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#INVOLVING  
EVERYONE



*Human Research Program*

# PRE-FLIGHT TRAINING OF AUTONOMIC RESPONSES FOR MITIGATING THE EFFECTS OF SPATIAL DISORIENTATION DURING SPACEFLIGHT

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# BACKGROUND



## *Human Research Program*

**Human Research Program Risk:** Impaired control of spacecraft associated systems and decreased mobility due to vestibular/sensorimotor alterations associated with spaceflight.

Orion vehicle re-entry will likely produce large cross-coupled angular accelerations that may significantly impact crew including their ability to operate the vehicle and egress.

**Question:** Can crewmember spatiomotor abilities be accurately predicted and countermeasures and training techniques developed to mitigate spatial disorientation during spaceflight?

**Countermeasure:** Autogenic-Feedback Training Exercise (AFTE)



# BACKGROUND



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## Autogenic-Feedback Training Exercise: AFTE

A 6-hour training method used to teach voluntary control of physiological responses and normalize autonomic balance. Patented by NASA in 1997. Subjects learn to voluntarily increase and decrease levels of 24 responses.

### Spaceflight research

Originally a countermeasure for space motion sickness aboard the Space Shuttle, AFTE was also tested as a treatment for post-flight orthostatic intolerance on the Russian MIR space station.

### Ground based research

- reduces or eliminates Earth-based motion sickness (N=500).
- improves pilot performance under emergency conditions.
- relieves nausea and syncope in dysautonomia patients.
- effective control of blood pressure (increases).



# SPECIFIC OBJECTIVES



## *Human Research Program*

- To simulate the Orion re-entry cross-coupled angular accelerations with participants in a rotating chair;
- To measure physiological responses, manual task performance, and motion sickness symptoms;
- To evaluate the effects of AFTE for mitigating symptoms and performance degradation;
- To determine the minimum amount of training needed to achieve these goals.



# METHODS



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**Participants:** Twenty men and women volunteers, ages 24 to 65

**Groups:** AFTE and No Treatment Control (10 per group). Groups matched for motion sickness susceptibility and gender

**Procedures:**

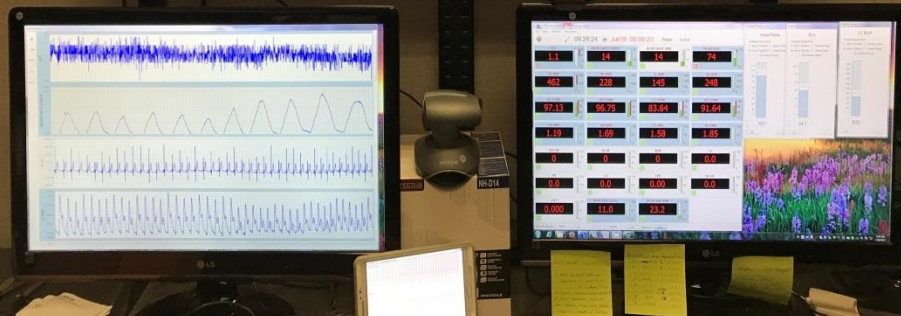
- standard rotating chair test to assess Motion Sickness susceptibility
- training on manual task - three, 30 minute sessions
- modified rotating chair test with manual task - four tests, 1 per week
- AFTE training - twelve, 30 minute sessions, 4 per week



# Autogenic-Clinical Work Stations



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# Autogenic-Feedback Training Exercise (AFTE) Detailed Screen Display



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Skin Conductance, Respiration & Heart Rate

