



Assessing the Relationships Between Sensorimotor Biomarkers and Post-Landing Functional Task Performance

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Purpose

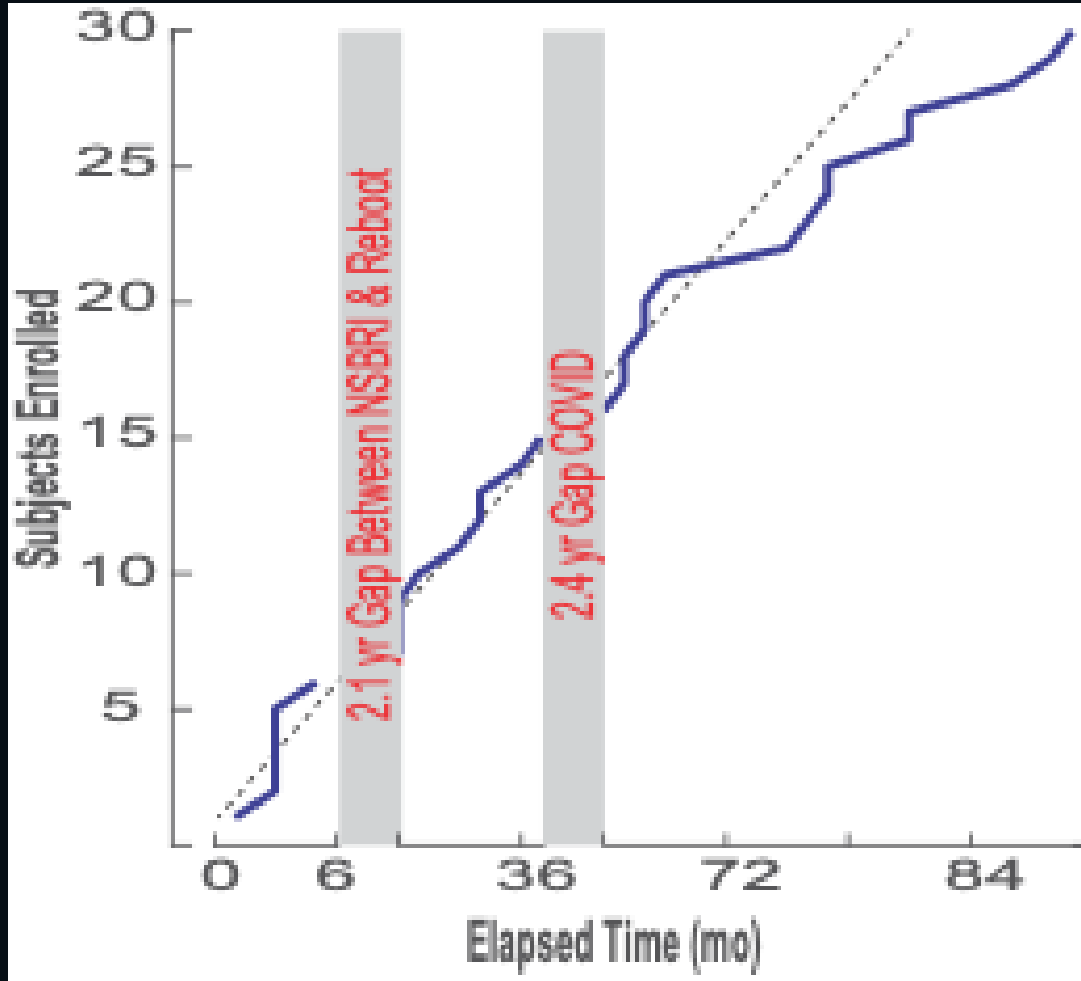


- Purpose: Evaluate a set of behavioral, neuroimaging and genetic measures that can potentially be used to predict and better explain early performance following G-transitions such as return to Earth on a set of sensorimotor tasks
- To accomplish this we recruited ISS astronauts who previously participated in sensorimotor field tests and/or dynamic posturography (MedB) within R+1 day following long-duration spaceflight to participate in a battery of behavioral, neuroimaging and genetic tests





Study Timeline



- Initial NSBRI study led by PI Ajit Mulavara, restarted by HHC Element in 2019 led by PI Jacob Bloomberg
- Subjects: Thirty ISS crewmembers were recruited, including 12 first-time fliers, 6F, with mission durations lasting 185.5 ± 45.5 days, mean $\pm$ std.



