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

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

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and
Michael E. McCauley, PhD
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)

**1st Experimental Session**

<table>
<thead>
<tr>
<th>Group A</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Group C</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

**2nd Experimental Session**

<table>
<thead>
<tr>
<th>Group A</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Group C</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Motion stimulus
Experimental Design: SYNWIN Cognitive Multi-Task

- Counterbalanced (motion)
Results
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
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

[Graph showing frequency of occurrence in symptomatic participants]
Symptomatology, Performance and Session
Symptomatology, performance, and session Scores vs Motion Sickness

### Performance vs subjective metrics

<table>
<thead>
<tr>
<th>SYNWIN 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></td>
<td>↘ MSAQ Total</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↘ MSAQ C</td>
<td>↘ SSS</td>
</tr>
<tr>
<td>Memory task</td>
<td>↘ SSS</td>
<td></td>
<td>↘ SSS</td>
</tr>
<tr>
<td>Arithmetic task</td>
<td>↘ MSAQ G</td>
<td>↘ MSAQ Total</td>
<td>↘ MSAQ Total</td>
</tr>
<tr>
<td></td>
<td>↘ MSAQ G</td>
<td>↘ MSAQ P</td>
<td>↘ MSAQ S</td>
</tr>
<tr>
<td>Visual task</td>
<td>-</td>
<td>-</td>
<td>↘ MSAQ S</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>SYNWIN 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></td>
<td>↘ (&gt;4 cpm)</td>
</tr>
<tr>
<td>Memory task</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arithmetic task</td>
<td>-</td>
<td>-</td>
<td>↘ (&gt;4 cpm)</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 (tachy gastria)

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

Experimental Session 1

- Composite: 120%
- Memory: 120%
- Arithmetic: 140%
- Visual: 100%
- Auditory: 110%

Experimental Session 2

- Composite: 130%
- Memory: 150%
- Arithmetic: 130%

Symptomatic (Dark Gray) vs Asymptomatic (Light Gray)

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

- Between-sessions
  - Performance Δ 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

![Graph showing Composite Score over ES 1 and ES 2 blocks for different conditions]
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

Static

Nauseogenic motion

Asymptomatic individuals

Symptomatic individuals

Performance decrement

Adaptation

Hypothetical

Multitasking Performance

Time --> Severity of symptoms -->
Conclusions: Conceptual Modeling II

Symptomatic individuals 2nd Session

Asymptomatic individuals

Symptomatic individuals 1st Session

Symptomatic individuals 2nd Session

Multitasking Performance

Static

Nauseogenic motion

Practice Effect

Time -->

Severity of symptoms -->
Why?

- **Background**
  - Simple tasks needing automated responses will suffer less from stress than performance in complex task (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
Why II?

- 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>
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<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>