Blood Volume Pulse both hands and feet

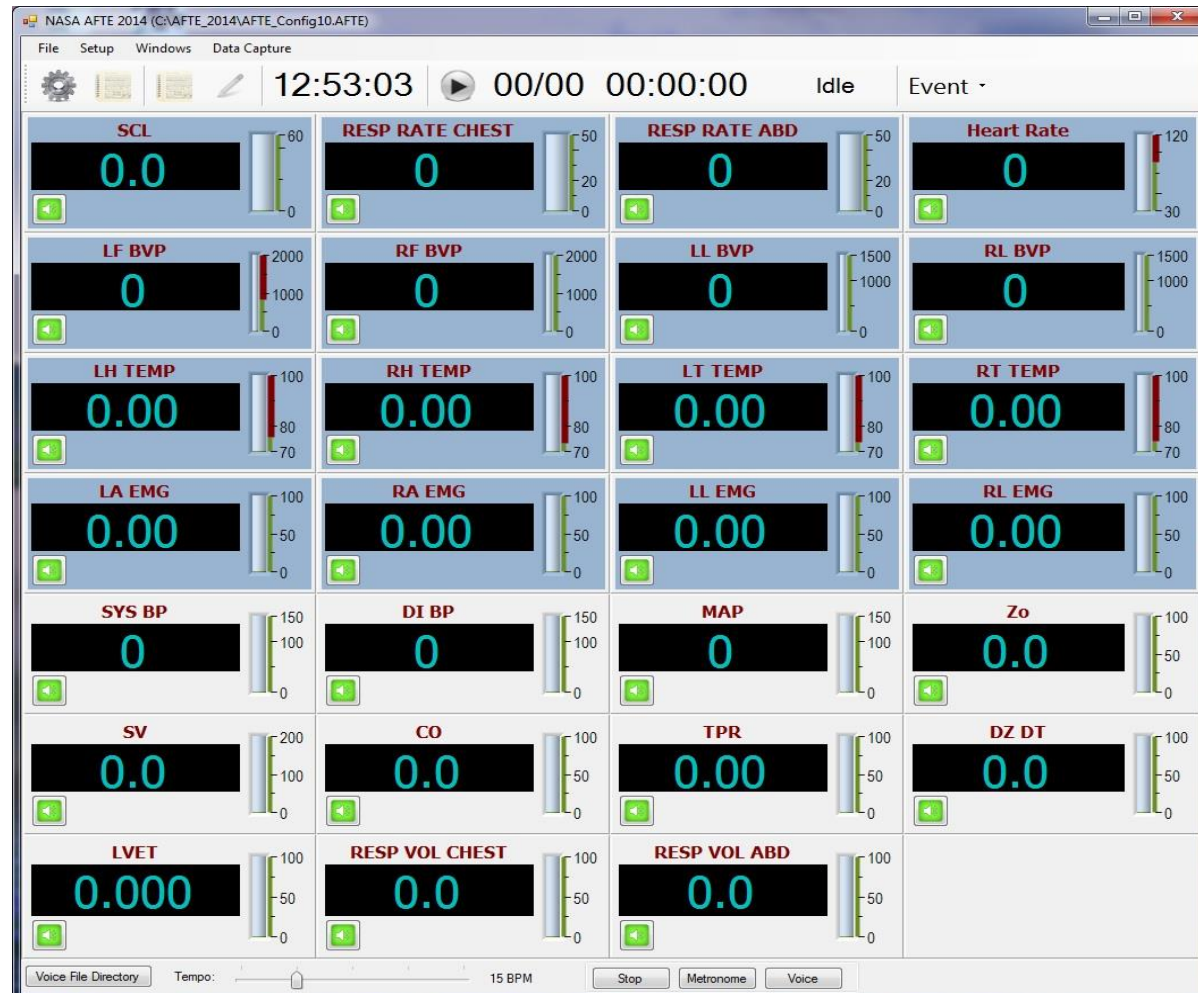
Skin Temperature both hands and feet

Muscle activity both arms and legs

Systolic, Diastolic & MAP Blood Pressure Z0=Thoracic Impedance

Stroke volume, cardiac output, total peripheral resistance, DzDt

