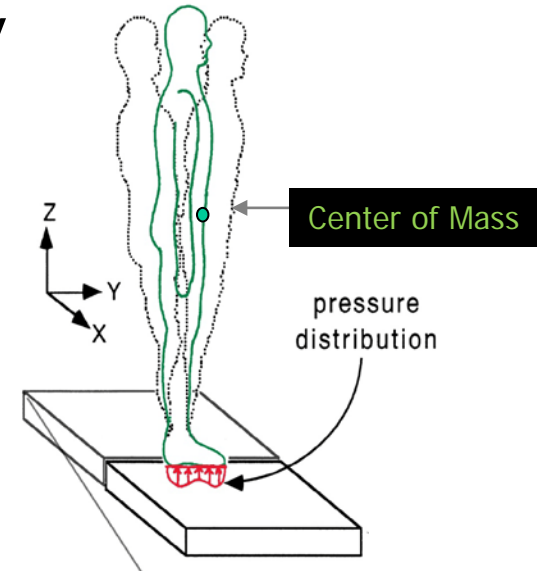
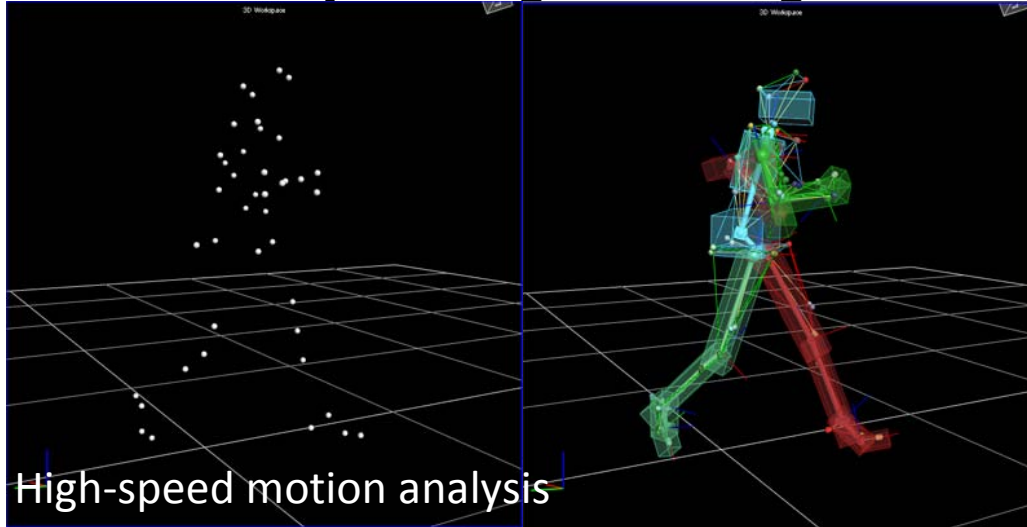
Tandem Stance



Single Leg Stance

Impaired Postural Control in People with MS: Posturography

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



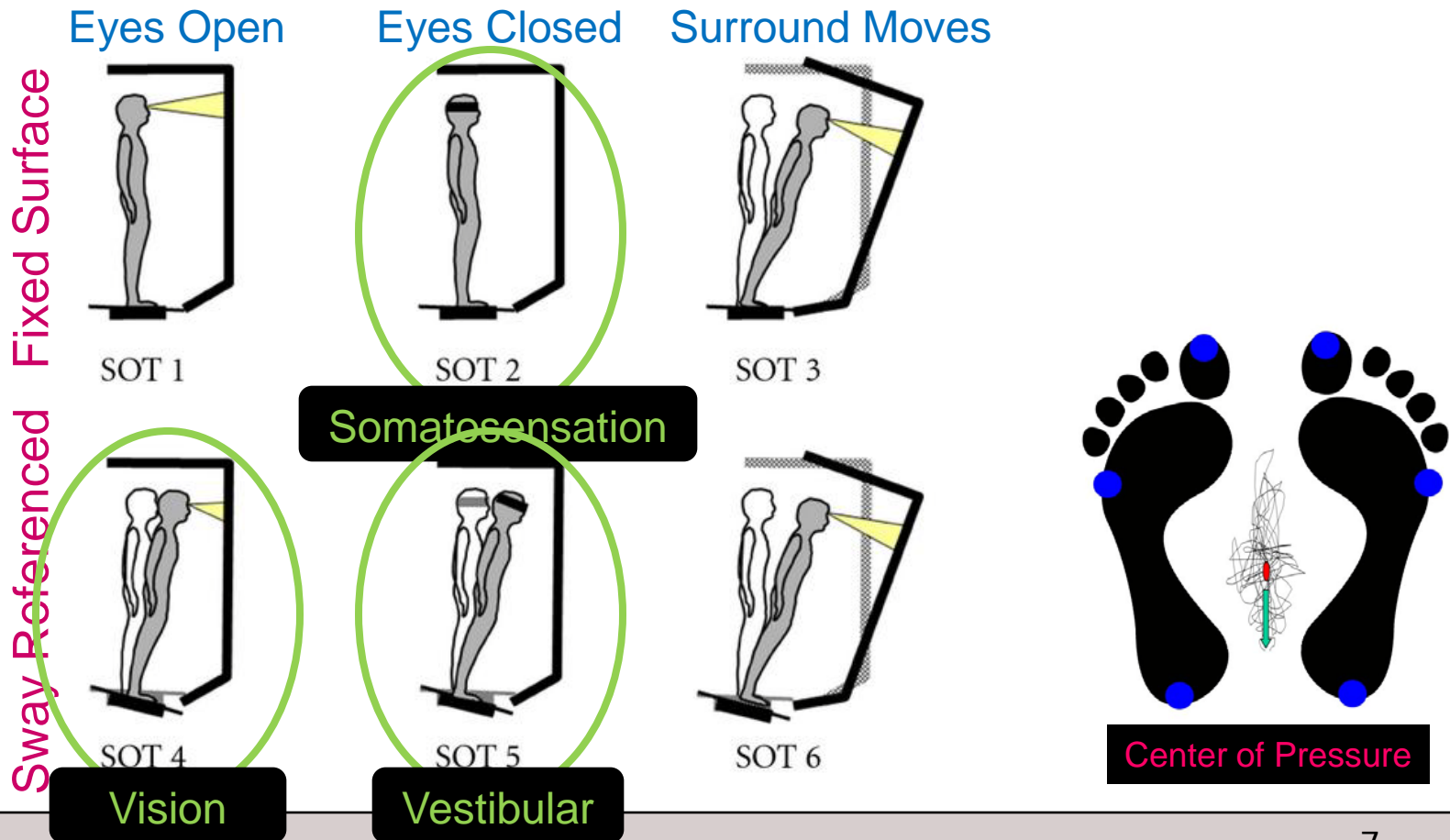
- worsened with increased task difficulty
 - ⇒ BOS restrictions
 - ⇒ self-generated perturbations (Van Emmerik 2010)
 - ⇒ dual task (Boes 2012; Negahban 2011)
 - ⇒ altered sensory conditions (Findling 2011; Porosinksa 2010; Spain 2012; Fjeldstad 2009; Cattaneo 2009)



