Spaceflight Effects on Neurocognitive Performance: Extent, Longevity, & Neural Bases (NeuroMapping)

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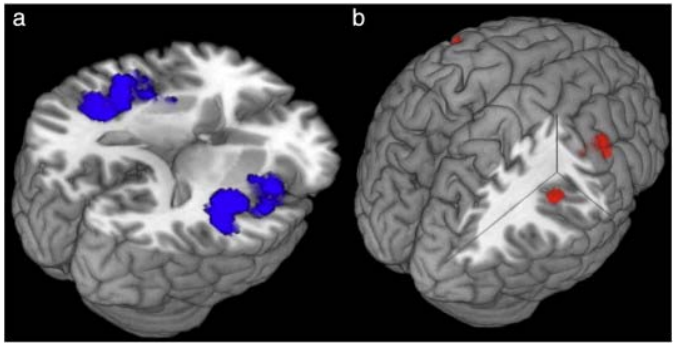


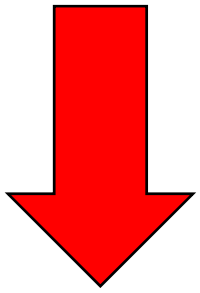
Science Background

- Spaceflight affects balance, spatial orientation, & motor control
- Rodent models have shown sensorimotor neural structural changes
- This study will address whether these neural structural changes occur in humans and how they impact astronaut functional performance
- We will also investigate whether spaceflight affects sensorimotor adaptation; important for transitioning between varying gravitational environments

Objectives

1) Identify changes in brain structure and function that occur with spaceflight and characterize their recovery time course.

2) Identify whether / how these changes contribute to decrements in functional performance.



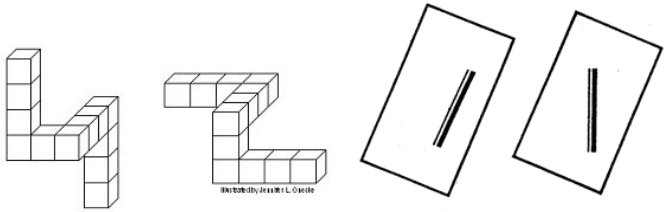
Assess the risk of long-duration spaceflight on brain structure / function, & impact on performance

NeuroMapping

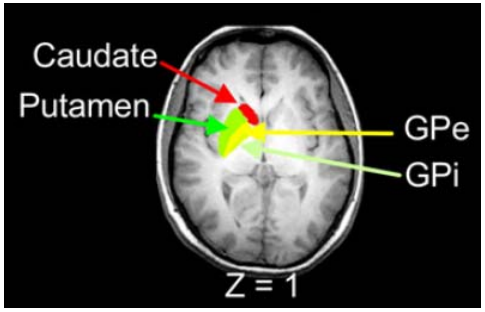
R. D. Seidler

Functional Performance MAP *Brain Structure & Function*

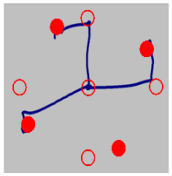
Spatial Cognition & Orientation

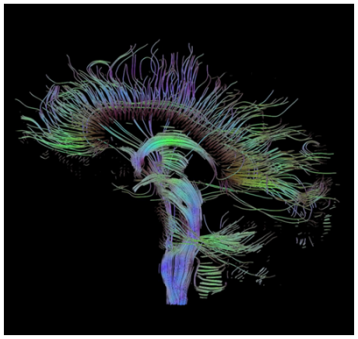


Rod and Frame test—Align a rod within these frames so that the rod is vertical.