Left Ventricular Ejection Time (LVET), Respiration volume-chest and abdomen

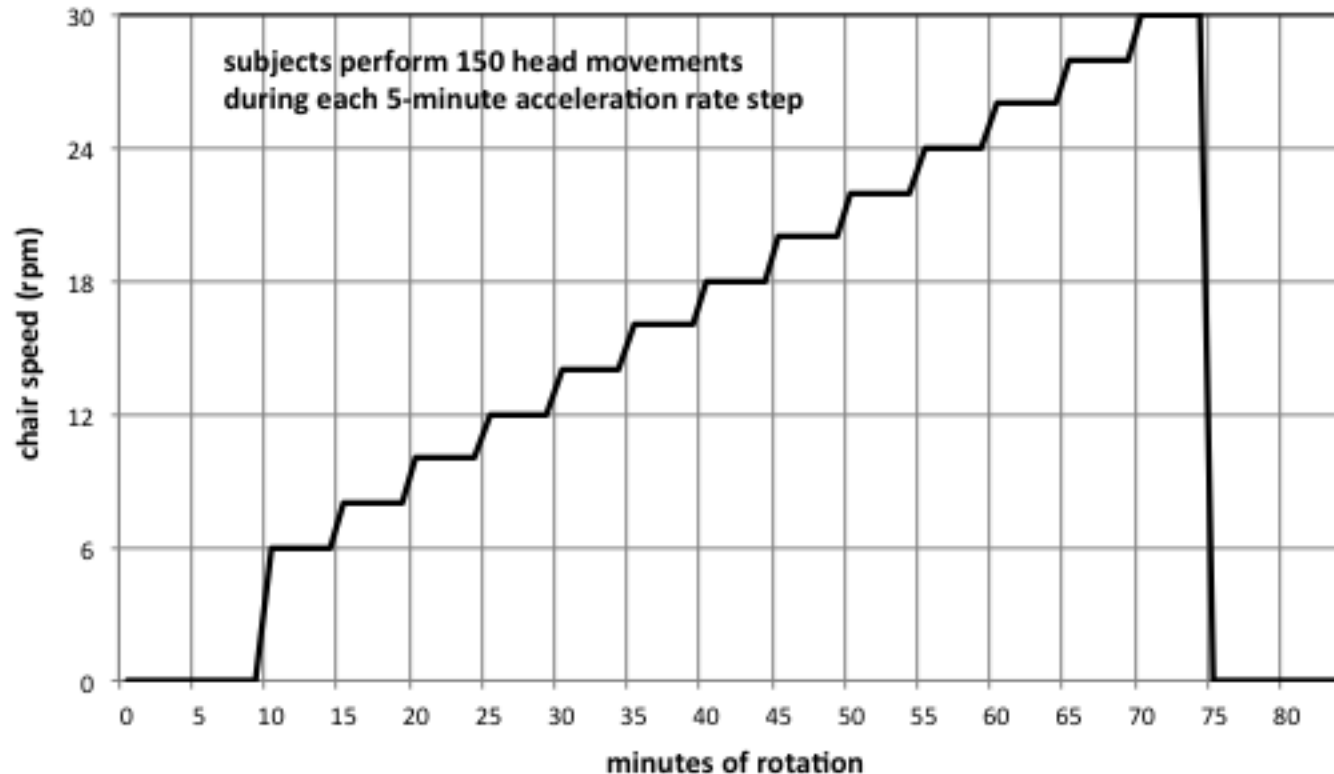




# Standard Rotating Chair Test (motion sickness susceptibility)



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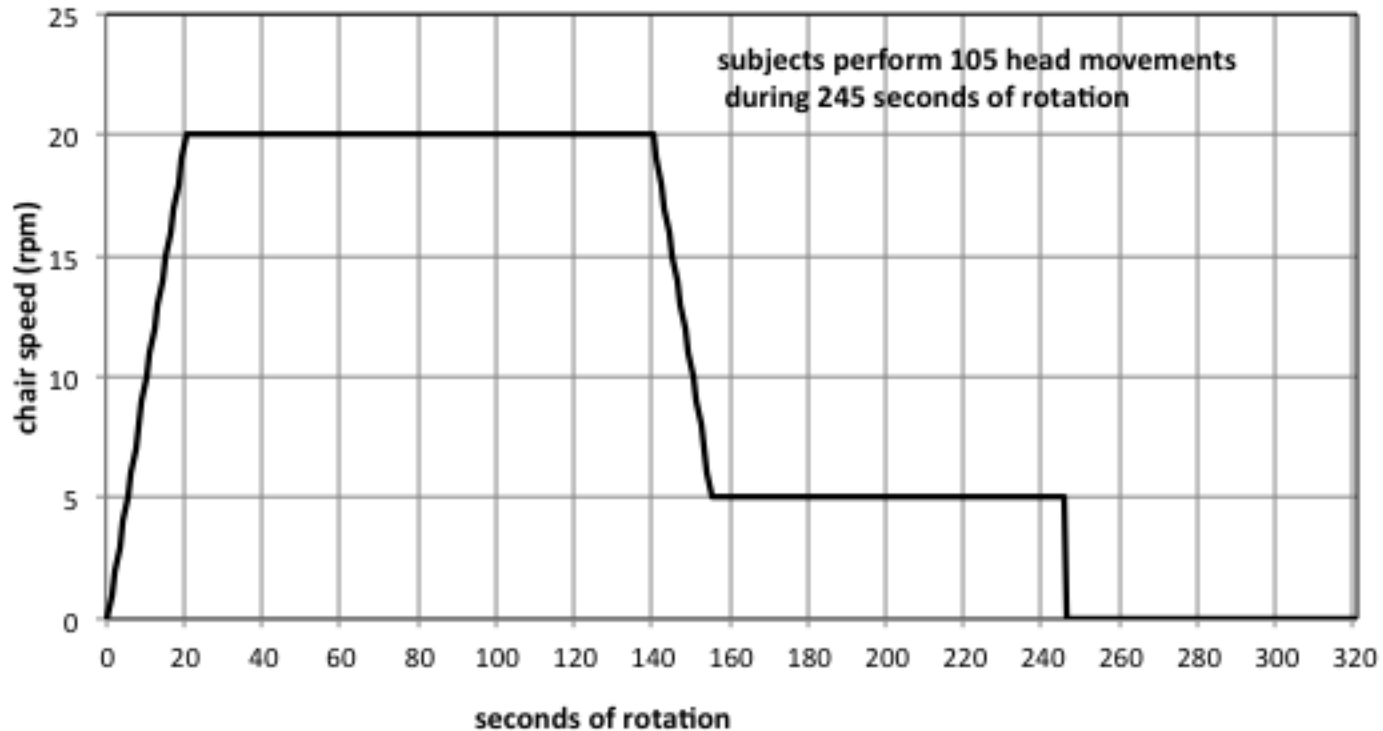




