BIOMARKER-ENHANCED VR-BASED PLATFORM FOR ASSESSING MOTION SICKNESS SUSCEPTIBILITY

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Motion sickness in flight - is it a big deal?

Airline passengers: ~1%
Astronauts: >60% in first 2-3 days weightless (Heer & Paloski 2006)
Student pilots: 39% (RAF, 1974) – 50% (Taiwan AF, 2000).

Counter-measures: - pharmacological (H1 and ACh M1 antagonists);
- MS desensitization programs (lengthy & expensive).
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RAAF AvMed, Adelaide, Australia
Cybersickness: what it is, and can we make use of it?

- Cybersickness is a subtype of motion sickness (MS) provoked by exposure to VR (i.e., it is predominantly visually-induced MS).
- Similar to motion-induced MS, repetitive exposure to VR provocations results in desensitization:

![Graphs showing ride duration and line fit slope](image)

- It is currently not known which brain structures are responsible for desensitization of responses to provocative stimuli.
Cybersickness: what it is, and can we make use of it?

- Cybersickness is a subtype of motion sickness (MS) provoked by exposure to VR (i.e. it is predominantly visually-induced MS).
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![Graph showing ride duration and line fit slope over three days (D1, D2, D3).](image)

- It is currently not known which brain structures are responsible for desensitization of responses to provocative stimuli.
- Hypothesis: Cross-desensitization?
- Step 1: Clarify relationship between CS and MS;
- Step 2: Test whether repetitive exposure to VR provocations reduces sensitivity to provocative motion.
On different days (a week apart) 30 young healthy volunteers were subjected to:

either (A) Coriolis cross-coupling  or (B) virtual ride on a roller coaster

(purely vestibular provocation) (purely visual provocation)

Assessed: - nausea rating (every min);
- MSAQ (post-test);
- forehead sweating (SCL).
Why we measured **forehead** sweating?
Similarities of symptoms in VR and RC conditions:

A. Correlation of max nausea ratings (VR vs rotating chair)

- \( R = 0.58 \), \( P = 0.001 \)

B. MSAQ total scores

C. Correlation of total MSAQ scores (VR vs rotating chair)

- \( R = 0.69 \), \( P < 0.0001 \)

There were equally high and significant positive correlations between 4 MSAQ symptom clusters and between 14 of 16 individual symptoms:

- GI: \( R = 0.59 \), \( P = 0.000 \)
- Central: \( R = 0.69 \), \( P < 0.0001 \)
- Peripheral: \( R = 0.67 \), \( P < 0.0001 \)
- Sopite: \( R = 0.54 \), \( P = 0.001 \)

Gavgani et al. J Appl Physiol 2018
Similarity in forehead sweating responses in VR and RC:

![Graph showing similarity in forehead sweating responses in VR and RC.](image)

**Amplitude**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Amplitude RMS(V)</th>
</tr>
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<tbody>
<tr>
<td>N0-BR</td>
<td>0.02</td>
</tr>
<tr>
<td>N1-N3</td>
<td>0.04</td>
</tr>
<tr>
<td>N4-N6</td>
<td><strong>0.06</strong></td>
</tr>
<tr>
<td>N&gt;6</td>
<td>0.04</td>
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</tbody>
</table>

**Frequency**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Forehead frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0-BR</td>
<td>0.05</td>
</tr>
<tr>
<td>N1-N3</td>
<td><strong>0.10</strong></td>
</tr>
<tr>
<td>N4-N6</td>
<td><strong>0.15</strong></td>
</tr>
<tr>
<td>N&gt;6</td>
<td>0.10</td>
</tr>
</tbody>
</table>

**Nausea Rating**

Gavgani et al. *J Appl Physiol* 2018
Similarities in changes of brain hemodynamics in VR and RC conditions (NIRS imaging):

NIRS = ‘Near-Infrared Spectroscopy’. Basic principle is similar to pulse oximetry (Hb/HbO₂ detection).

Gavigan et al. Physiol Behav 2018
Similarities in changes of brain hemodynamics in VR and RC conditions (NIRS imaging):

VR condition

Baseline

Max. nausea

RC condition

Nausea (motion sickness)

Gavgani et al Physiol Behav 2018
Conclusions for Step 1 (Clarify relationship between cybersickness and “classical” MS):

Symptoms and physiological changes occurring during cybersickness and "classical" motion sickness are quite similar, at least during advanced stages of these malaises.

Step 2: Test whether repetitive exposure to VR provocations reduces sensivity to provocative motion.

N=1 (but it is positive!)

For the details of the protocol, contact eugene.nalivaiko@newcastle.edu.au
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