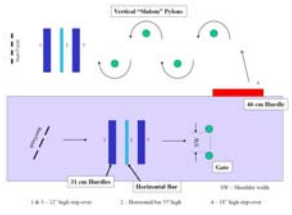


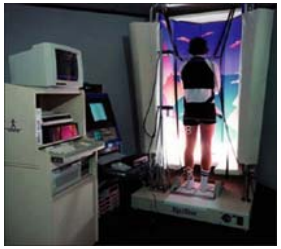
Processing Speed & Manual Control

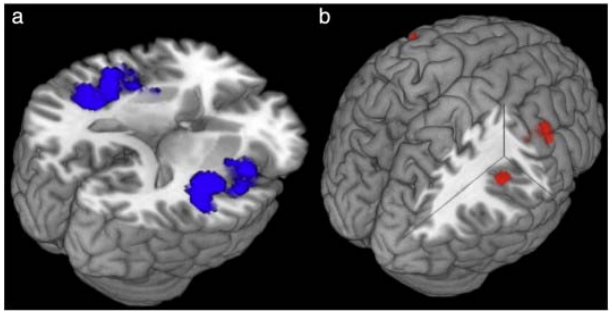




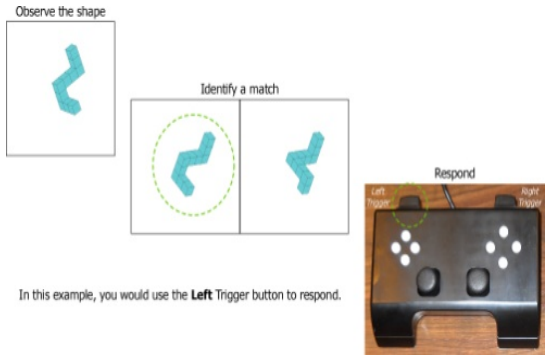
Mobility, Balance & Vestibular Function



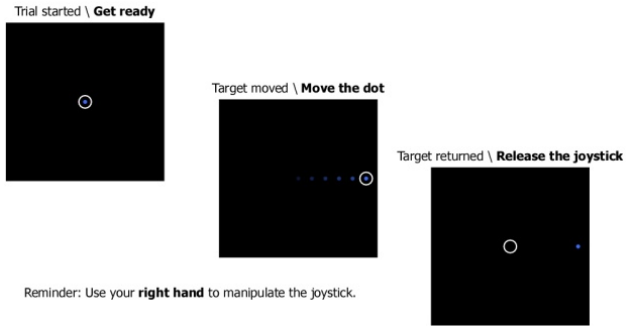




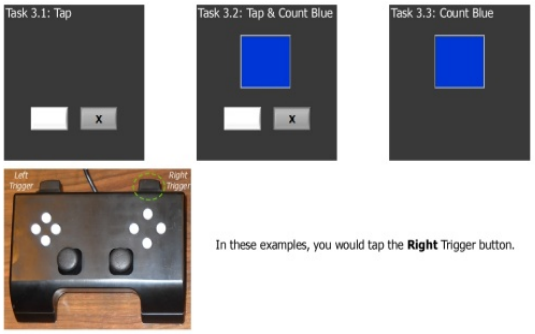
In flight Tests



Spatial Cognition

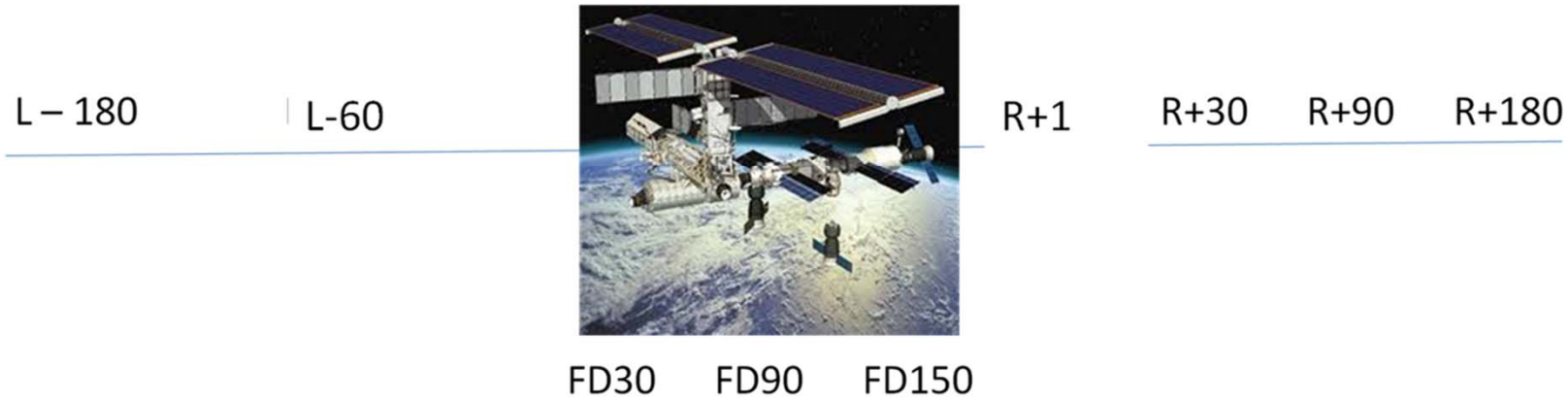


Sensorimotor adaptation



Single / Dual Tasking

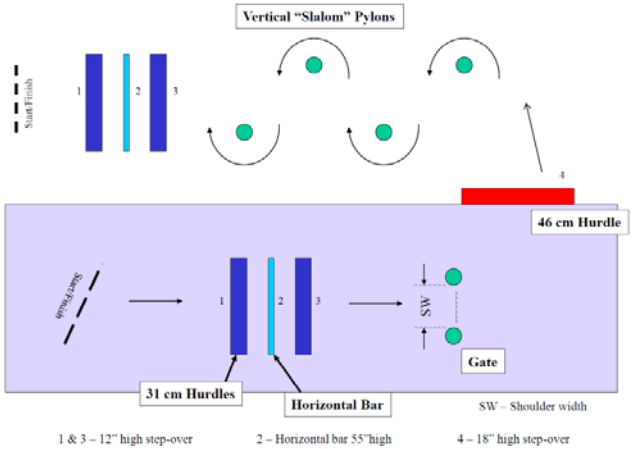
NeuroMapping Timeline



Pre & Post Flight Test Descriptions

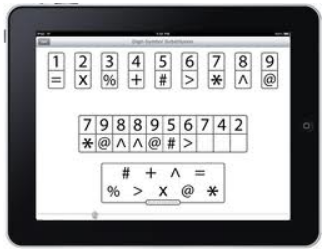
Functional Performance

1. Functional Mobility Test (FMT): navigate obstacle course with foam pylons, a gate, an obstacle, and a ‘portal’.

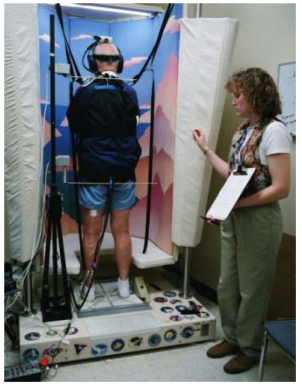


2. Purdue Pegboard test: assemble pegs and washers bimanually and place into board.

