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The Effect of Mild Motion Sickness and Soporific Symptoms on Multitasking Cognitive Strategy

P. Matsangas and M.E. McCauley



Introduction

Definitions

▶ Motion sickness

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



▶ Sopite syndrome (Graybiel & Knepton, 1976)

- ▶ A symptom-complex centered around excessive drowsiness, disinterest/ disinclination to work, mood changes, and reduced ability to focus on an assigned task, in real or apparent motion settings, at levels that cannot be accounted for in a healthy individual by sleep deprivation, and mental or physical fatigue due to increased activity (Matsangas, 2013)



Introduction

▶ The Problem

- ▶ Effect of motion sickness on multitasking not investigated in depth

▶ But

- ▶ Multitasking characterizes military operations

Concurrent multitasking
“Doing several things at once”



- ▶ Personnel may often believe that training and motivation overcome mild MS effects

Mild Motion Sickness
Not incapacitating symptoms



Introduction

Scope

- ▶ To investigate whether non-incapacitating motion sickness severity affects the cognitive strategy of performing in a multitasking environment

Cognitive strategy

The selection and sequencing of mental operations in the performance of concurrent tasks with the intent of optimizing behavior with respect to the external situation

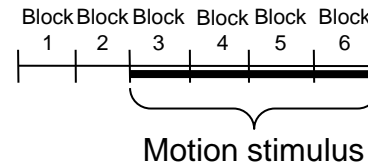


Method

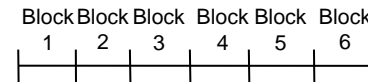
- ▶ 39 healthy participants
 - ▶ 34 M – 5 F
 - ▶ Age M=35.2 yrs, SD=6.02
- ▶ Inter-session interval
 - ▶ M=6.61d, SD=1.28, MD=7
- ▶ Nauseogenic motion stimulus
 - ▶ z-axis: +/- 2 inches (heave)
 - ▶ y axis: +/- 15 degrees (roll)
 - ▶ x axis: +/- 15 degrees (pitch)
 - ▶ All axes: $f=0.167$ Hz sinusoidal

1st Experimental Session ES-1

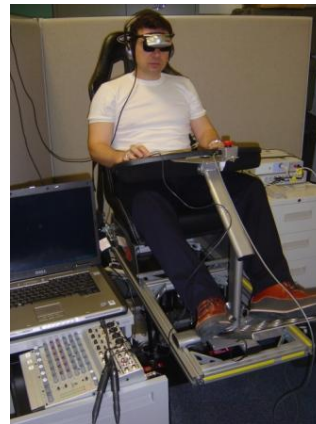
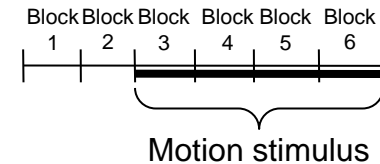
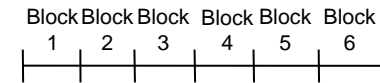
Group A
(n=20)



Group B
(n=19)