Consistent with decreased stability

Impaired Postural Control in People with MS: Posturography

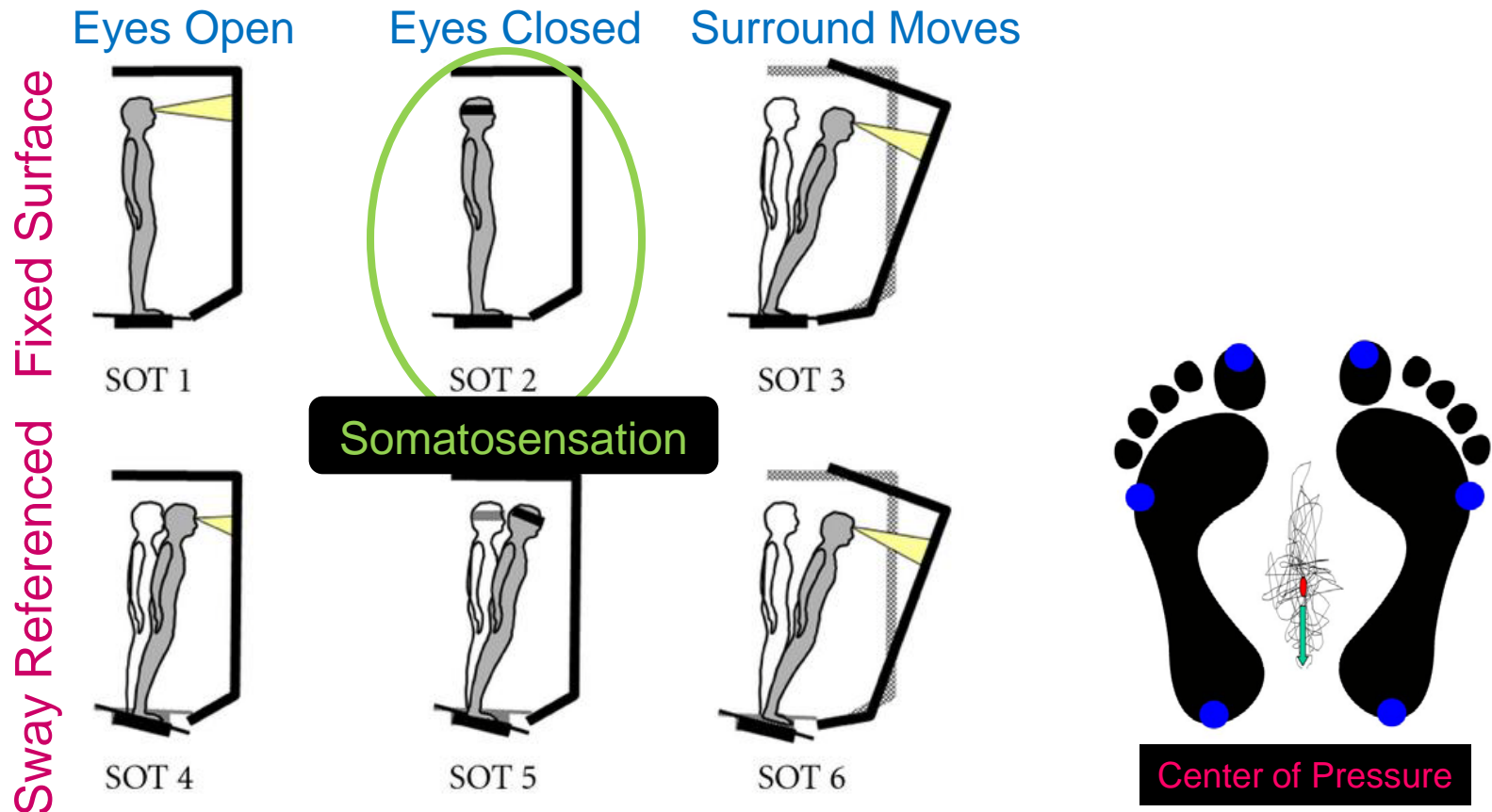
- Sensory Organization Test
 - ⇒ Manipulate sensory conditions
 - ⇒ Understand contribution of different sensory modalities