# Modified Rotating Chair Test (simulated spacecraft re-entry)



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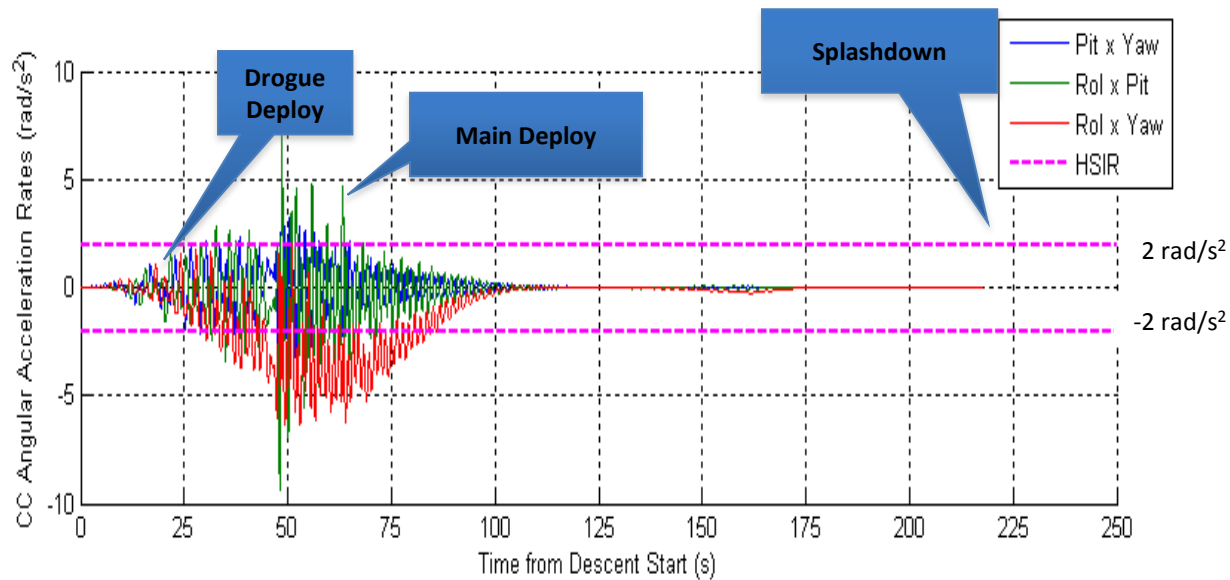




# Model of Re-entry Acceleration Rate



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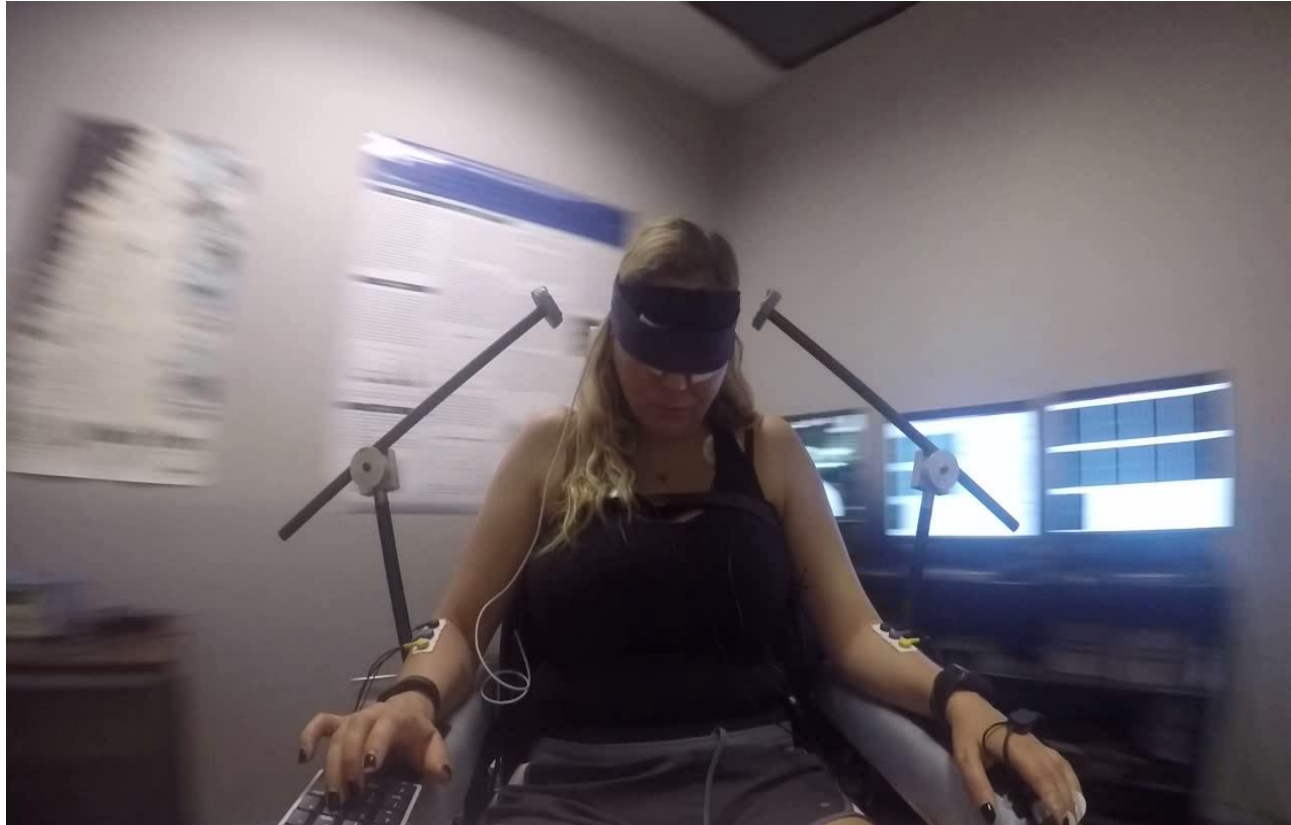




