Postural recovery following spaceflight

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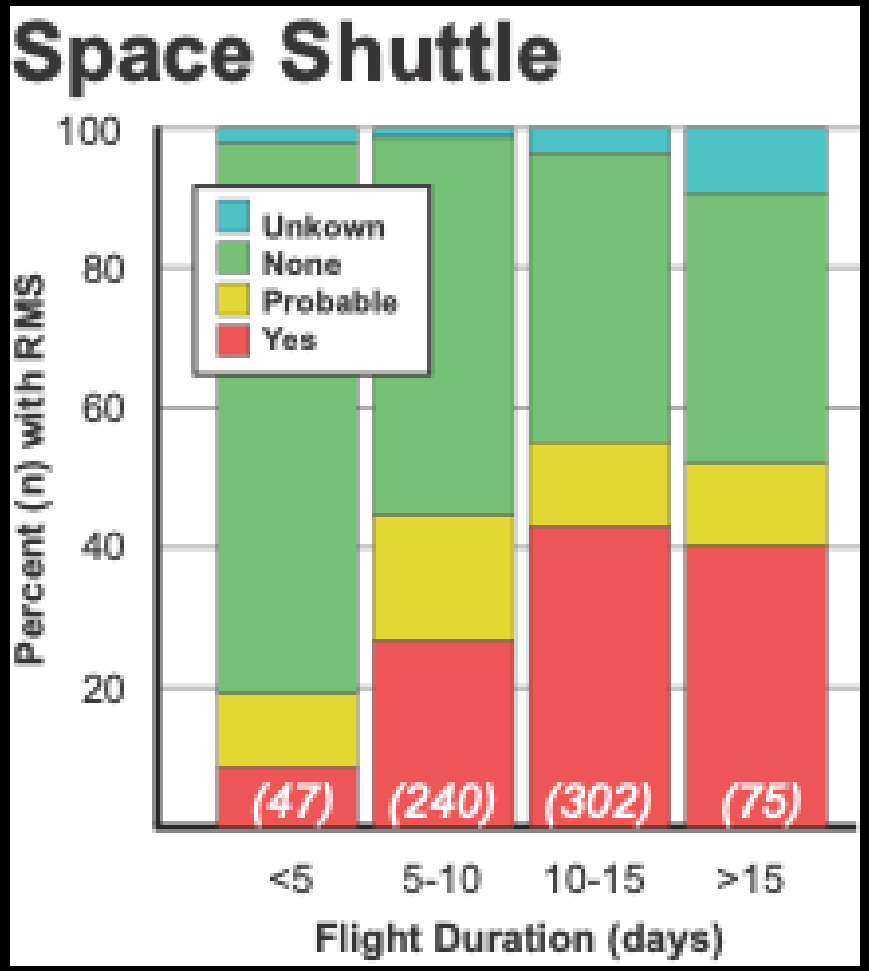
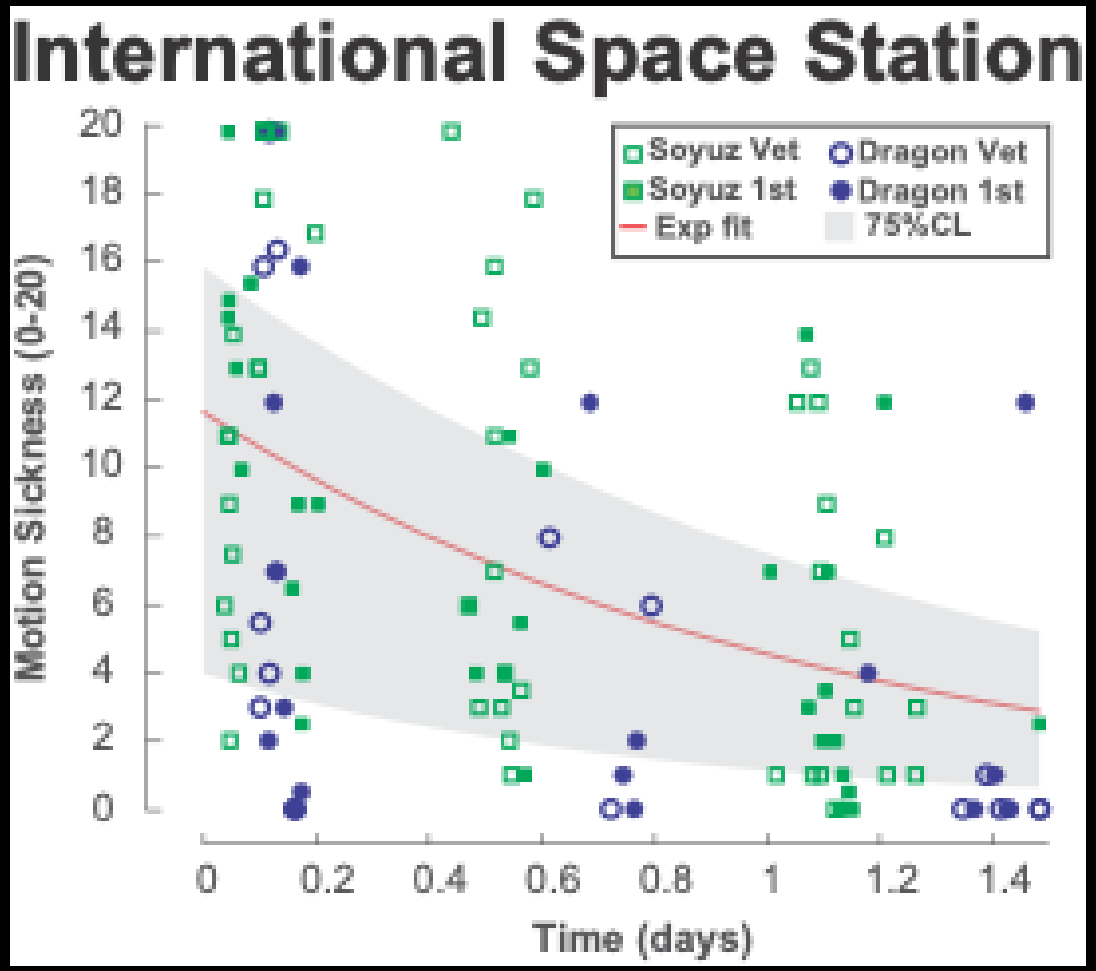
Adaptation to altered gravity states