Impaired Postural Control in People with MS: Posturography

Tasks that rely on somatosensation greatly impacted in MS

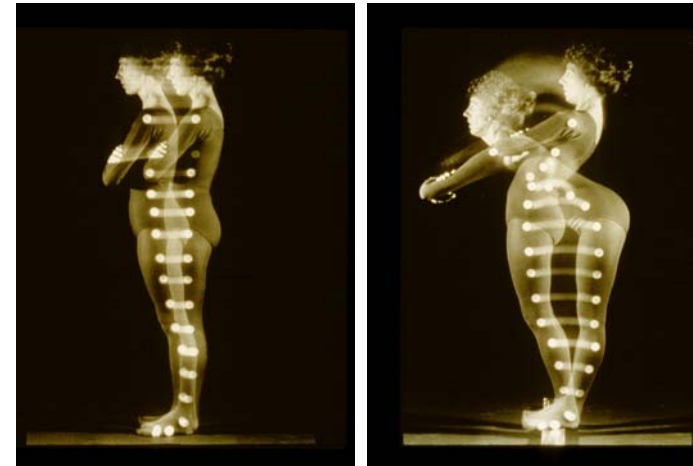
(Fjeldstad 2009)



Impaired Postural Control in People with MS: Postural Responses



Automatic postural responses

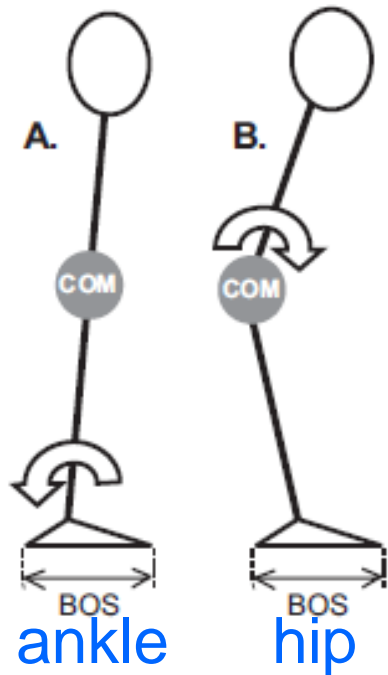


70-100ms latency

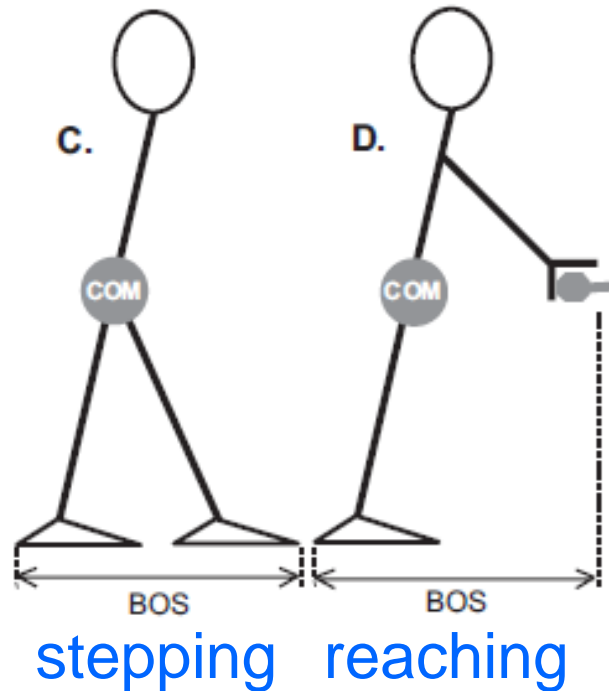
Impaired Postural Control in People with MS: Postural Responses