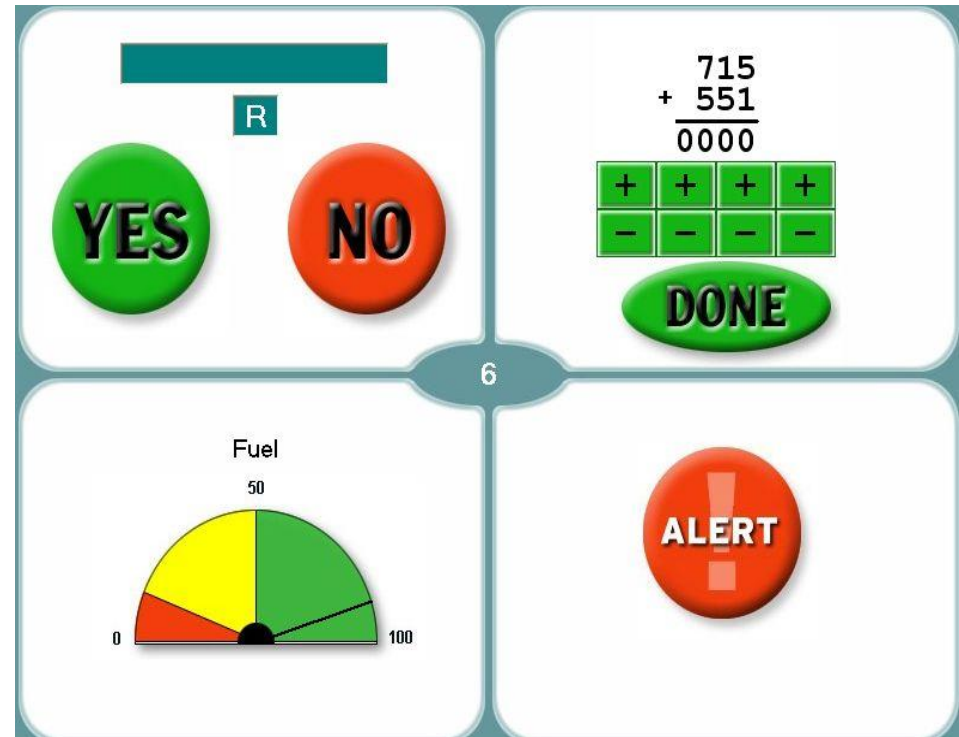
2nd Experimental Session ES-2



Method

Cognitive Multi-Task

- ▶ SYNWIN multitasking battery
- ▶ Four component tasks
 - ▶ Cognitive
 - ▶ Memory task
 - ▶ Arithmetic (self-paced)
 - ▶ Monitor and react tasks
 - ▶ Visual
 - ▶ Auditory
- ▶ Presented simultaneously
- ▶ Objective
 - ▶ Increase the composite score

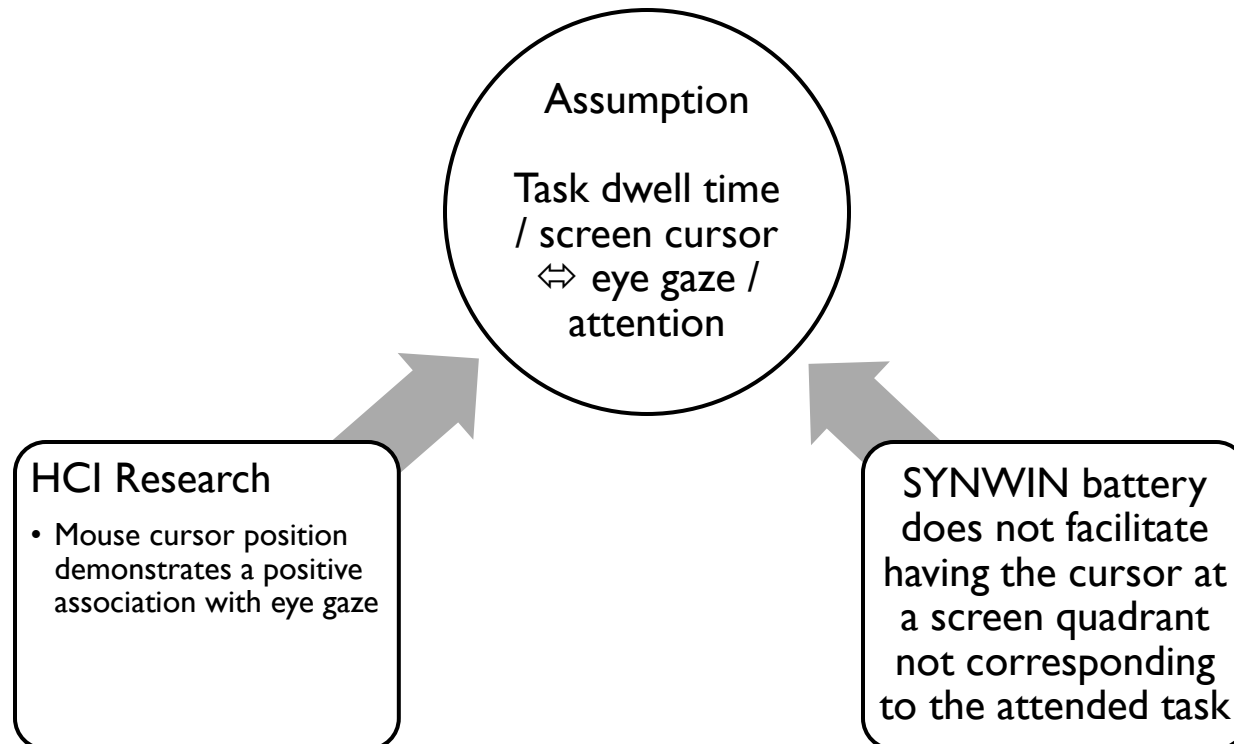


Method

Task Dwell Time

▶ Task dwell time

- ▶ The amount of time the screen cursor is in the corresponding task screen quadrant
-