Post-flight outcome measures



Recovery from fall (RFF)
Prone to upright stand test



Tandem Walk (TW)
Eyes Open & Closed



Computerized Dynamic
Posturography (CDP)



- Motion sickness symptom severity was also captured using 0-20 scale during the field testing at the landing sites

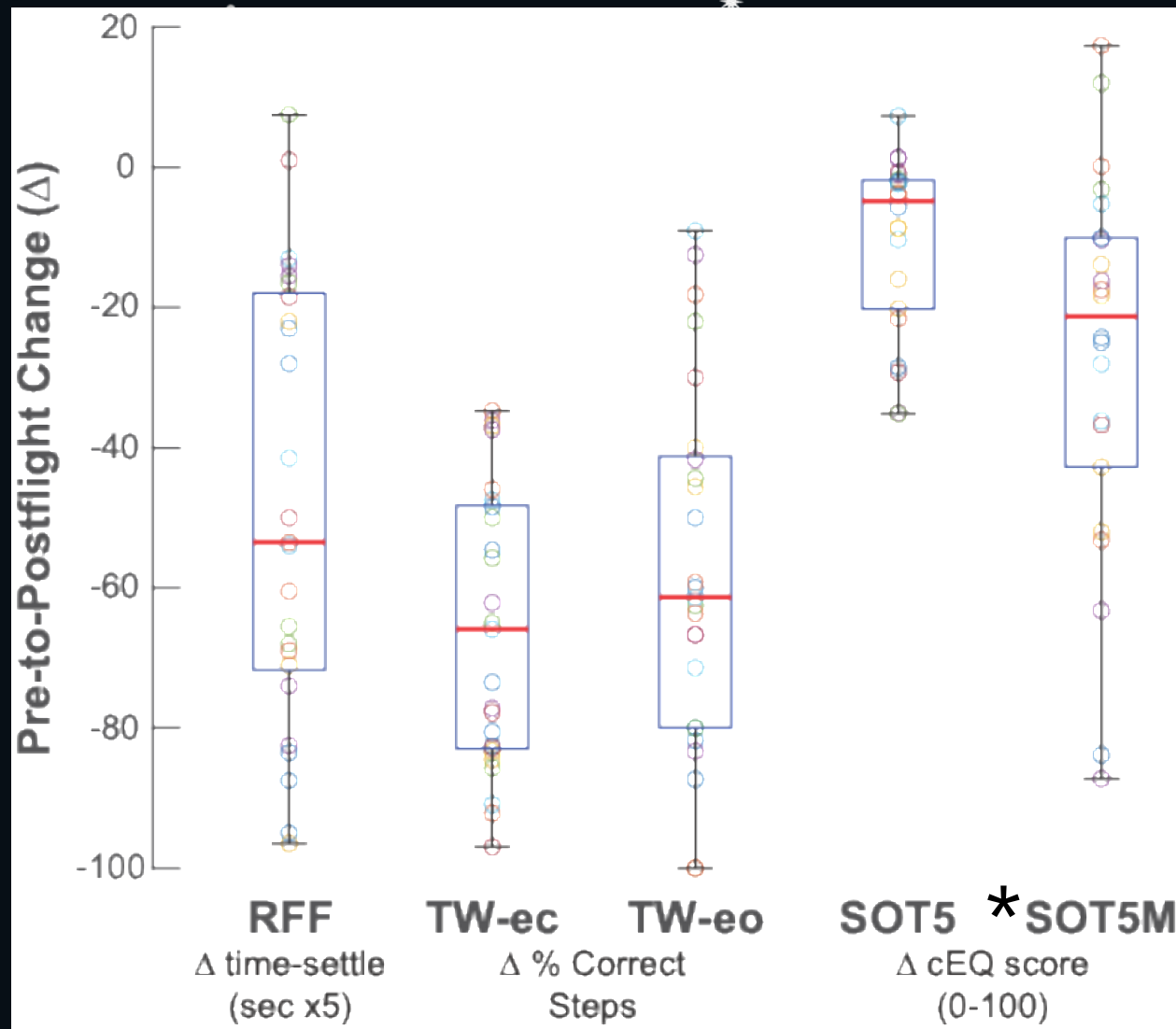


Post-flight outcome measures



RFF and TW were captured near the landing zone ($R+ 3.0 \pm 1.1$ hr, $n=26$) and following return to JSC, while CDP was captured following return to JSC ($R+31.0 \pm 7.2$ h, $n=23$). There was considerable variability among all postflight performance outcomes.

