The Effects of One Year of Spaceflight on Neurocognitive Performance: Extent, Longevity, & Neural Bases

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Background & Justification

- Spaceflight effects on gait, balance, & manual motor control have been well studied; some evidence for cognitive deficits
- Rodent cortical motor & sensory systems show neural structural alterations with spaceflight
- We found extensive changes in behavior, brain structure & brain function following 70 days of HDBR

Specific Aims

- Aim 1- Identify changes in brain structure, function, and network integrity as a function of spaceflight and characterize their time course.

- Aim 2- Specify relationships between structural and functional brain changes and performance and characterize their time course.

Evaluating neurocognitive changes occurring with spaceflight

Testing timeline

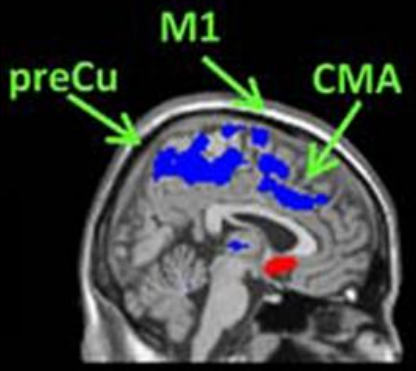
L – 180 L - 60

R+ 2~4 R+30 R+90 R+180

FD30 FD90 FD150

1 YRM allows investigation of dose-response effects

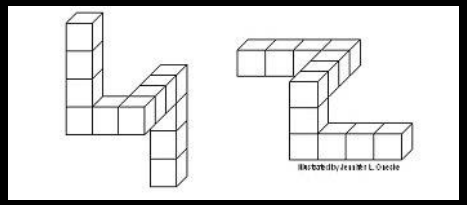
Assessments

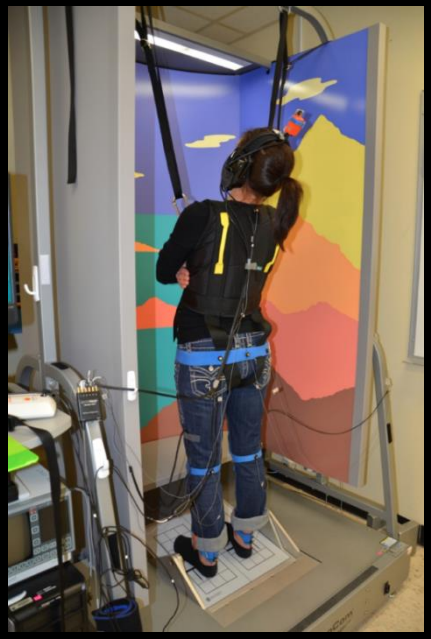


Structural MRI:
- Volumetric gray matter changes
- Diffusion weighted images

Functional MRI:
- Resting state functional connectivity of cognitive & motor networks
- Task based fMRI of motor, cognitive & sensory processing

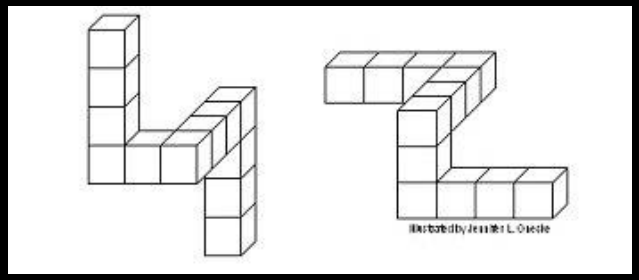
Additional Behavioral Metrics:
- Spatial cognition / working memory
- Manual motor control
- Vestibular evoked myogenic potentials
- Gait & balance (FMT, SOT)
- Sensory bias (rod & frame test)