Method

Variables

Independent (motion sickness related)

- MSAQ Total
 - Gastrointestinal – G
 - Peripheral – P
 - Central – C
 - Sopite - S
- Stanford Sleepiness Scale (SSS)

Dependent (SYNWIN metrics)

- Primary
 - Four task dwell times
- Secondary
 - Memory task
 - Reaction time (RT) of correct responses
 - Arithmetic task
 - % correct responses
 - RT correct responses
 - Number of responses



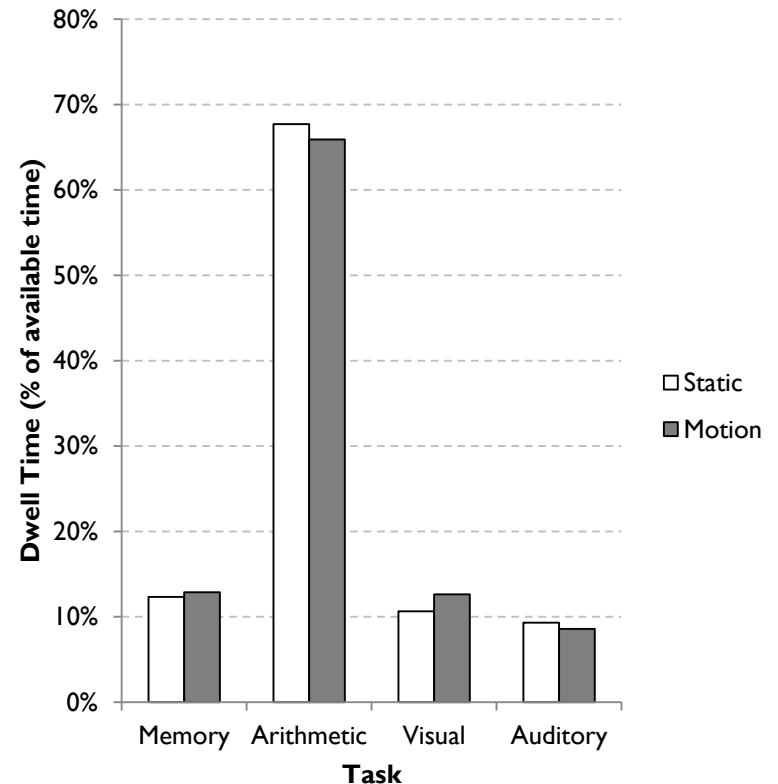
Results

- ▶ Mild motion sickness
 - ▶ MSAQ Total $M=14.4$, $SD=6.35$

- ▶ Strategy
 - ▶ $\approx 65\%$ of DT for the arithmetic task
 - ▶ Verified by 90% of post-test Q.



- ▶ Results suggest
 - ▶ Participants consciously used the strategy to focus on the arithmetic task



Results

SYNWIN vs MSAQ indices / SSS

Metric	Memory	Arithmetic				Visual	Auditory
	DT	DT	RT correct	% correct	# of responses	DT	DT
MSAQ Total		-0.270**	0.380*		-0.346*	0.326*	
SSS		-0.394*	0.314**		-0.278**	0.368*	
MSAQ G		-0.336*	0.443+		-0.451+	0.355*	
MSAQ C			0.374*		-0.282**		-0.339*
MSAQ P			0.272**				
MSAQ S			0.268**			0.287**	

- ▶ When MS ↗
- ▶ Arithmetic task
 - ▶ DT ↘
 - ▶ RT of correct responses ↗
 - ▶ Number of responses ↘
 - ▶ Visual task
 - ▶ DT ↗