3. Digit symbol substitution test: transcribe symbols to numbers.



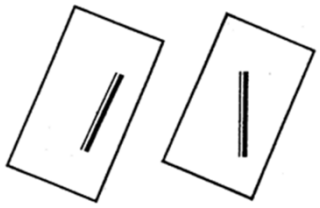
Pre & Post Flight Test Descriptions



4. Postural Stability: Maintain balance on sway-referenced support surface with eyes closed. This test will be performed with and without head movements.

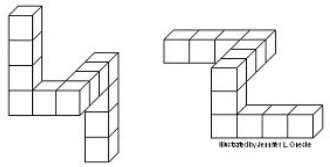
5. Tests of spatial cognition & working memory:

a. Rod & frame- align a rod to perceived vertical



b. Card rotation- rotate 2-dimensional shapes to match

c. Cube rotation- rotate 3-dimensional shapes to match



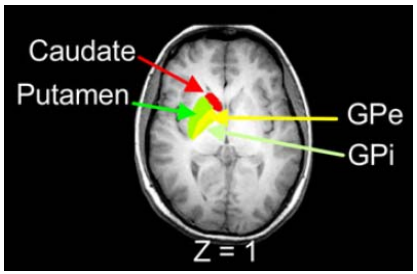
Pre & Post Flight Test Descriptions

6. Vestibular stimulation: the vestibular system will be stimulated by either a brief acoustic stimulus or a brief tap to the forehead. Muscle responses will be recorded.

