The Effect of Mild Motion Sickness and Sopite Syndrome on Multitasking Cognitive Performance

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Motion Sickness and Sopite Syndrome

- **Motion sickness**
  - A general term describing a constellation of symptoms including stomach awareness, yawning, disorientation, drowsiness, facial pallor, cold sweating, nausea and emesis
  - Neural mismatch (or sensory conflict) theory

- **Sopite syndrome** (identified by Graybiel & Knepton, 1976)
  - Another type of motion sickness
  - A symptom-complex characterized by drowsiness and lethargy related to motion sickness
    - Drowsiness; yawning; disinterest/ disinclination to work; lassitude; mood changes; withdrawal; mental depression
    - Independent of nausea & emesis
Human Performance and Hypothesis

Typical Human Performance Findings

- Cognitive performance not affected by motion per se
- Severe motion sickness can result in cessation of performance
- There have been very few studies on multitasking cognitive performance and motion sickness

Hypothesis

- Mild motion sickness and sopite syndrome deteriorate multitasking cognitive performance
## Experimental Design: Groups and Sessions

(N = 39)

<table>
<thead>
<tr>
<th></th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Experimental Session</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Experimental Session</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>Block Block Block Block Block Block</td>
<td>Block Block Block Block Block Block</td>
</tr>
<tr>
<td></td>
<td>1, 2, 3, 4, 5, 6</td>
<td>1, 2, 3, 4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>Motion stimulus</td>
<td>Motion stimulus</td>
</tr>
</tbody>
</table>

Group B

|                  | Block Block Block Block Block Block  | Block Block Block Block Block Block  |
|                  | 1, 2, 3, 4, 5, 6                      | 1, 2, 3, 4, 5, 6                      |

Group C

|                  | Block Block Block Block Block Block  | Block Block Block Block Block Block  |
|                  | 1, 2, 3, 4, 5, 6                      | 1, 2, 3, 4, 5, 6                      |
Experimental Design: SYNWIN Cognitive Multi-Task

- Counterbalanced (motion)
Symptomatology Incidence I (MSAQ)

- 23 “Symptomatic” participants
  - At least 1 symptom
- All 16 symptoms are reported
- Symptoms reported per Symptomatic participant
  - M=6.09 symptoms (SD=4.56, MD=5)

![Average MSAQ Total per participant in motion conditions](chart.png)
Symptomatology Incidence II (from MSAQ)

- **Gastrointestinal cluster**
  - Ready to vomit
  - Sick to the stomach
  - Nauseated
  - Queasy

- **Central-related**
  - Faint-like,
  - Like spinning
  - Lightheaded
  - Disoriented
  - Dizzy

- **Peripheral-related**
  - Clammy/cold sweat
  - Hot/warm
  - Sweaty

- **Sopite syndrome-related**
  - Drowsiness
  - Annoyance/irritation,
  - Fatigue
  - Uneasiness

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**Symptoms frequency of occurrence in symptomatic participants**

**Frequency of occurrence**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel uneasy (S)</td>
<td>70%</td>
</tr>
<tr>
<td>I feel tired/ fatigued (S)</td>
<td>60%</td>
</tr>
<tr>
<td>I feel queasy (G)</td>
<td>40%</td>
</tr>
<tr>
<td>I feel hot/ warm (P)</td>
<td>30%</td>
</tr>
<tr>
<td>I feel sweaty (P)</td>
<td>20%</td>
</tr>
<tr>
<td>I feel annoyed/ irritated (S)</td>
<td>10%</td>
</tr>
<tr>
<td>I feel nauseated (G)</td>
<td>10%</td>
</tr>
<tr>
<td>I feel dizzy (C)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel disoriented (C)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel sick to my stomach (G)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel clammy/ cold sweat (P)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel drowsy (S)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel lightheaded (C)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel as if I may vomit (G)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel like I was spinning (C)</td>
<td>5%</td>
</tr>
<tr>
<td>I feel faint-like (C)</td>
<td>5%</td>
</tr>
</tbody>
</table>

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**Frequency of occurrence**

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sopite-related</td>
<td>90%</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>80%</td>
</tr>
<tr>
<td>Peripheral</td>
<td>70%</td>
</tr>
<tr>
<td>Central</td>
<td>60%</td>
</tr>
</tbody>
</table>
Symptomatology, Performance and Session
Symptomatology, performance, and session Scores vs Motion Sickness

Performance vs subjective metrics

<table>
<thead>
<tr>
<th>SYNNWIN Scores</th>
<th>All</th>
<th>Experimental Session 1</th>
<th>Experimental Session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite</td>
<td>↘️ MSAQ G</td>
<td>↘️ MSAQ G</td>
<td></td>
</tr>
<tr>
<td>Memory task</td>
<td>↘️ SSS</td>
<td>↘️ SSS</td>
<td></td>
</tr>
<tr>
<td>Arithmetic task</td>
<td>↘️ MSAQ G, ↘️ MSAQ Total, ↘️ MSAQ P</td>
<td>↘️ MSAQ Total, ↘️ MSAQ S</td>
<td></td>
</tr>
<tr>
<td>Visual task</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Auditory task</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Multitasking performance is MAINLY associated with:
- Gastrointestinal symptoms
- Soporific symptoms