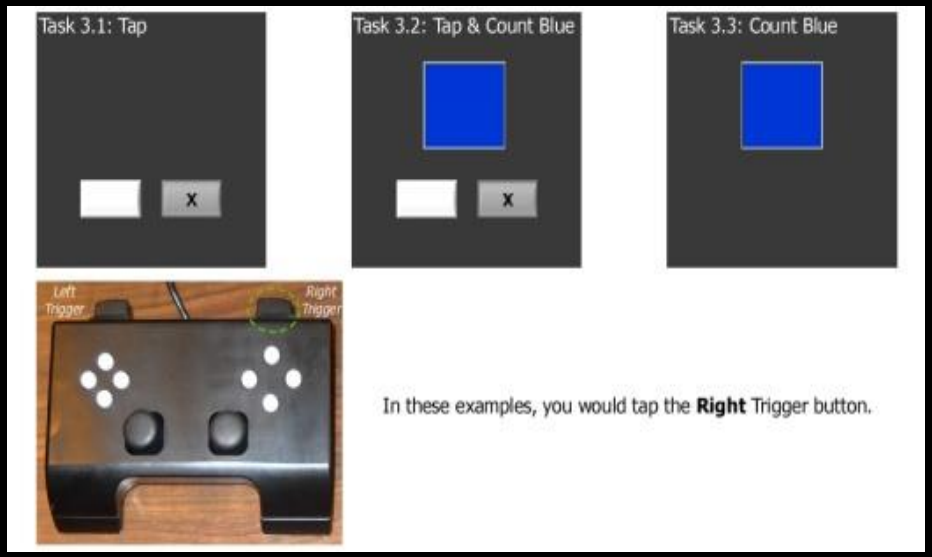




Inflight tests

- Sensorimotor adaptation
- Spatial cognition
- Cognitive-motor dual tasking





Progress Report

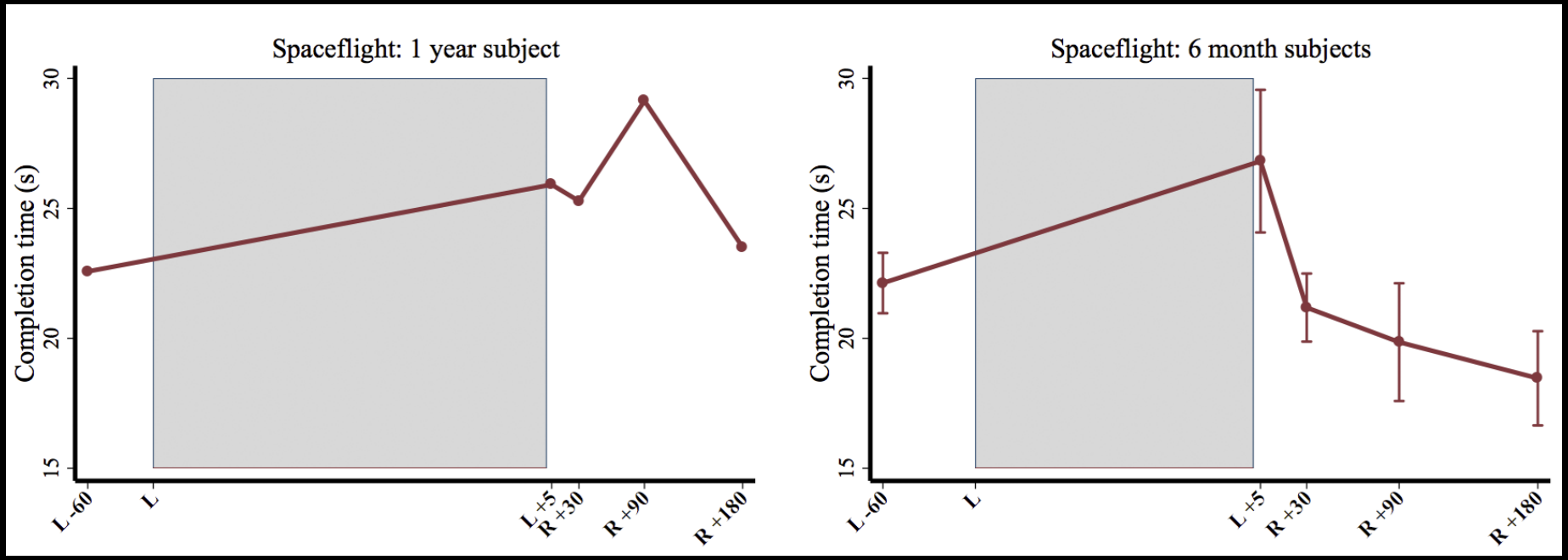
- 5, 6-month crew members have completed at least 1 post flight scan
- 1, 1 YRM crew member
- Bed rest version of the study is complete
- CO2 and AG bed rest versions kicking off soon

Retrospective study arm

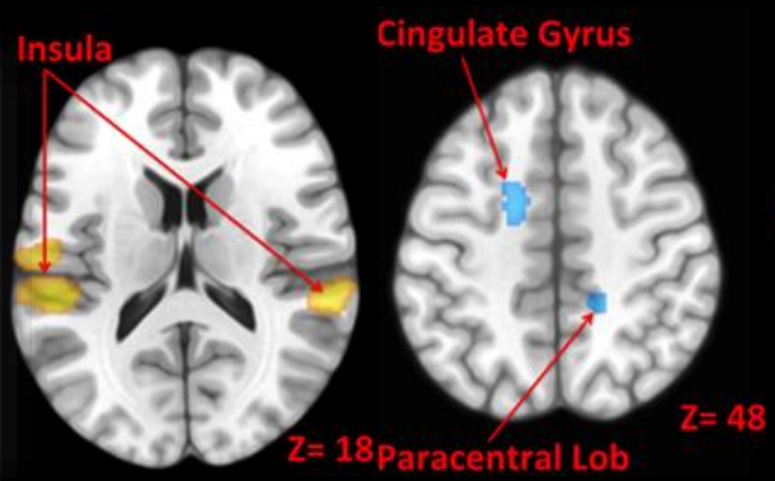
- Paper has been published:

Koppelmans V, Bloomberg J, Mulavara AP, & Seidler RD (in press). Brain structural plasticity with spaceflight. *npj Microgravity*.