# Modified Rotating Chair Test



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# Seat Egress and Walk



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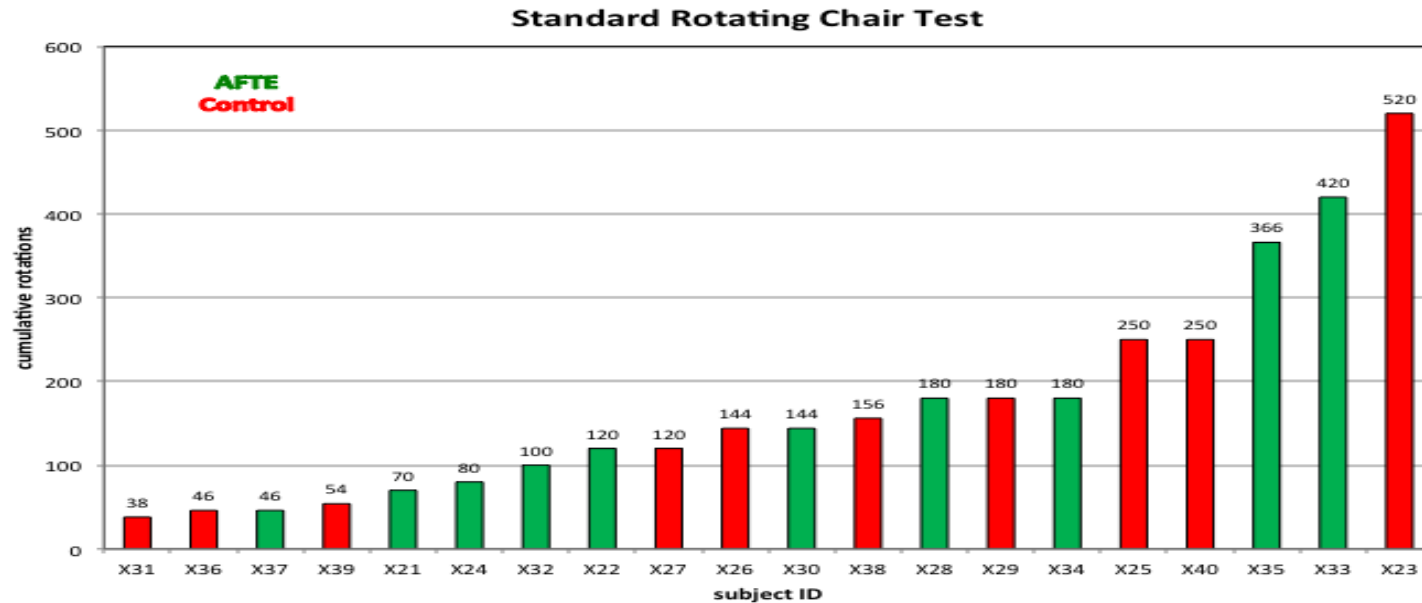




# Results - Motion Sickness Tolerance



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### Group Demographics

Treatment	Gender	Age: mean (se)	Rotations Tolerated: mean (se)
AFTE	3f, 7m	35.9 (3.7)	170.6 (39.8)
CONTROL	3f, 7m	35.2 (3.2)	176 (45.3)

?