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

fixed-support strategies



change-in-support strategies



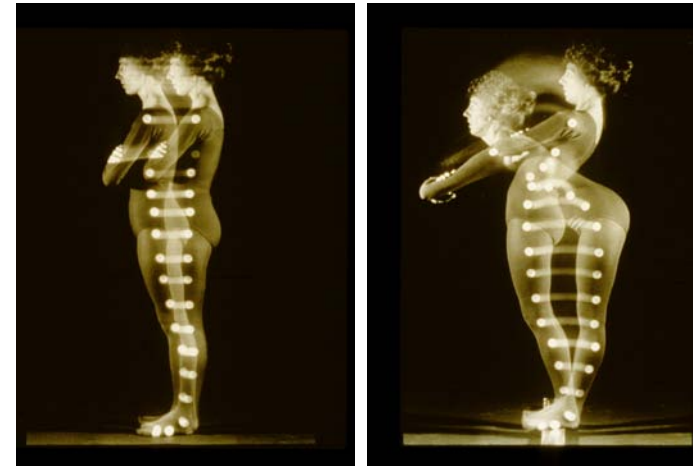
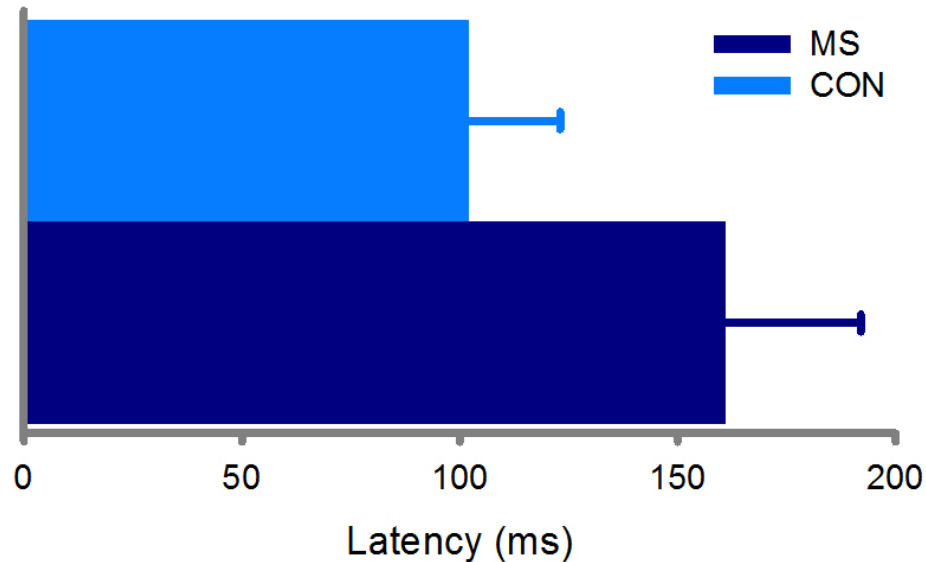
Initiated by feedback from the Somatosensory System

Impaired Postural Control in People with MS: Postural Responses

- Significantly delayed automatic postural responses

(Cameron et al., 2008)

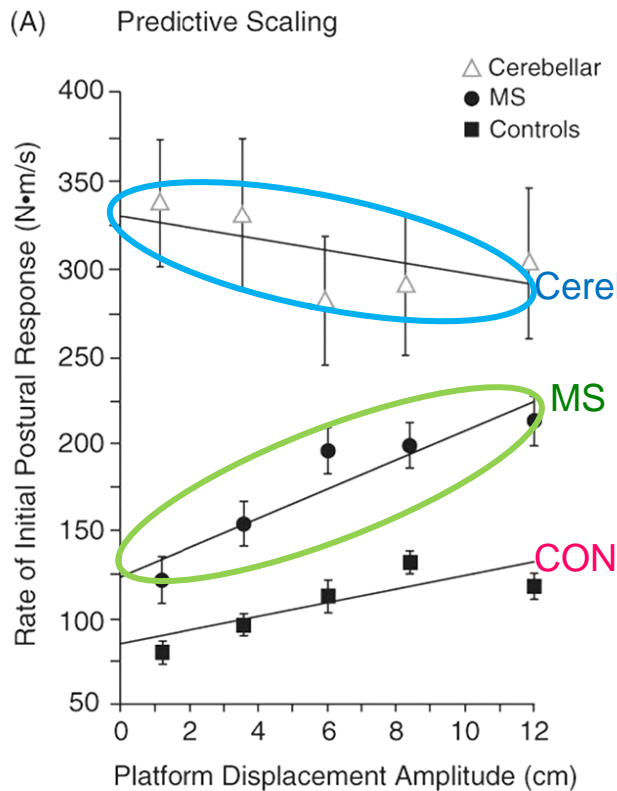
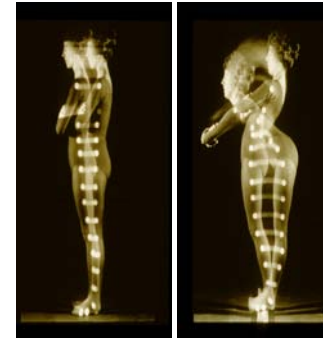
Postural Response Latencies



Impaired Postural Control in People with MS: Postural Responses

- Reduced reactive scaling but enhanced predictive scaling

(Cameron et al., 2008)