*SOT = Sensory Organization Test from CDP

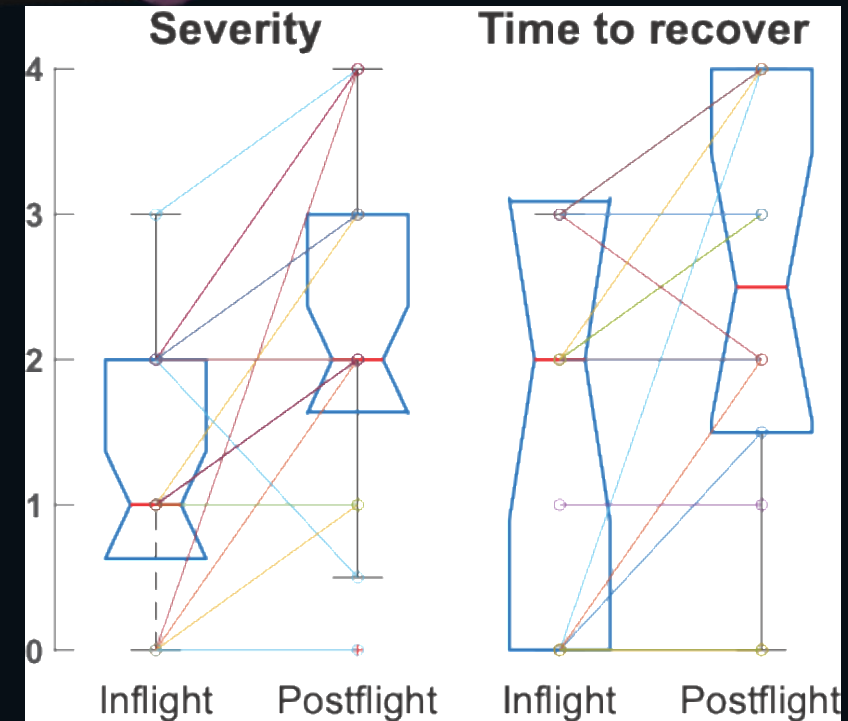




Qualtrics retrospective survey



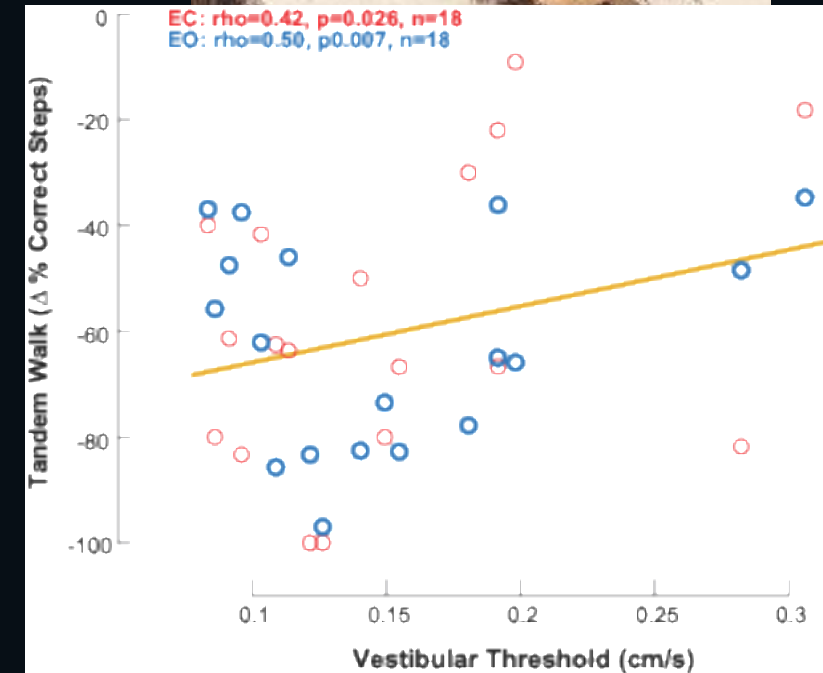
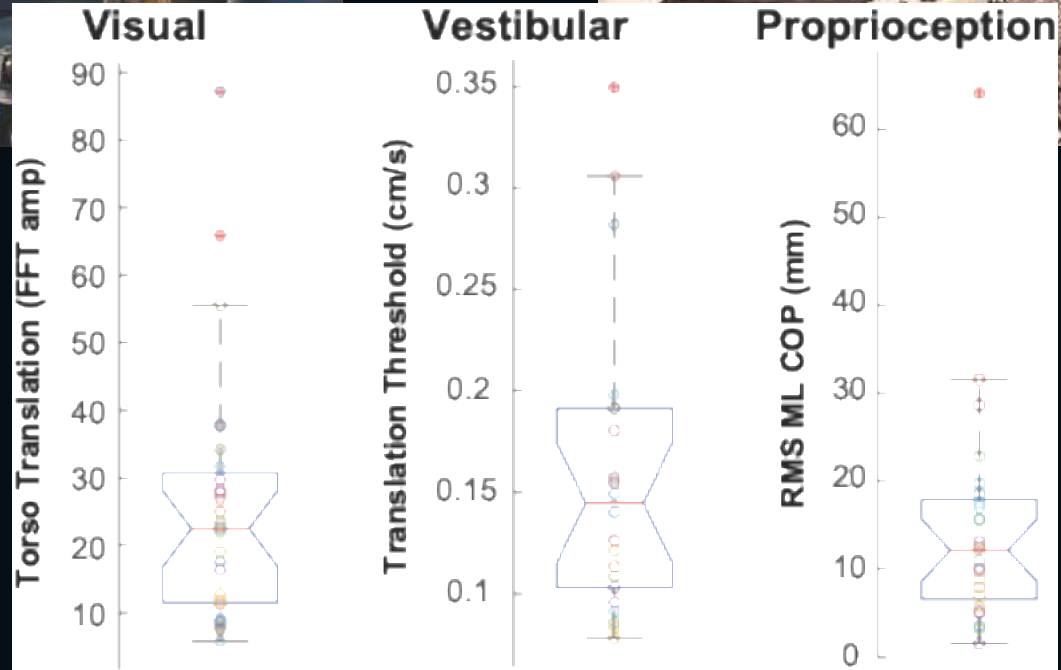
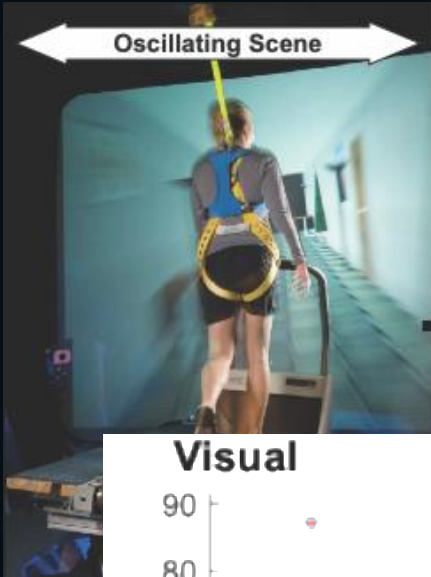
For these long-duration crewmembers, 72% subjectively reported a greater severity of impacts during the early post-flight period versus early inflight period (n=20). Time-to-recover inflight tended to be the same or greater than postflight.



