Context-dependent threats to standing balance have long been known to affect fear and anxiety about falling, as well as static, dynamic reactive, and anticipatory control of upright standing balance. While the neural mechanisms underlying changes in balance behaviors are not yet understood, changes in balance-relevant sensory-motor interactions have been suggested as a possible means to alter balance behaviors with threat. The purpose of this thesis was to understand how different balance-relevant sensory systems are affected by threats to standing balance. Four studies are presented in this thesis which each address the effects of postural threat on a different balance-relevant sensory reflex.

Height-induced postural threat was employed in all studies included in this thesis to manipulate balance threat or challenge: participants stood at, or away from the edge of a hydraulic lift which was elevated to different heights, to create LOW and HIGH threat conditions. The first study revealed that the gain and coupling of balance responses to electrical vestibular stimulation was increased in the HIGH, compared to LOW threat conditions. The second study demonstrated increases in muscle spindle stretch reflexes, and steeper dynamic gain relationships between stretch velocities and short-latency reflex amplitudes with HIGH postural threat. The third study validated a novel technique for probing Golgi tendon Ib reflexes in standing, and used this technique to demonstrate reduced Ib inhibition in an ankle plantar flexor muscle with increased threat. The fourth study examined lower-limb muscle reflexes, as well as cortical potentials to cutaneous nerve electrical stimulation. While cutaneous reflexes were not observed to change independently from background muscle activity, cortical potentials were affected by threat at stages which may represent altered primary and/or secondary somatosensory, as well as posterior parietal processing.

Combined, these studies suggest people respond to height-induced postural threat with a multi-sensory adaptation process where balance-relevant muscular and vestibular senses are tuned to facilitate reactive responses to balance disturbances and/or sensory monitoring of postural state. These novel results provide important insight into neural mechanisms underlying the effects of fear and anxiety on human balance control, and have important implications for clinical balance and neurophysiological testing.


**SELECTED PRESENTATIONS**

Horslen, BC*, Zaback, M, Inglis, JT, Blouin, JS, Carpenter, MG (2016) Static and dynamic soleus stretch reflex responses in standing humans are independently modulated by postural threat. 2016 Society for Neuroscience annual meeting, San Diego, CA. International conference (poster- 723.07/VV17 - Accepted)


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**PROGRAMME**

The Final Oral Examination
For the Degree of

**DOCTOR OF PHILOSOPHY**
(Kinesiology)

**BRIAN CHRISTOPHER HORSLEN**

M. Sc., University of British Columbia, 2010
B. Sc. Hon. Co-op, University of Waterloo, 2007

Monday, October 3, 2016, 12:30 pm
Room 200, Graduate Student Centre
Latecomers will not be admitted

“Vestibular, Proprioceptive, and Cutaneous Reflex Modulation Explored Through a Height-Induced Postural Threat”

**EXAMINING COMMITTEE**

Chair:
Dr. William Honer (Neuroscience)

Supervisory Committee:
Dr. Mark Carpenter, Research Supervisor (Kinesiology)
Dr. J. Timothy Inglis (Kinesiology)
Dr. Jean-Sébastien Blouin (Kinesiology)

University Examiners:
Dr. Michael Koehle (Kinesiology)
Dr. Todd Handy (Psychology)

External Examiner:
Dr. Arthur Prochazka
School of Molecular & Systems Medicine.
University of Alberta
Edmonton, Alberta