The effects of rehabilitation on sensory reweighting in patients with chronic mTBI

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PRESENTED BY: Dr Lucy Parrington, PhD.

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Balance related complaints are common in people suffering chronic effects of mild traumatic brain injury (mTBI) (Vanderploeg et al., 2007).

Abnormal use of vestibular and visual systems may be linked to postural instability people with mTBI (Haran et al., 2016).
Use of sensory systems will change depending on the availability of sensory information

(Derived from sway responses evoked by low amplitude surface motion stimuli, Peterka 2002)
**Study aim 1:** To characterize the differences in sensory weighting between people with and without chronic mTBI

**Study aim 2:** To evaluate whether sensory weighting changes with rehabilitation
Study overview

### mTBI

<table>
<thead>
<tr>
<th>N</th>
<th>Age (Years)</th>
<th>Years since injury</th>
<th>Body Mass Index (BMI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>39.4 (9.9)</td>
<td>1.6 (2.4)</td>
<td>28.6 (4.6)</td>
</tr>
</tbody>
</table>

#### Baseline testing

#### Vestibular rehabilitation 2x per week for 6 weeks

#### Post rehabilitation testing

### control

<table>
<thead>
<tr>
<th>N</th>
<th>Age (Years)</th>
<th>Years since injury</th>
<th>Body Mass Index (BMI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>25.9 (6.1)</td>
<td>17.3 (12.5)</td>
<td>23.9 (5.0)</td>
</tr>
</tbody>
</table>

#### Baseline testing

#### No intervention

#### 6 wk testing
Vestibular rehabilitation program – progressing in difficulty over 6 weeks  (Fino, et al., 2017)
Central sensorimotor integration test (CSMI) (Peterka, 2002)
Sensory weight and sensory-to-motor transformation components

**Sensory weight**
- Measure of the relative contribution of one or more sensory systems

**Stiffness (Kp)**
- Corrective ankle torque (T) generated in proportion to the body sway angle (θ)

**Damping (Kd)**
- Corrective ankle torque (T) generated in proportion to the body sway angular velocity (ω)

**System time delay**
- Time between stimuli and response

(Reproduced from van der Kooij & Peterka, 2011)
mTBIs changed their sensory weighting on vision and vestibular systems

mTBIs
• Initially show reduced vision + vestibular weighting
• Higher weighting on vision + vestibular systems post rehabilitation
• Decreased reliance on proprioception post rehabilitation
Changes in sensory-to-motor transformations

**Stiffness**

- **BL Control**
- **6wk Control**
- **BL mTBI**
- **6wk mTBI**

**Damping**

- **BL Control**
- **6wk Control**
- **BL mTBI**
- **6wk mTBI**

**Delay**

- **BL Control**
- **6wk Control**
- **BL mTBI**
- **6wk mTBI**

**Damping (Kd/mgh)**

- **UNSTABLE**

- **Stiffness (Kp/mgh)**

- **100ms**
- **150ms**
- **200ms**

**mTBI**

- **mTBI**

**Control**

- **Control**
Interpreting sensory-to-motor transformations together

[Graph showing the relationship between stiffness and damping, with regions marked as UNSTABLE for different time delays (100ms, 150ms, 200ms).]
Rehabilitation improved symptom severity score

Change in symptom severity

- change in sensory weight
- change in damping
- change in stiffness
- change in time delay
mTBIs show improved function following rehabilitation

• mTBIs show deficits in baseline

• Motor transformation measures suggest mechanisms of change

• Rehabilitation programs:
  – individualized
  – reaction/ response timing
  – muscle co-contraction
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Laurie King, Ph.D., P.T., (PI), Balance Disorders Laboratory, Department of Neurology, Oregon Health & Science University, Portland; VA Portland Health Care System, Portland

Peter Fino, Ph.D., Balance Disorders Laboratory, Department of Neurology, Oregon Health & Science University & VA Portland Health Care System, Portland, OR

Robert Peterka, Ph.D., National Center for Rehabilitative Auditory Research, VA Portland Health Care System, Portland, USA

James Chesnutt, M.D., Orthopedics and Rehabilitation, Oregon Health & Science University, Portland, USA

Fay Horak, Ph.D., P.T., (PI), Balance Disorders Laboratory, Department of Neurology, Oregon Health & Science University, Portland; VA Portland Health Care System, Portland

Jenny Wilhelm, P.T., D.P.T., N.C.S., Department of Rehabilitation Services, Oregon Health & Science University, Portland, USA

Tim Hullar, M.D., Department of Otolaryngology, Oregon Health & Science University, Portland, USA