Functional mobility recovery takes longer after 1 year in space than after 6 months



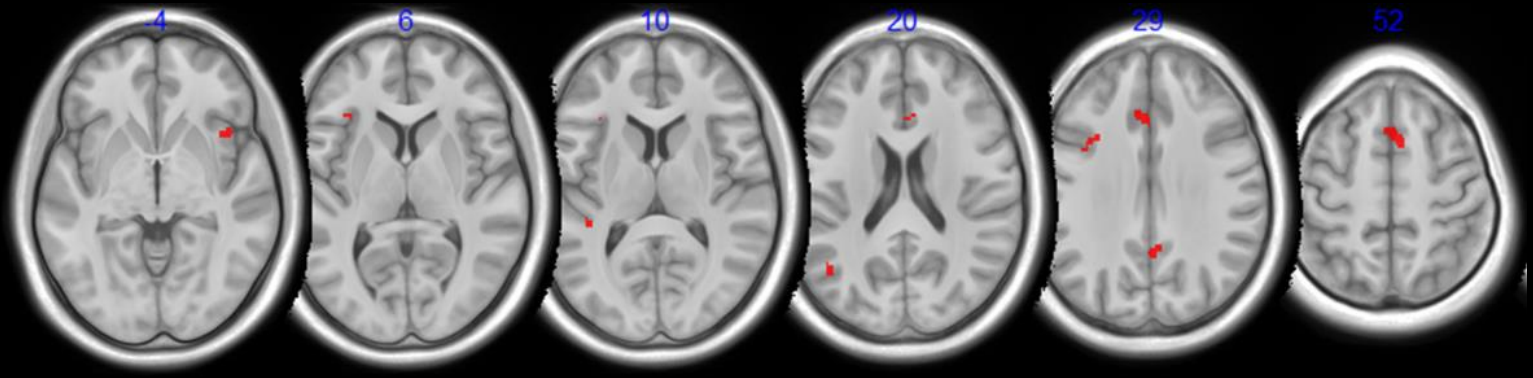
Functional imaging of human vestibular cortex



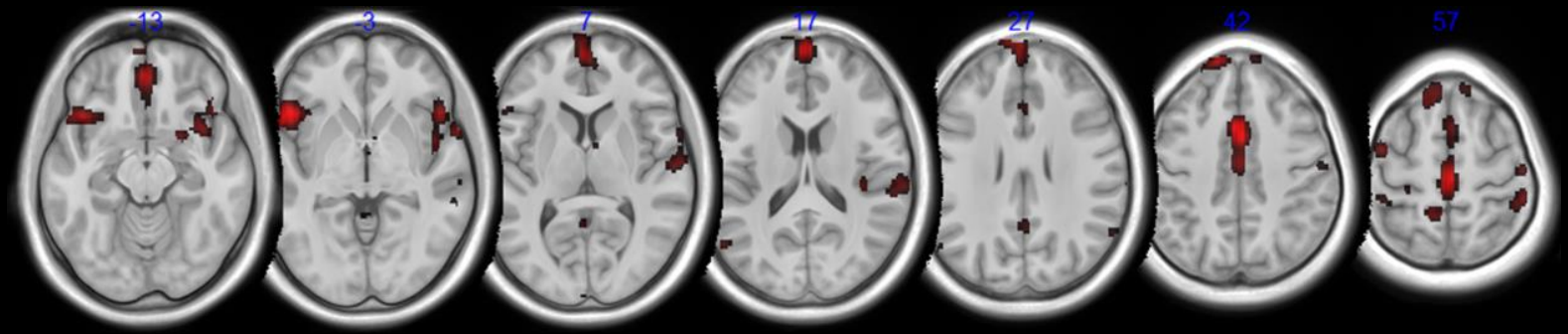
Noohi et al. under review

Brain responses to vestibular stimulation increase with flight, more so with increasing flight duration

Correlation with flight duration



1 YRM



Please note that activation results are overlaid onto a standard template brain for

Summary

- Magnitude of mobility changes do not seem to differ for 6 mos. versus 1 year
- Mobility recovery takes longer after 1 year
- Despite no differences in behavior change, pre to post flight vestibular brain changes increase with flight duration

Want to see more?

- Poster today 17296
- Talk tomorrow 17029
- Talk tomorrow 17512
- Poster tomorrow 17420

Acknowledgements

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