• Average values per participant in motion conditions

• Correlations (Spearman's rho)
• "+" : $p < 0.01$, "*" : $p < 0.05$, "***" : $p < 0.10$

Results

SYNWIN vs MSAQ indices / SSS

	Memory	Arithmetic				Visual	Auditory
Metric	DT	DT	RT correct	% correct	# of responses	DT	DT
MSAQ Total		↘	↗		↘	↗	
SSS		↘	↗		↘	↗	
MSAQ G		↘	↗		↘	↗	
MSAQ C			↗		↘		↘
MSAQ P			↗				
MSAQ S			↗			↗	

- ▶ When MS ↗
- ▶ Arithmetic task
 - ▶ DT ↘
 - ▶ RT of correct responses ↗
 - ▶ Number of responses ↘
 - ▶ Visual task
 - ▶ DT ↗

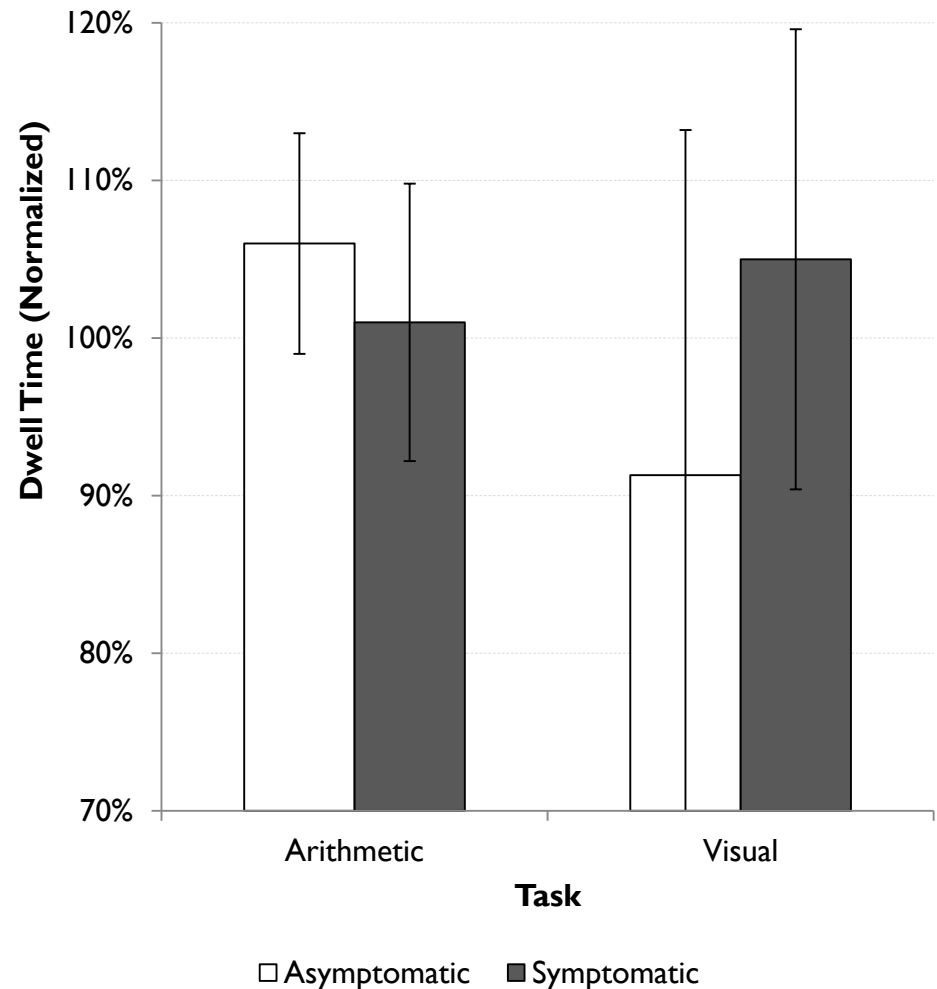
▶ • Average values per participant in motion conditions

• Correlations (Spearman's rho)
 • “+” : p < 0.01, “*” : p < 0.05, “***” : p < 0.10