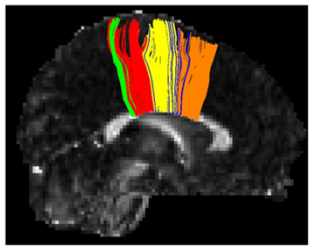
Pre & Post Flight Test Descriptions

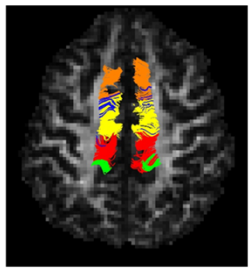
Brain Structural & Functional Assessments

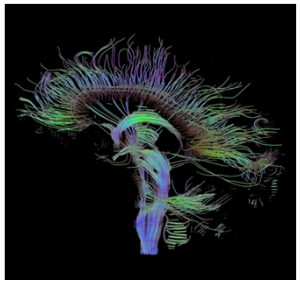
1. Structural MRI: lie still while we take a 3 dimensional image of your brain structure.



2. Diffusion weighted MRI: lie still while we take a 3 dimensional image of your brain's white matter.

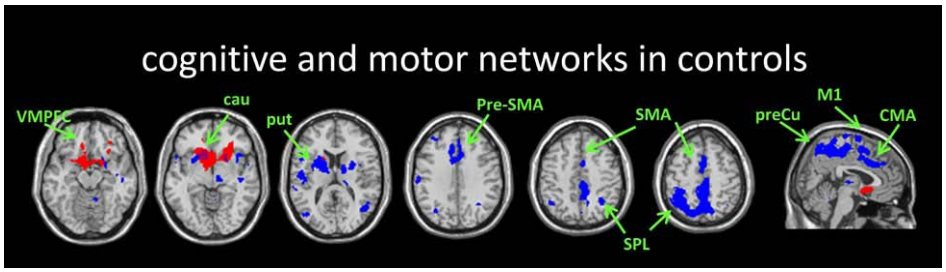




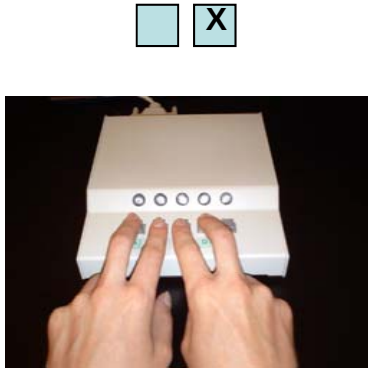


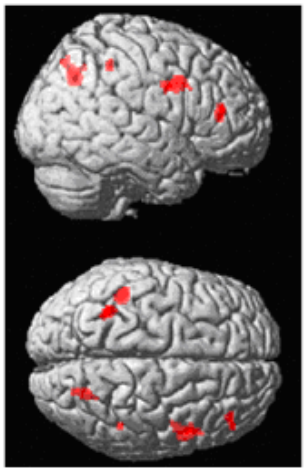
Pre & Post Flight Test Descriptions

3. Resting state functional connectivity MRI: lie still while we image functional network interactions.



4. Functional MRI during single and dual task finger tapping: tap buttons bimanually in response to cues on the screen, count # of appearances of a target color, or both simultaneously.