↓ ability to predictively scale

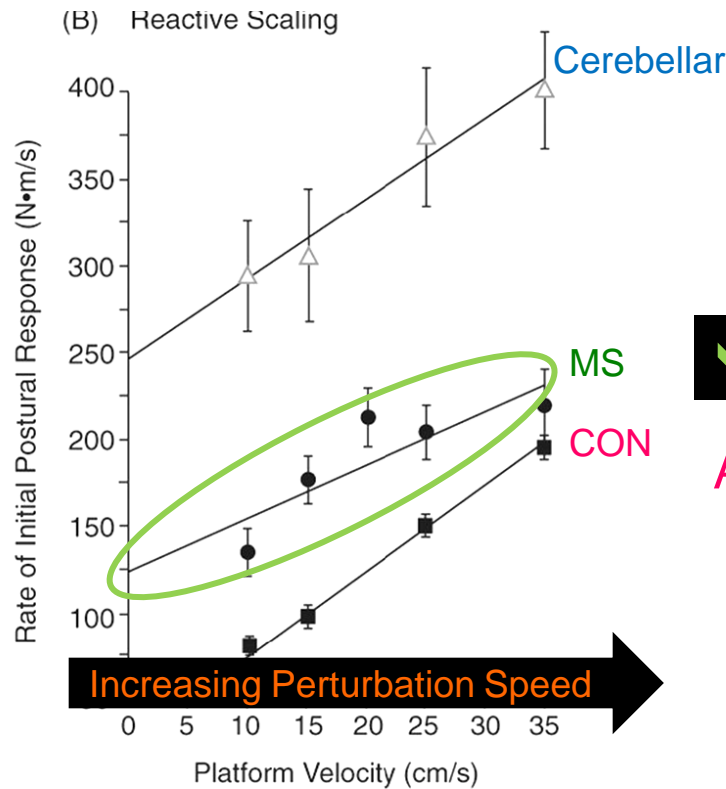
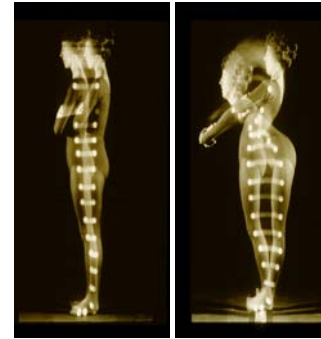
↑ ability to predictively scale

Increasing Perturbation Size

Impaired Postural Control in People with MS: Postural Responses

- Reduced reactive scaling but enhanced predictive scaling

(Cameron et al., 2008)