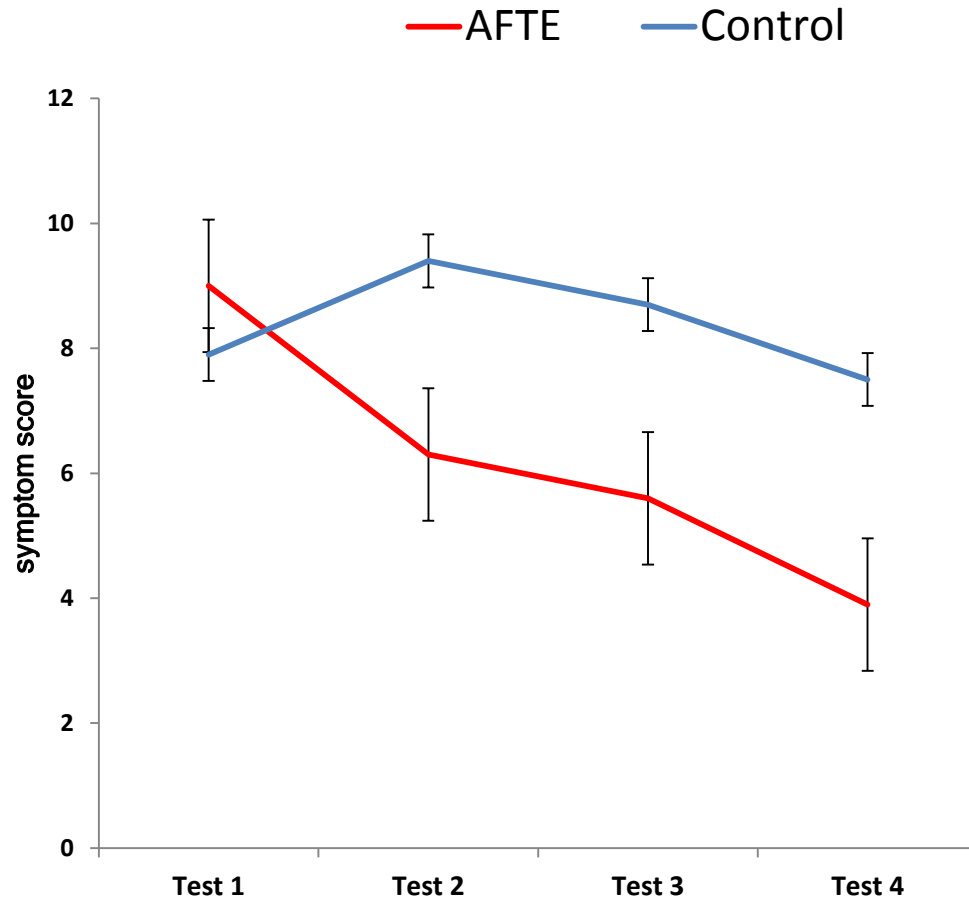


# Results - Motion Sickness Symptoms



## Groups

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Test 2 = 2 hours of AFTE,  $p < 0.05$   
Test 3 = 4 hours of AFTE,  $p < 0.04$   
Test 4 = 6 hours of AFTE,  $p < 0.01$



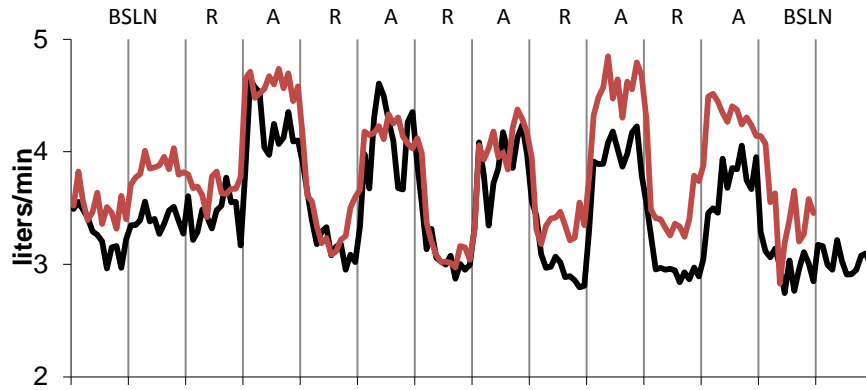
# X35 Training Data



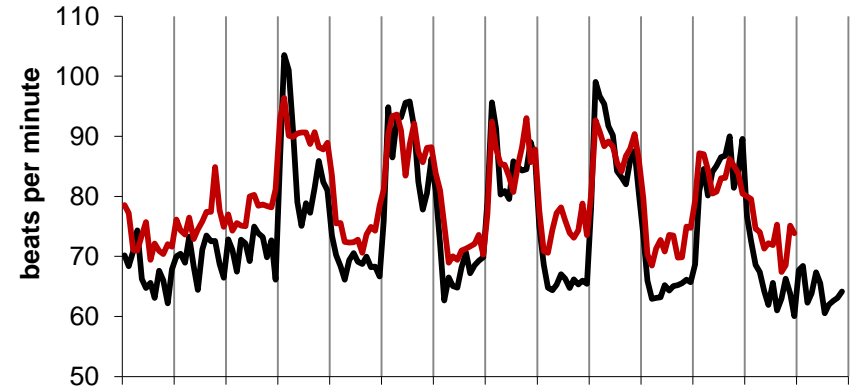
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### Cardiac Output