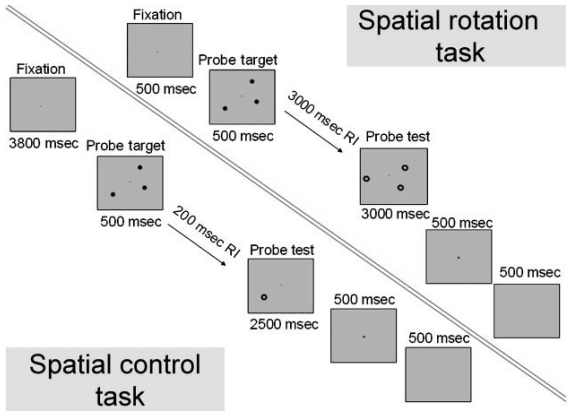




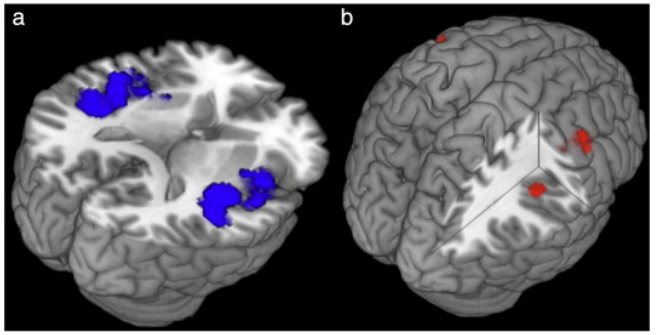
Pre & Post Flight Test Descriptions

5. Functional MRI during manual sensorimotor adaptation task: move a joystick to hit targets on the computer screen.

6. Functional MRI during spatial working memory task: mentally rotate 2-dimensional shapes to match targets.

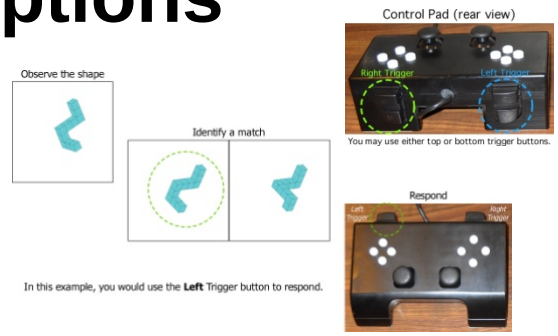


7. Functional MRI during vestibular stimulation: the vestibular system will be stimulated by either a brief acoustic stimulus or a brief tap to the forehead.

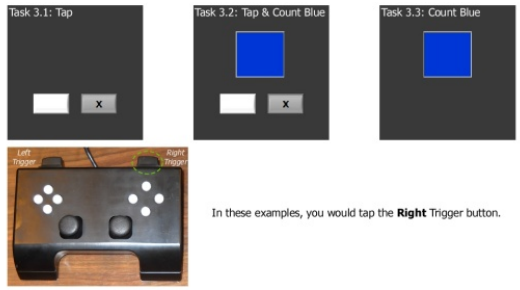


In Flight Test Descriptions

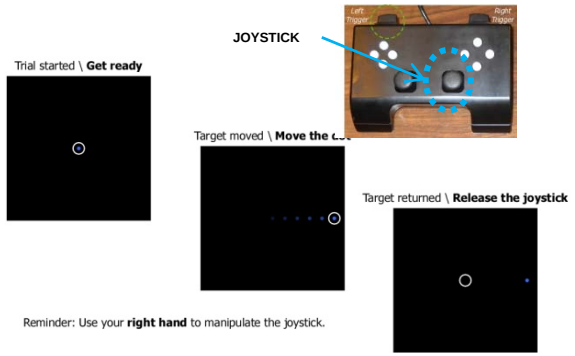
1. Cube rotation- rotate 3-dimensional shapes to match



2. Single and dual task finger tapping: tap buttons bimanually in response to cues on the screen, count # of appearances of a target color, or both simultaneously.