Results

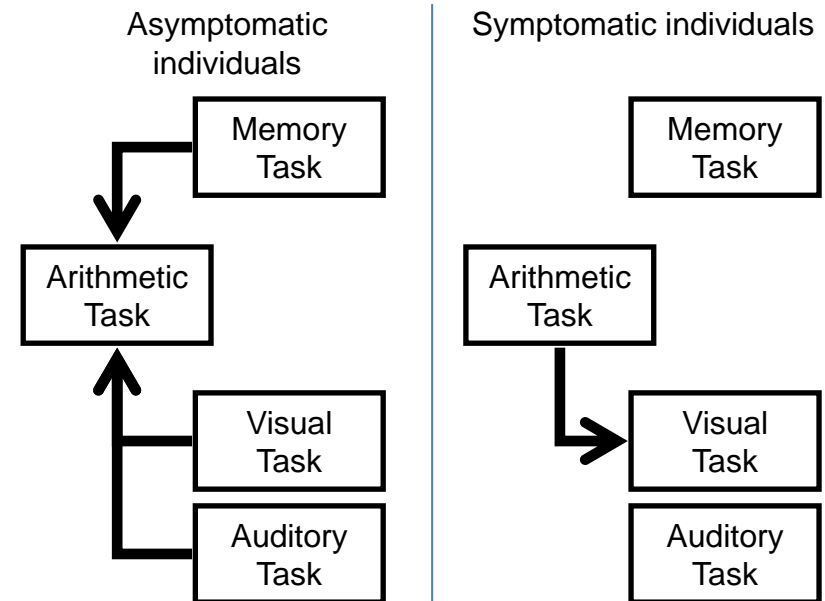
Dwell Time Differences

- ▶ Classify participants
- ▶ Compare each participant's average symptom severity between motion and static conditions
 - ▶ If $(MS)_{\text{Motion}} > (MS)_{\text{Static}}$
⇒ “Symptomatic” (n=20)
 - ▶ If $(MS)_{\text{Motion}} \leq (MS)_{\text{Static}}$
⇒ “Neutral” (n=2)
 - ▶ If $(MS)_{\text{Motion}} = (MS)_{\text{Static}} = \text{MIN}$
⇒ “Asymptomatic” (n=16)



Conclusions

- ▶ **Symptomatic individuals**
 - ▶ **Complex arithmetic task**
 - ▶ Still focus on the complex arithmetic task (DT)
 - ▶ Decreased number of responses
 - ▶ Increased reaction time of correct responses
 - ▶ Shift focus to the simple visual task (DT)
- ▶ **Memory and auditory tasks**
 - ▶ Not affected



Task dwell time allocation shifting versus severity of symptoms

▶

Conclusions

- ▶ Mild motion sickness and soporific symptoms affect the cognitive strategy
 - ▶ Shifting focus from more “complex” to “simpler” tasks
- ▶ “speed versus accuracy” trade-off
 - ▶ Symptomatic individuals need more time to decide their answer
 - ▶ Only “well-thought” answer has been derived, do participants respond to the task