Severity		Time to recover	
Severe, tasks not attempted	4	More than 3 days	
Moderate, extended time req'd	3	Between 1 – 3 days	
Mild, transient, worse with motion	2	Between 6 hrs and 1 day	
Functioning nominally, increased effort	1	Less than 6 hrs	
No impact or restriction of movement	0	No impact or restriction of movements	

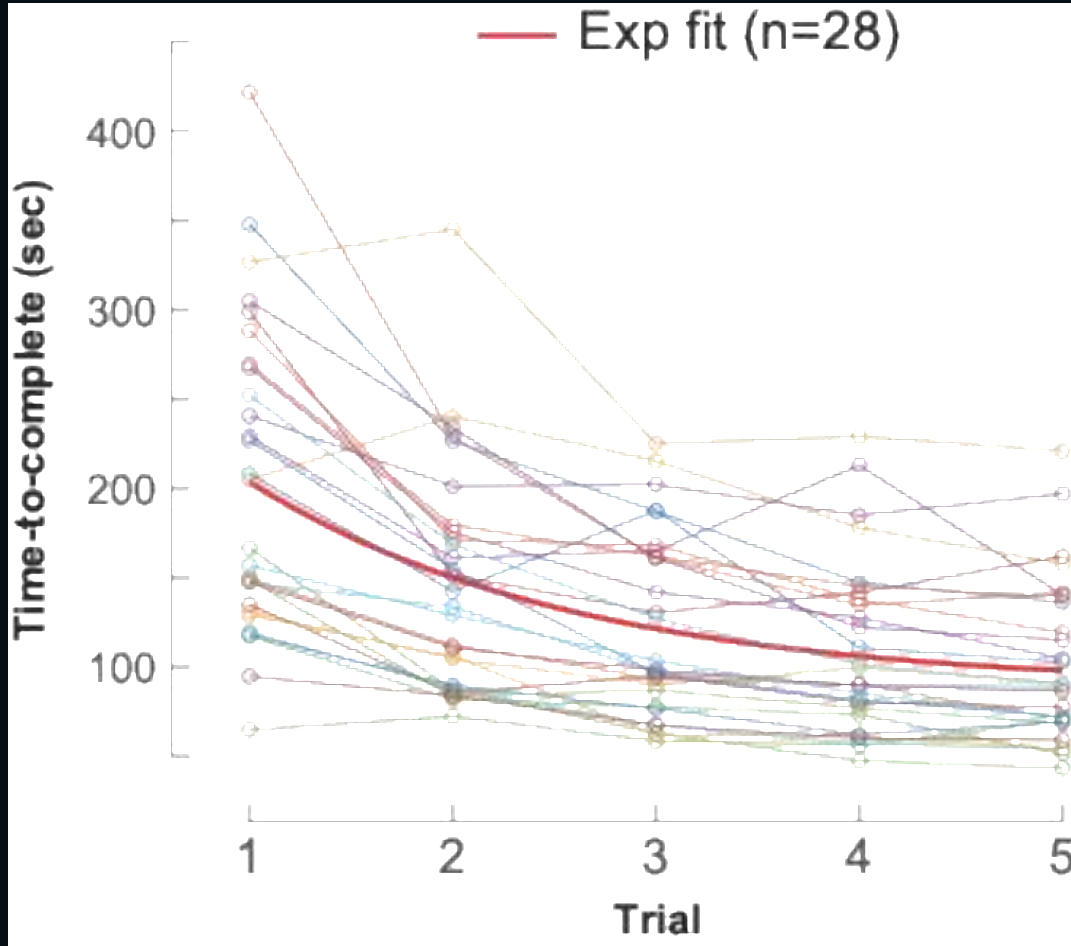


Sensory Dependency





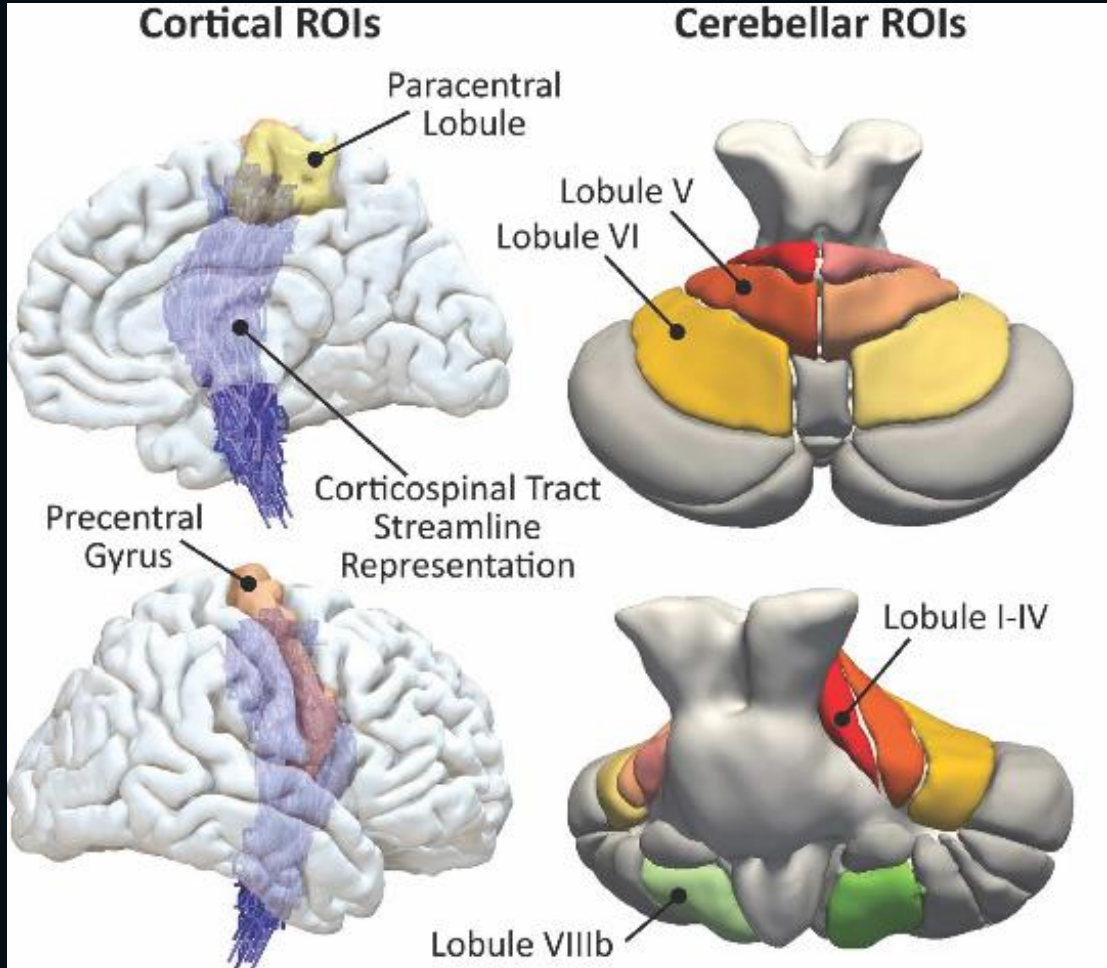
Adaptive Functional Mobility Test



- Ground assessment of adaptability was performed during multiple trials of navigating an obstacle course while wearing reversing prisms
- The time-to-complete the first trial was significantly correlated with the visual dependency measures during treadmill walking



Neuroimaging



Koppelmans et al., Brain Struct Funct, 2022.

- Whole-brain analyses showed that paracentral and precentral gyri thickness significantly predicted recovery from fall post-spaceflight
- Thickness of vestibular and sensorimotor regions, including the posterior insula and the superior temporal gyrus, predicted balance performance post-flight and pre-to-post-flight decrements