Performance scores vs psychophysiological metrics (EGG power)

<table>
<thead>
<tr>
<th>SYNNWIN Tasks</th>
<th>All</th>
<th>Experimental Session 1</th>
<th>Experimental Session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite</td>
<td>-</td>
<td>↘️ (&gt;4 cpm)</td>
<td></td>
</tr>
<tr>
<td>Memory task</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Arithmetic task</td>
<td>-</td>
<td>↘️ (&gt;4 cpm)</td>
<td></td>
</tr>
<tr>
<td>Visual task</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Auditory task</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Performance decrement is associated with:
- Shift of gastric power to higher frequencies (tachygastria)

Average values per participant in motion conditions
Linear or logarithmic fit
Regression analysis
Performance vs Motion Sickness

Experimental Session 1

Experimental Session 2

- Composite Δ=9%
- Memory Δ=25%
- Arithmetic Δ=13%

• Average values per participant in motion conditions
Skill Acquisition & Reminiscence

- **Between-sessions**
  - Performance $\Delta$ between the end of ES 1 and beginning of ES 2

- This effect was NOT associated with:
  - Motion in ES 1
  - Development of mild motion sickness symptoms in ES 1
Conclusions
Conclusions
Overall

- Multitasking cognitive performance deteriorates even in mildly nauseogenic motion environments
  - Composite -9%, Memory -25%, Arithmetic -13%

- Mild motion sickness does not seem to interfere with the reminiscence effect in a novel cognitive multitasking environment
Conclusions

- **Order effect**
  - ES 1
    - Participants seem to overcome mild motion sickness
  - ES 2
    - Symptomatology takes a toll on performance

- **Probable explanations**
  - **Task involvement/ Task novelty**
    - Mental activity reduces severity (Bos, 2011; Correia & Guedry, 1966; Griffin, 1990)
  - **Self-motivation**
    - Encouragement to suppress symptoms (“cognitive counseling”) (Dobie et al., 1987; Dobie et al., 1989)
Conclusions: Conceptual Modeling I

- Symptomatic individuals
- Asymptomatic individuals

Performance decrement

Adaptation

Static

Nauseogenic motion

Severity of symptoms

Time

Multitasking Performance

Hypothetical
Conclusions: Conceptual Modeling II

Conceptual Modeling II

Symptomatic individuals
2nd Session

Asymptomatic individuals

Symptomatic individuals
1st Session

Symptomatic individuals
2nd Session

Static
Nauseogenic motion

Multitasking Performance

Practice Effect

Time -->
Severity of symptoms -->
Why?

Background

- Simple tasks needing automated responses will suffer less from stress than performance in complex tasks (Yerkes & Dodson, 1908; van Hiel & Mervielde, 2007)

- Mental tasks decrease motion sickness severity (Bos, 2011; Correia & Guedry, 1966; Graybiel, 1968)

- Postural control, sensory integration, and disorientation require cognitive and attentional resources
Previous research combined with our results suggest that:

Motion sickness acts as a **distractor** by absorbing or denying the use of attentional resources.
The End!

Questions?
Demographics

- 2 data collection phases
- 39 healthy participants
  - 34 M – 5 F
  - Air Force=4, Army=6, Navy=22, USMC=1, Civilian=4, NOAA=1, Other=1
  - O2 to O5 (O2=4, O3=16, O4=14, O5=1)
- Equivalent participant groups in
  - Demographics
  - Subjective (MSAQ, MISC, SSS, etc)
  - Psychophysiological (SC, ECG, EGG)
  - 33 of SYNWIN metrics
- Differences in visual task
  - Group B resets more frequently than group A
    - Number of resets
    - Reset time
    - Reset position
- Inter-session interval
  - M=6.51d, SD=1.45, MD=7

<table>
<thead>
<tr>
<th>Parameters</th>
<th>M</th>
<th>SD</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>35.2</td>
<td>6.02</td>
<td>34</td>
</tr>
<tr>
<td>Height (inches)</td>
<td>69.9</td>
<td>3.56</td>
<td>70</td>
</tr>
<tr>
<td>Weight (pounds)</td>
<td>185</td>
<td>28.2</td>
<td>180</td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td>26.7</td>
<td>3.84</td>
<td>26.3</td>
</tr>
<tr>
<td>NEO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>16.4</td>
<td>7.59</td>
<td>16</td>
</tr>
<tr>
<td>E</td>
<td>29.9</td>
<td>5.62</td>
<td>29</td>
</tr>
<tr>
<td>O</td>
<td>27.9</td>
<td>6.01</td>
<td>29</td>
</tr>
<tr>
<td>A</td>
<td>31.0</td>
<td>5.12</td>
<td>31</td>
</tr>
<tr>
<td>C</td>
<td>33.8</td>
<td>6.81</td>
<td>34</td>
</tr>
<tr>
<td>MSSQ</td>
<td>17.2</td>
<td>27.7</td>
<td>9.77</td>
</tr>
</tbody>
</table>