Conclusions

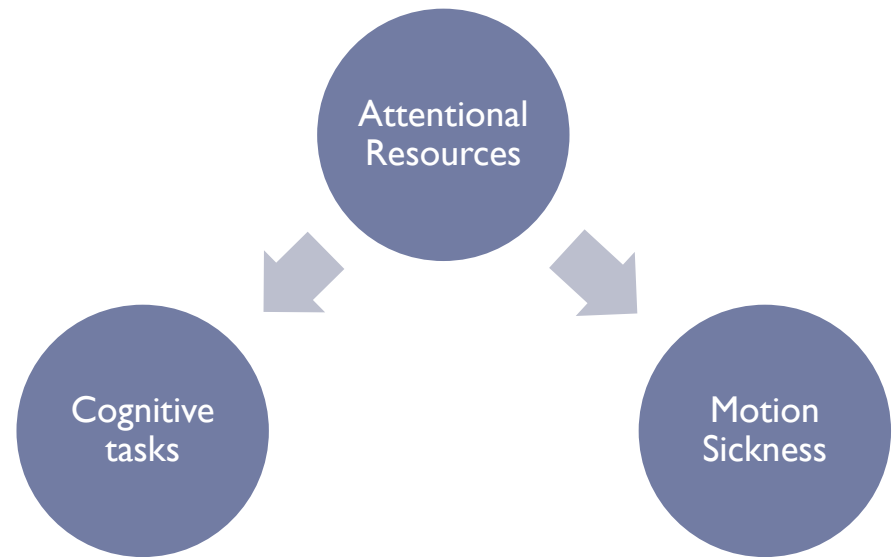
Plausible Explanation

▶ Background

- ▶ Simple tasks needing automated responses will suffer less from stress than performance in complex task
- ▶ Mental activity reduces motion sickness severity (Bos, 2011; Correia & Guedry, 1966; Griffin, 1990)
- ▶ Postural control, sensory integration, and disorientation require cognitive and attentional resources

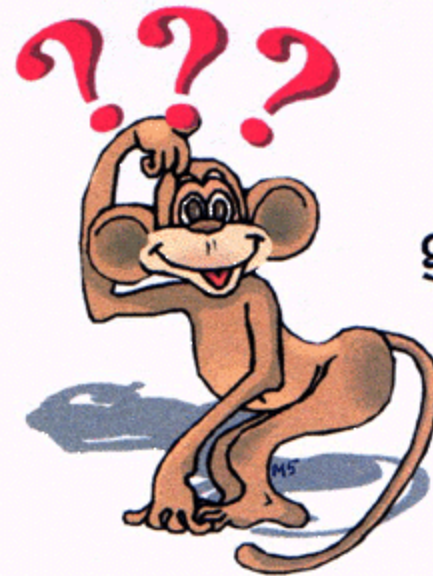
▶ + Our results

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



The End!

Questions?



Questions
are
guaranteed in
life;
Answers
aren't.

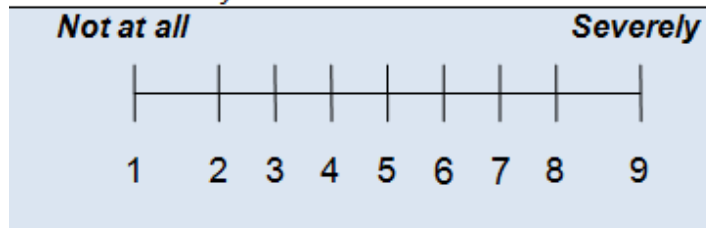


Method

Motion Sickness Metrics

1. MSAQ

Instructions: Using the scale below, please rate how accurately the following statements describe how you feel:



- | | |
|-----------------------------------|-------|
| a. I feel sick to my stomach (G) | _____ |
| b. I feel faint-like (C) | _____ |
| c. I feel annoyed/ irritated (S) | _____ |
| d. I feel sweaty (P) | _____ |
| e. I feel queasy (G) | _____ |
| f. I feel lightheaded (C) | _____ |
| g. I feel drowsy (S) | _____ |
| h. I feel clammy/ cold sweat (P) | _____ |
| i. I feel disoriented (C) | _____ |
| j. I feel tired/ fatigued (S) | _____ |
| k. I feel nauseated (G) | _____ |
| l. I feel hot/ warm (P) | _____ |
| m. I feel dizzy (C) | _____ |
| n. I feel like I was spinning (C) | _____ |
| o. I feel as if I may vomit (G) | _____ |
| p. I feel uneasy (S) | _____ |

4. SSS

Instructions: Circle ONE number that corresponds to your current rating of sleepiness.

Degree of Sleepiness	Scale Rating
Feeling active, vital, alert, or wide awake	1
Functioning at high levels, but not at peak; able to concentrate	2
Awake, but relaxed; responsive but not fully alert	3
Somewhat foggy, let down	4
Foggy; losing interest in remaining awake; slowed down	5
Sleepy, woozy, fighting sleep; prefer to lie down	6
No longer fighting sleep, sleep onset soon; having dream-like thoughts	7
Asleep	X

- Gianaros, et al. (2001). A questionnaire for the assessment of the multiple dimensions of motion sickness. *Aviat Space Environ Med*, 72(2), 115-119
- Hoddes, E., Dement, W. C., & Zarcone, V. (1972). The development and use of the Stanford sleepiness scale (SSS). *Psychophysiology*, 9, 150-151