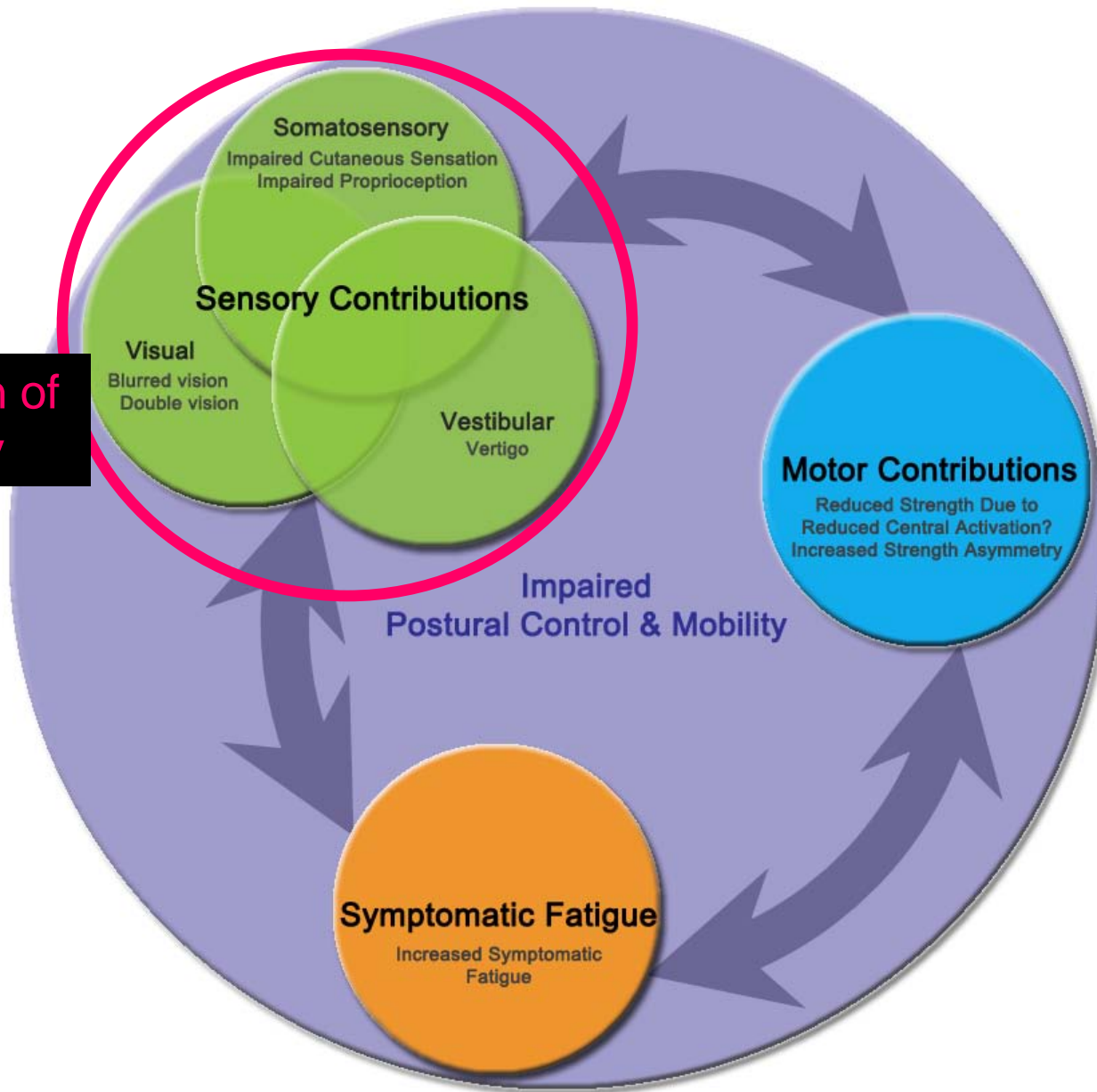
↓ ability to reactively scale

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

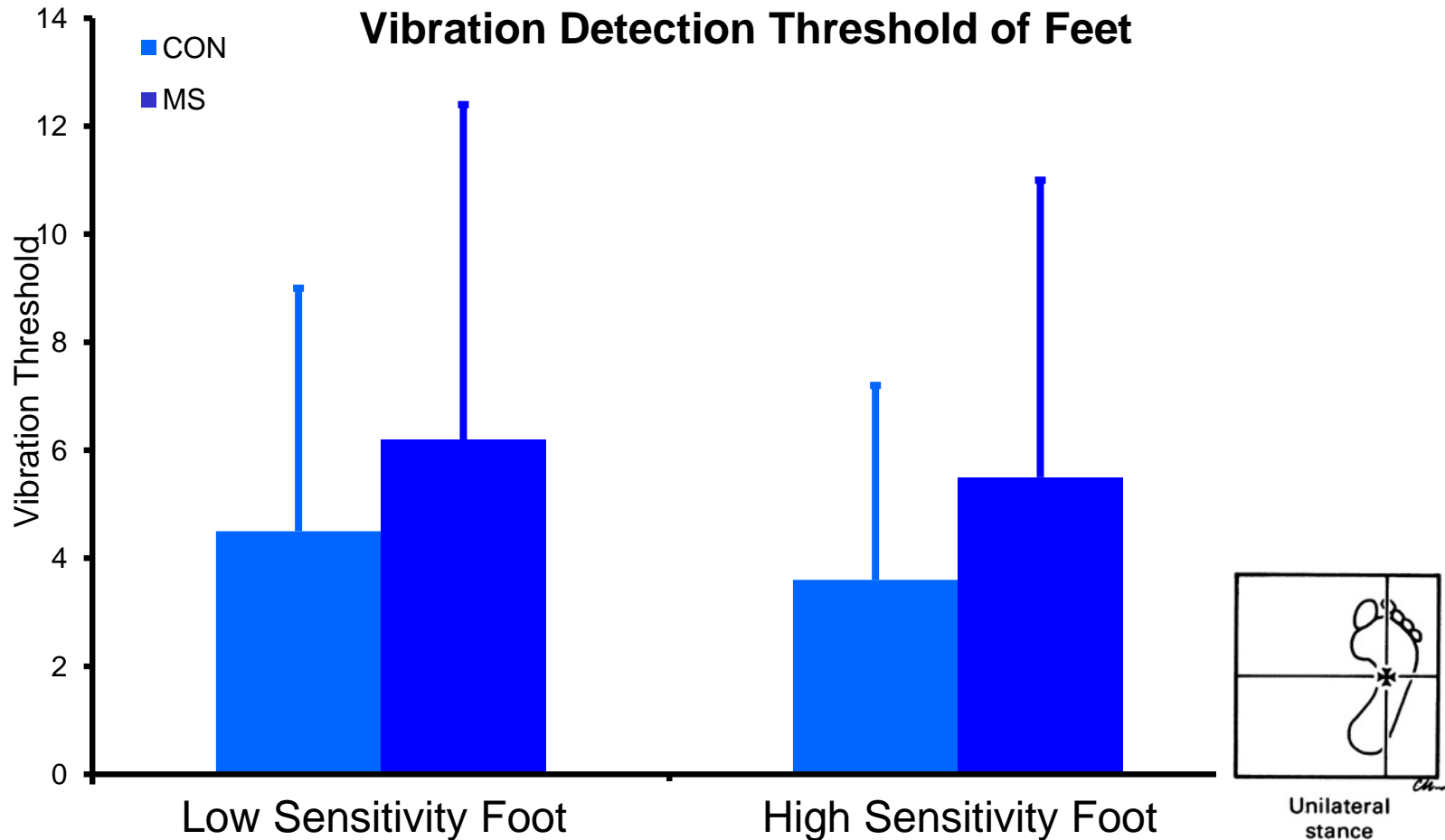
(Stapley 2002)

