



# BEHAVIORAL HEALTH AND PERFORMANCE

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SPACE LIFE SCIENCES  
SUMMER INSTITUTE

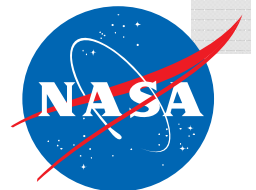


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July 30, 2014



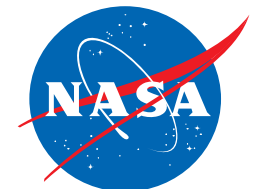
# Outline

- I. Introduction
- II. Health Risks of Increased CO<sub>2</sub> Exposure
  - ❖ Literature Review: Cognitive Effects
  - ❖ Headache Questionnaire Evaluation
- III. Performance Metrics for HERA
  - Spaceflight Analogue Research
- IV. Operational Communication Matrix



# INTRODUCTION

- ❑ BA/MA, Psychology (2007)
  - Harvard University, Cambridge MA
- ❑ PhD, Experimental Psychology (2013)
  - University of Cambridge, Cambridge UK
- ❑ MS, Aeronautics and Astronautics (2014, expected)
  - Massachusetts Institute of Technology, Cambridge MA



# ELEVATED ENVIRONMENTAL CO<sub>2</sub> EXPOSURE

## ❑ Risk: Adverse Cognitive & Physiological Effects of Acute and Chronic High CO<sub>2</sub>

~ 0.03% (0.23 mm Hg)

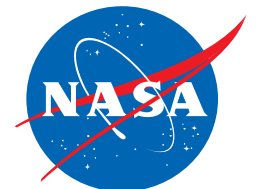
~ 0.5±0.2% (between 2.3-5.3 mm Hg),  
with large fluctuations



## ❑ Literature Review:

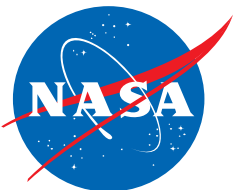
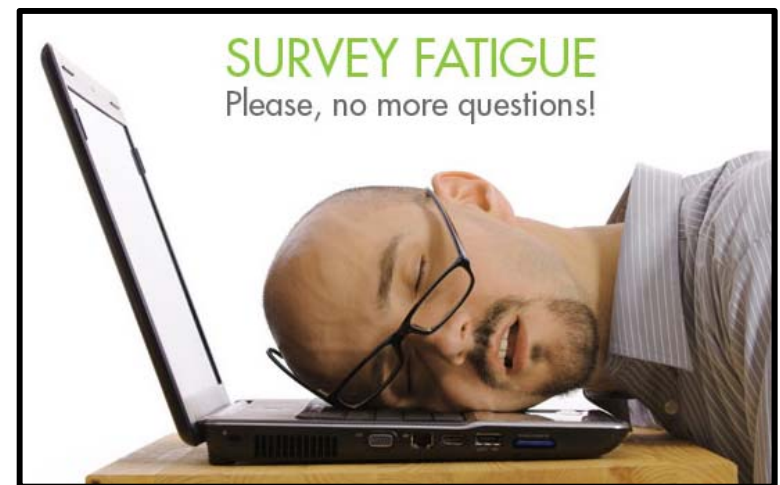
- Wide variation in administration levels, exposure concentrations, and assessment tools used.
- Inconsistent findings, limited interpretations.
- Lots of room for future work!

TOTAL	RELEVANT TO COGNITION	RELEVANT TO SLEEP
82	9	7



# HEADACHE QUESTIONNAIRE EVALUATION

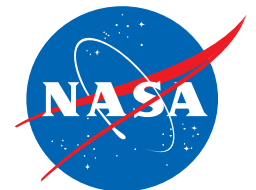
- **Objective: To improve the tracking of physiological symptoms related to CO<sub>2</sub> exposure**
- Investigation of *Survey Fatigue/Burden* and literature review of *Construct Validity* in multi-item inquiries
- Currently on ISS: 6 assessment tools probing headaches alone
  - ❑ Inconsistent symptom reporting, limited data-sharing across groups
- Possible end product: New questionnaire for CO<sub>2</sub> exposure symptoms