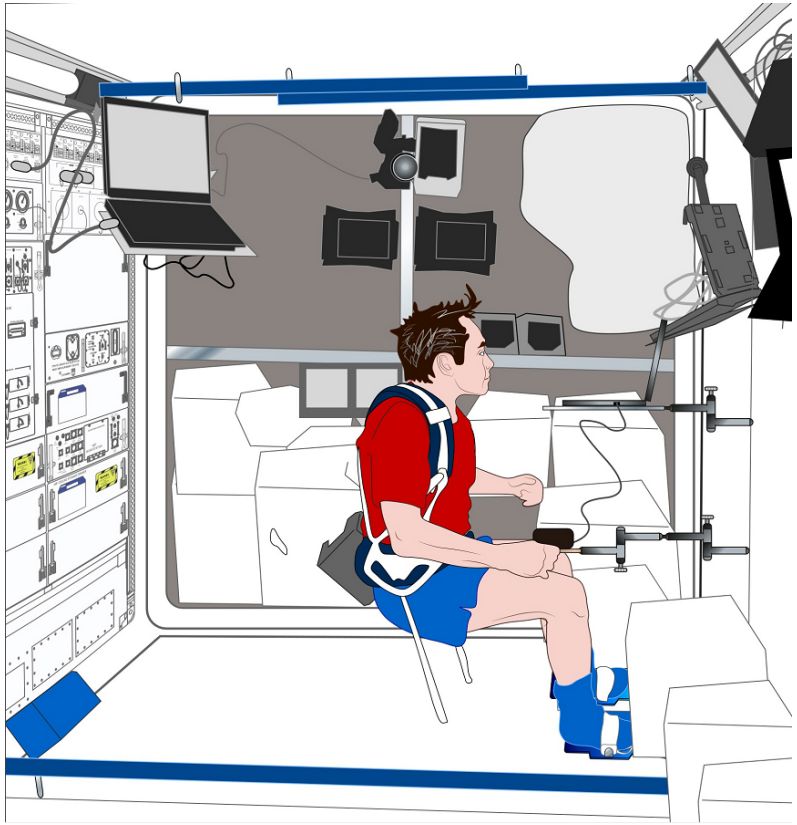


3. Manual sensorimotor adaptation task: move a joystick to hit targets on the computer screen.

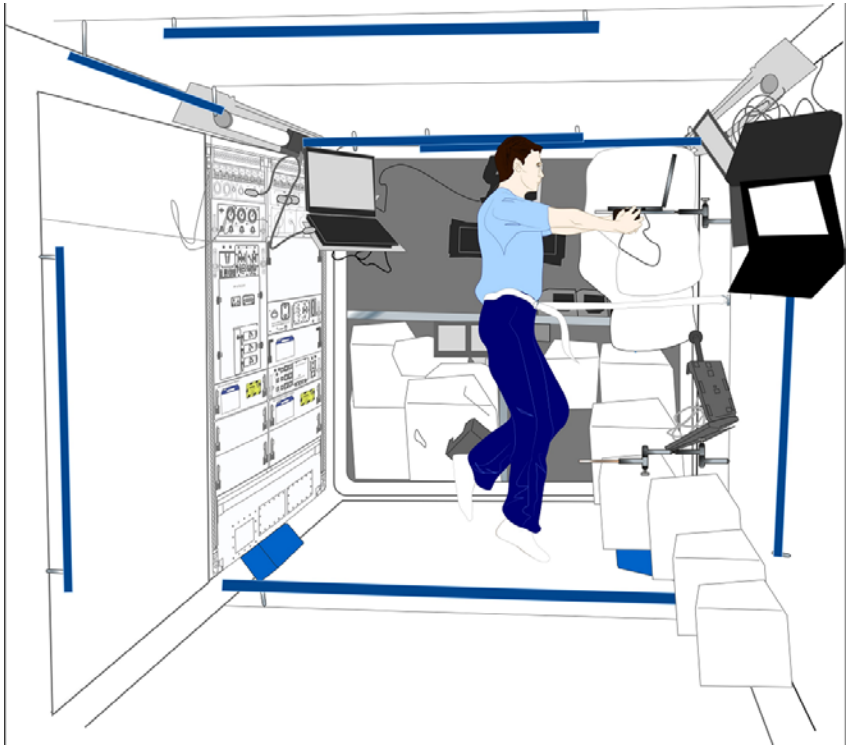


In-flight Tests - Subject Configuration

"Bungeed down"



"Free Floating"



Study Relevance

1) First interdisciplinary assessment of the effects of space flight on brain structure-function and functional performance changes.

2) Will allow us to assess the risk of long duration spaceflight on brain structure / function and impact on performance.