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

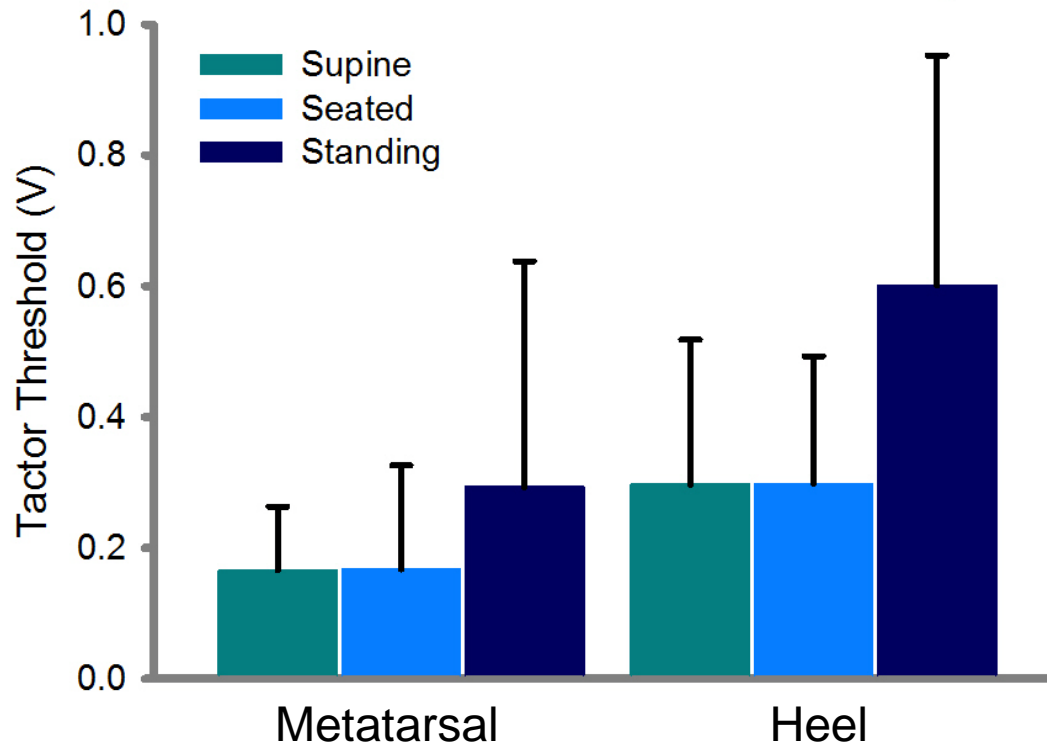


- Detect vibration thresholds while standing

Novel Functional Assessment of Cutaneous Sensation

- Vibration threshold increased with increasing load

Vibration Threshold Vs. Functional Loading Position



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 factors to enhance sensation

A



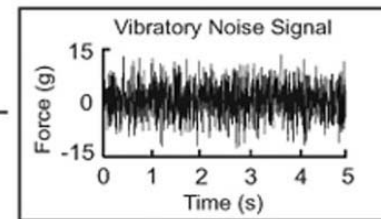
Threshold
Signal + Noise (too Low)