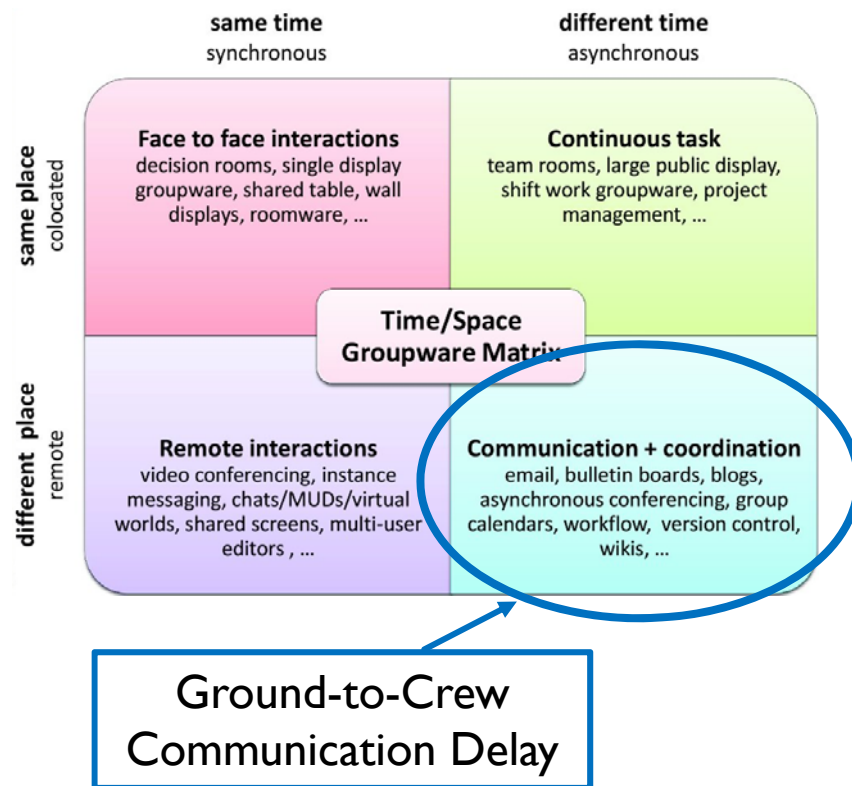
# HERA PERFORMANCE METRICS



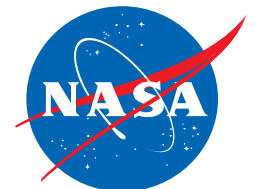
- ❑ Space flight analogue research:
  - The HERA facility
- ❑ 3 types of performance metrics
  - Emergency Simulation
  - Flight Simulators
  - Science
- ❑ Categories of recommended variables
  - Accuracy/Precision
  - Errors/Omissions
  - Mission Success (are all objectives met)
  - Time to Completion



# OPERATIONAL COMMUNICATION MATRIX



- ❑ Anticipated that the effects of transmission delays would start to occur around a 50 second (one way) delay.
- ❑ Objective: To assess the optimal communication strategies given a transmission delay based on the operational situation and the informational content of the message.
- ❑ Matrix-based classification system grounded in research field of computer-supported cooperative work.



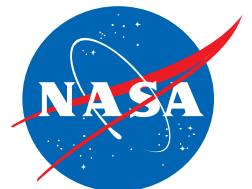
# OPERATIONAL COMMUNICATION MATRIX

## TASK: MAINTANENCE

		same time synchronous	different time asynchronous	same time synchronous	different time asynchronous
same place colocated		Verbal communication (crew-to-crew; within ground team)	Audio/video (prerecorded)	Text-based groupware (real-time collaborative software)	Text: editable docs
	different place remote	Audio/video conferencing	Audio/video (prerecorded)	Text-based chat	Text: email

**NON-CRITICAL**  
e.g. routine maintenance

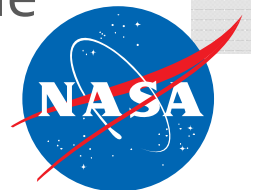
**CRITICAL**  
e.g. non-standard repair





## Conclusions

- Monitoring of CO<sub>2</sub> exposure levels on orbit and crew-reported symptoms is critical to the protection of astronaut health. However, more research is needed to fully understand how elevated atmospheric CO<sub>2</sub> impacts cognition and executive functioning.
- The tracking of outcome metrics during HERA mission simulations will allow for the direct measurement of operationally relevant performance in spaceflight analogue research.
- A time/space-based classification matrix assessing communication under delay will contribute towards a prioritization of communication modes based on the specifications of a given task.



# THANK YOU!

- Jason Schneiderman
- Diana Arias
- Lauren Leveton
- Laura Bollweg
- Sandra Whitmire
- Kristine Ohnesorge
- Al Holland
- Carli Domenico
- Stephen Vanderark
- The entire BHP Team
- Brandon Vessey
- Lauren Landon
- Holly Patterson
- Flight Analogues
- The HERA Team
- Dave Alexander
- Mary Van Baalen
- Claudia Mendez
- The CO2 Working Group
- Jackie Reeves
- Lauren Merkle
- Judy Hayes
- SSLSI
- Ron McNeel
- Amanda Hackler
- Jeff Sutton
- NSBRI, SBI
- The Summer Interns
- Everyone who made this great experience possible!