Genetic Polymorphisms

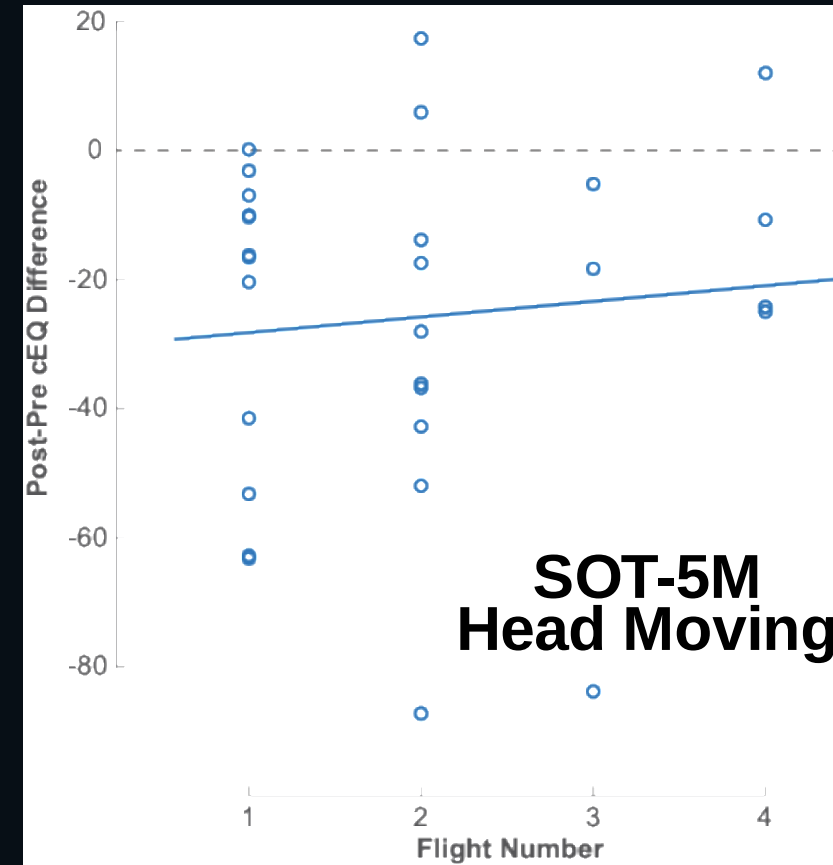
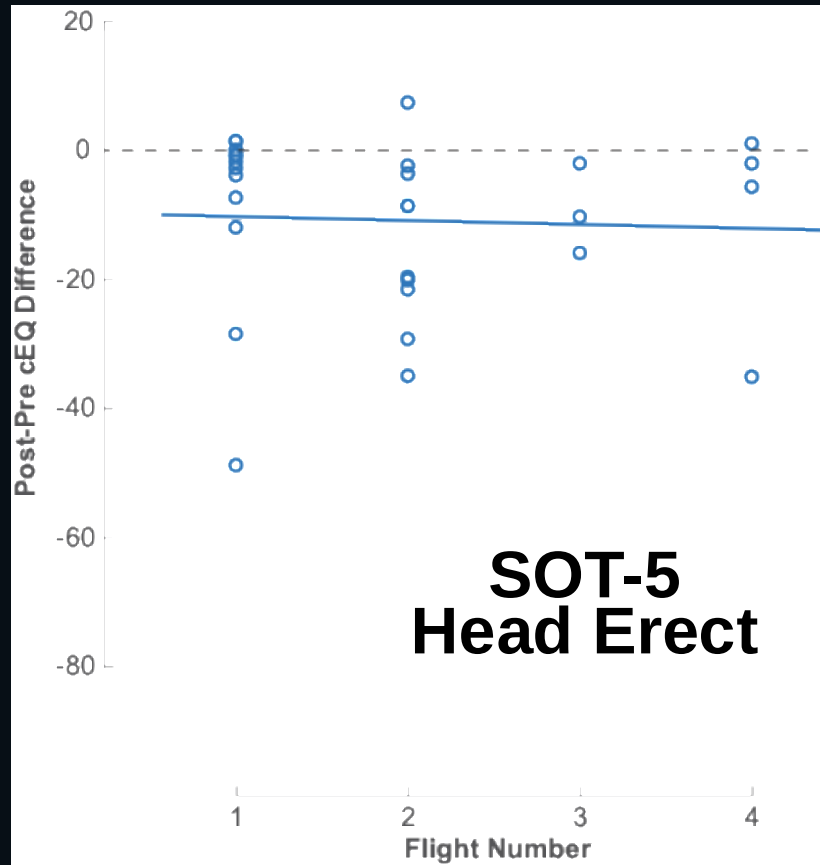