Priplata, 2006

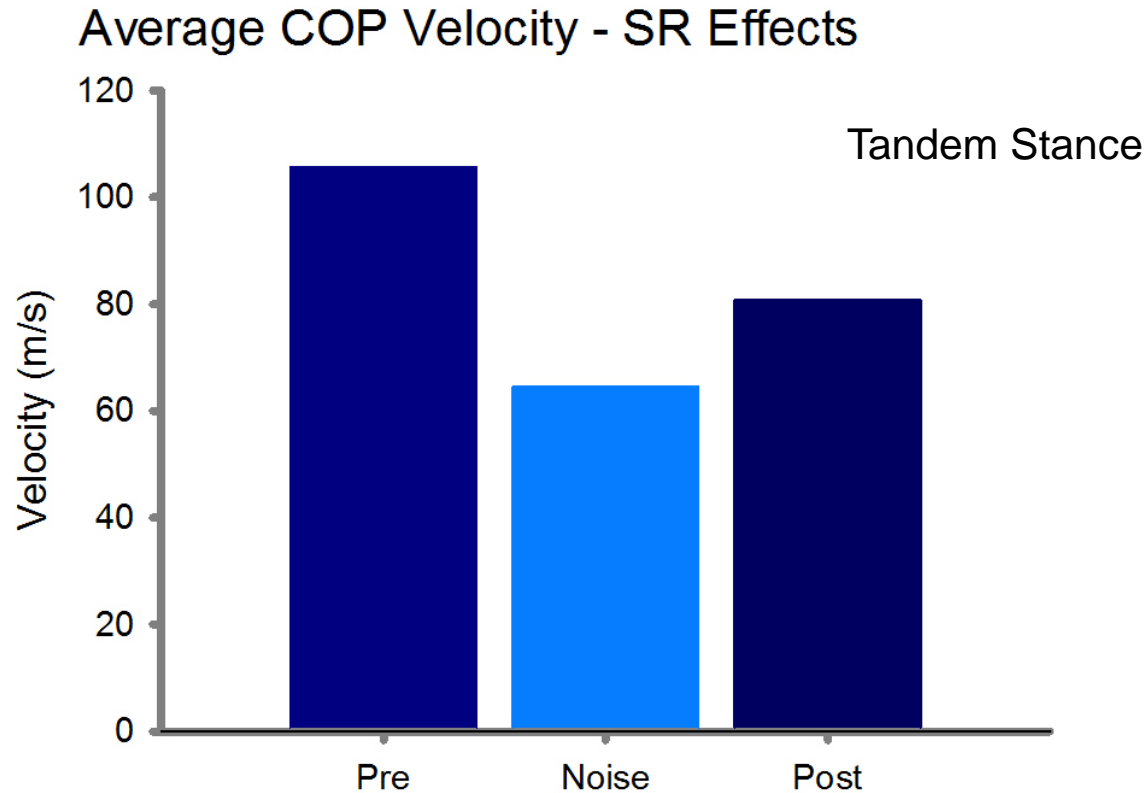
Increase likelihood of detecting signal

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



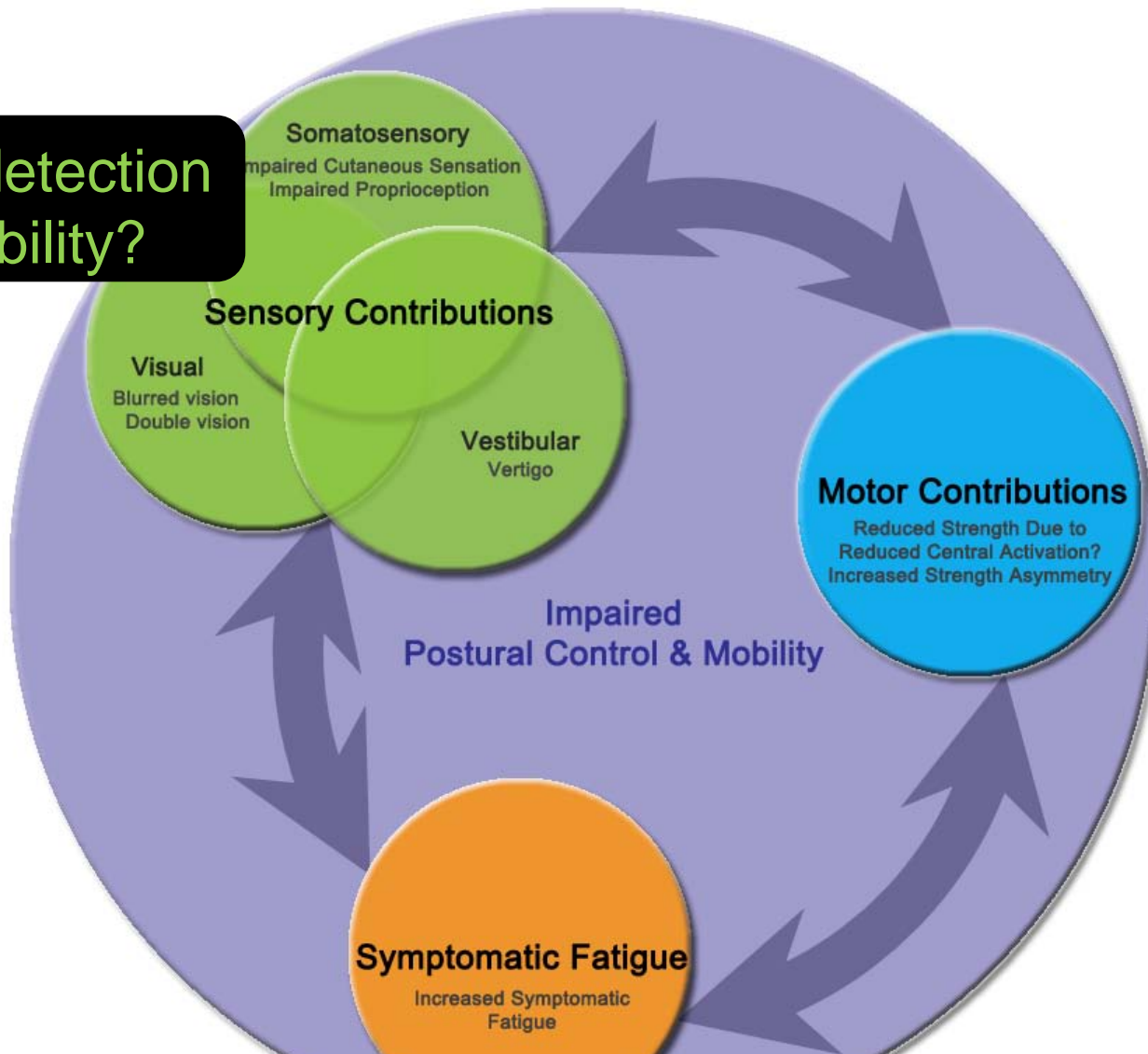
Improvement of Balance using Stochastic Resonance (SR)

- 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>