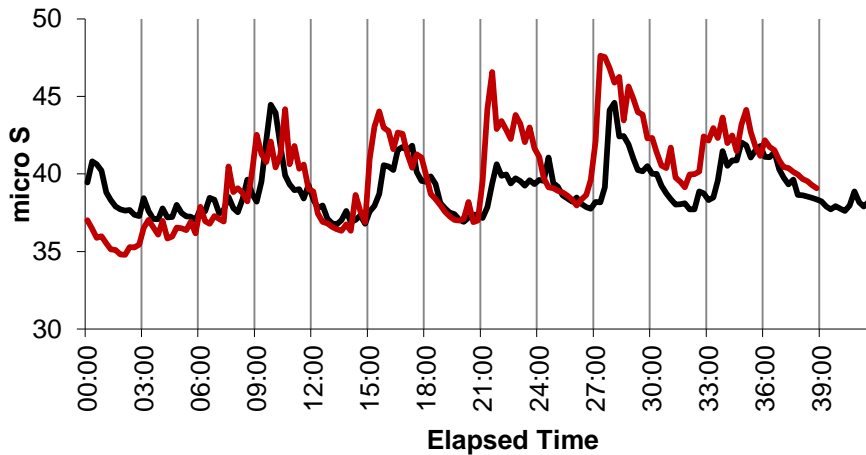
— 2-hours of AFTE — 4-hours of AFTE



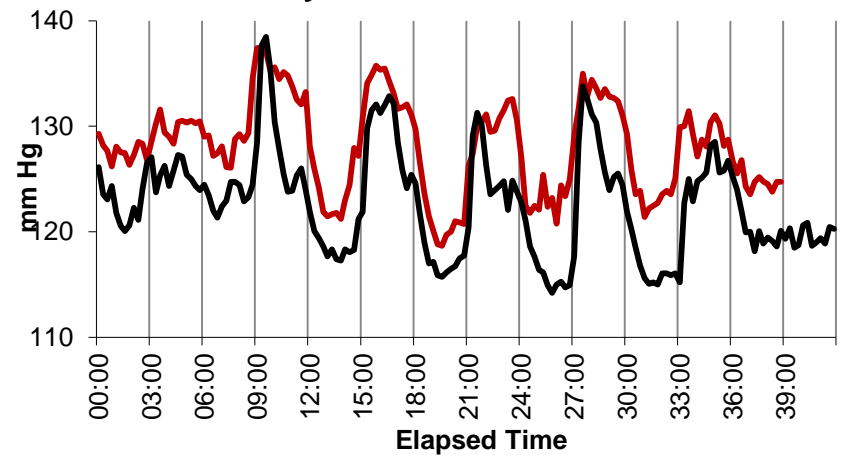
### Heart Rate



### Skin Conductance



### Systolic Blood Pressure

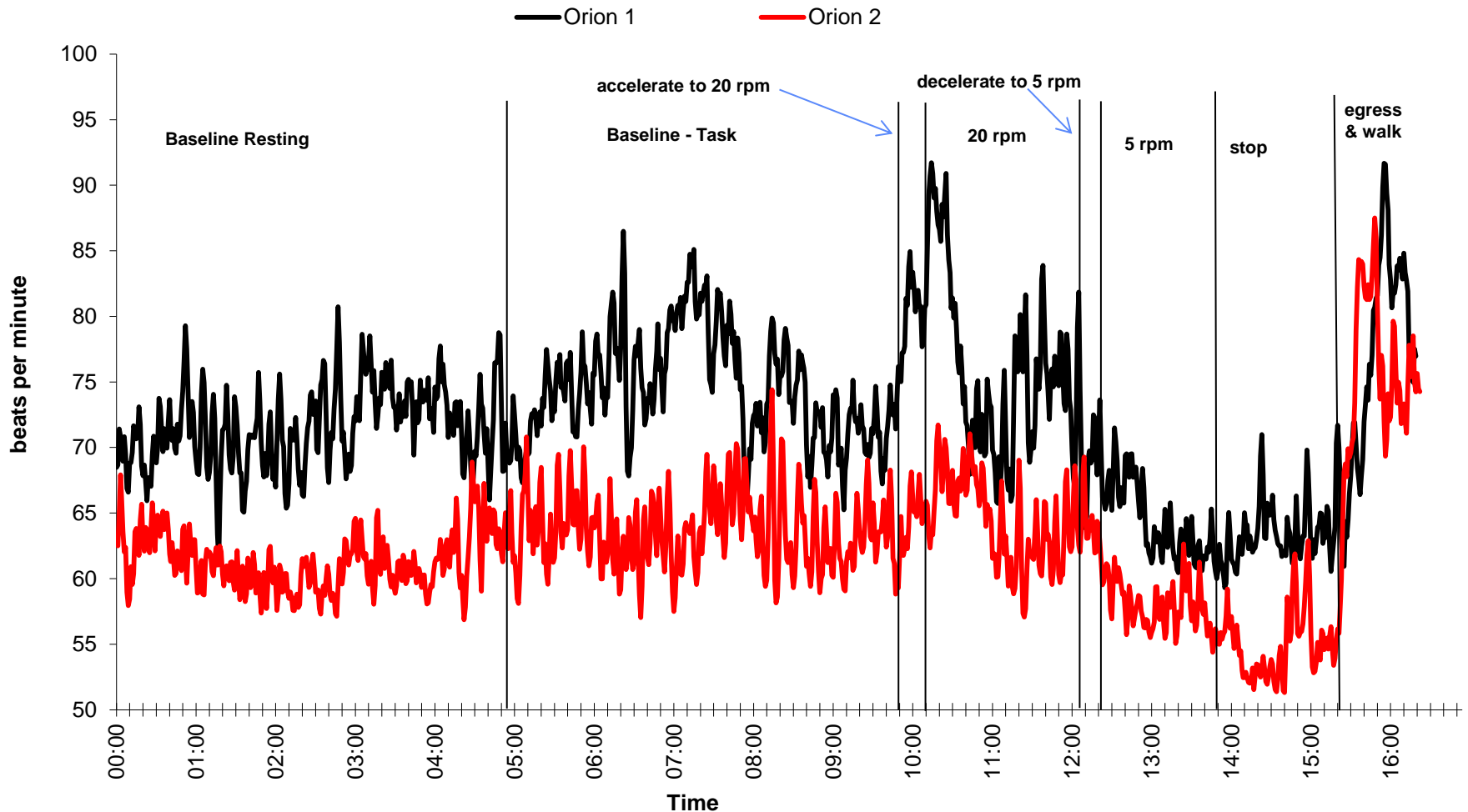




# X28 Heart Rate Data before AFTE and following 2 hours of AFTE



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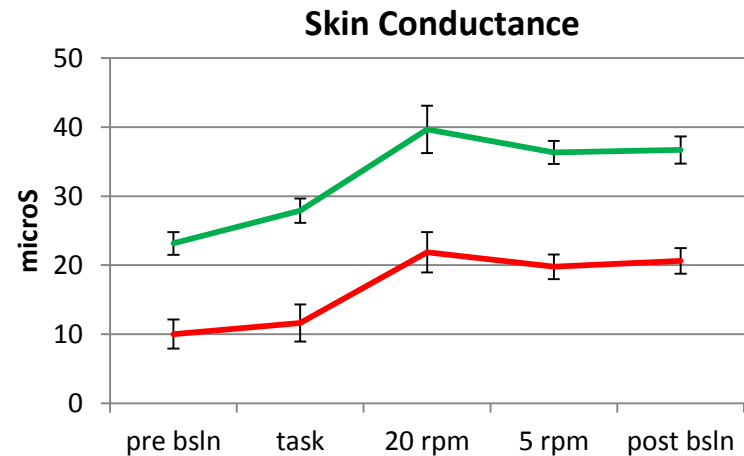
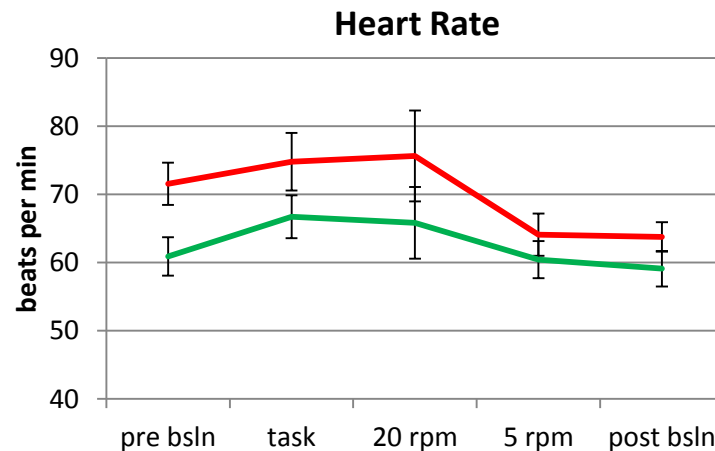
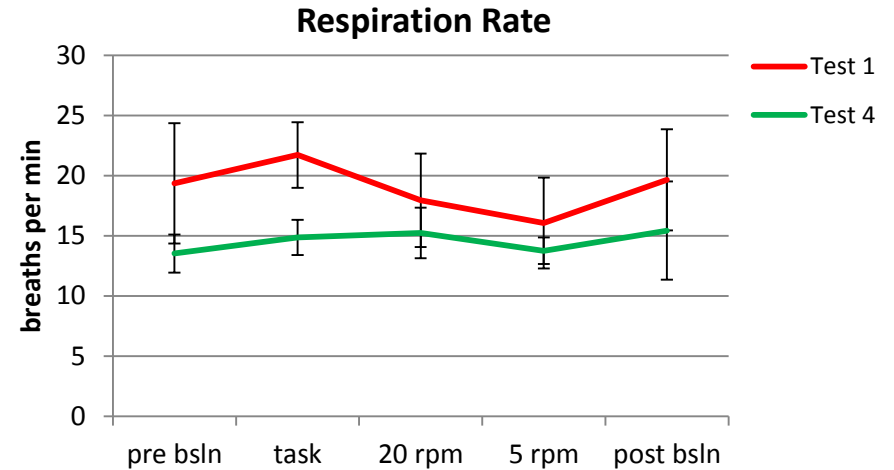
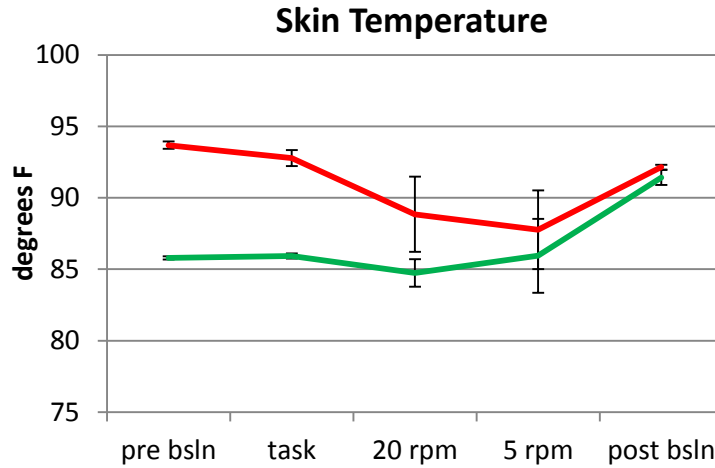


# Results - Physiological Measures



## AFTE Subject 28 (moderate susceptible)

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# Conclusions



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Objectives of this study were successfully met

- Simulated Orion Test did induce motion sickness symptoms
- AFTE subjects had significantly lower symptoms than Control Subjects
- Two hours of AFTE was sufficient for controlling symptoms
- Additional practice improved subjects' ability to self-regulate their responses
- Proposed analog studies will include 2 hours of AFTE pre-mission, and will provide wearable biosensors /mobile displays to allow self-practice during the mission
- Self-reports and performance tests during analog studies will allow more detailed assessment of AFTE effects during long duration missions.