DRD	COMT	BDNF	Dral	Δ TW-EC
GG	VM	VM	TGA/TAA	-97.0
TT	VM	VM	TGA/TGA	-90.9
GG	MM	VV	TAA/TAA	-87.9
GG	MM	VM	TGA/TAA	-77.8
GG	MM	VV	TGA/TGA	-76.8
GG	VM	VV	TGA/TGA	-66.7
GG	MM	VM	TGA/TGA	-65.9
GT	VV	VV	TGA/TAA	-61.1
GT	VV	VM	TGA/TAA	-50.4
GG	MM	VV	TGA/TAA	-50.0
GG	VV	VM	TGA/TGA	-48.5
GT	VV	VV	TGA/TGA	-46.9
GG	MM	MM	TGA/TGA	-46.0
GG	VM	VV	TAA/TAA	-42.7
GG	MM	VV	TGA/TGA	-40.0
TT	VM	VV	TGA/TAA	-36.0
GG	MM	VV	TGA/TGA	-34.8
GG	VV	VM	TGA/TAA	-33.0
GG	MM	VV	TGA/TGA	-31.3
GT	VV	VV	TGA/TAA	-30.7
GG	VV	VM	TGA/TAA	-29.2
GG	VM	VV	TGA/TGA	-28.0
GT	VM	VV	TGA/TAA	-24.0
GG	VM	VM	TGA/TGA	-21.7
GG	VM	VM	TGA/TGA	-21.2
GG	MM	VM	TGA/TGA	-18.9

- Examined Dopamine Receptor D2 (DRD2), Catechol-O-methyltransferase (COMT), Brain-derived neurotrophic factor (BDNF) and the α 2-adrenergic receptor
- While these differentiate sensorimotor adaptation ability in a normative population, no patterns with post-flight measures were observed



Effect of prior flight experience



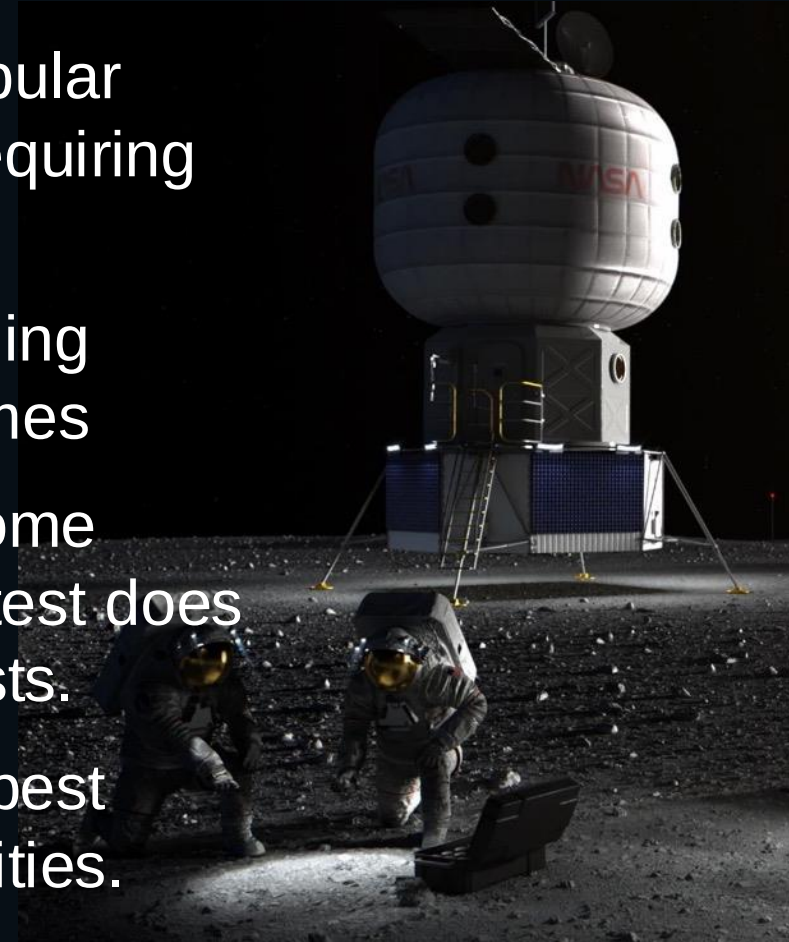
Post-flight outcome measures did not vary by prior flight experience, but when available, were consistent across flights within individuals



Summary



- Some biomarkers predict specific outcomes, e.g. vestibular thresholds are significantly related to postflight tasks requiring greater vestibular challenges such as tandem walk.
- Subject demographics (e.g. flight experience, sex, landing vehicle) are not significantly related to postflight outcomes
- While there is large intersubject variability across outcome measures, by R+24 hr performance on one post-flight test does not necessarily correlate with performance on other tests.
- Outcome measures from prior flights appear to be the best predictors of similar outcomes on future flight opportunities.



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