- The need to move and maintain awareness of spatial orientation in altered gravity environment drives sensorimotor adaptation and learning to acquire a new set of synergies optimized for the novel environment.
- The perceptual and motor coordination problems experienced postflight reflect the recalibration of predicted versus actual movement feedback that is required for readaptation back to the natural gravitational state.

Terrestrial readaptation motion sickness





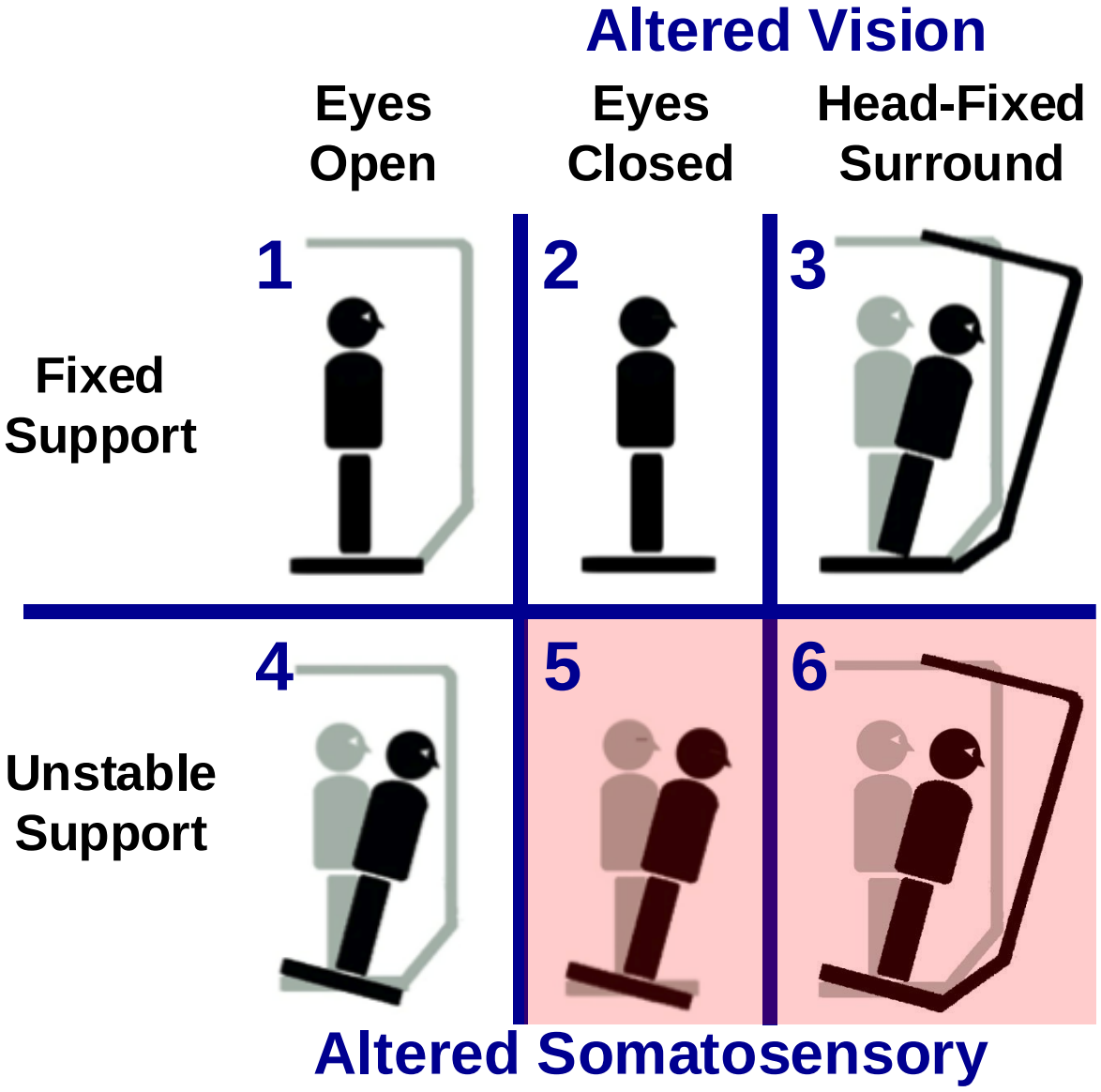
STS post-flight neurological exams

Clark JB. J Vestib Res (2002) 11:321-322

>5% 0%

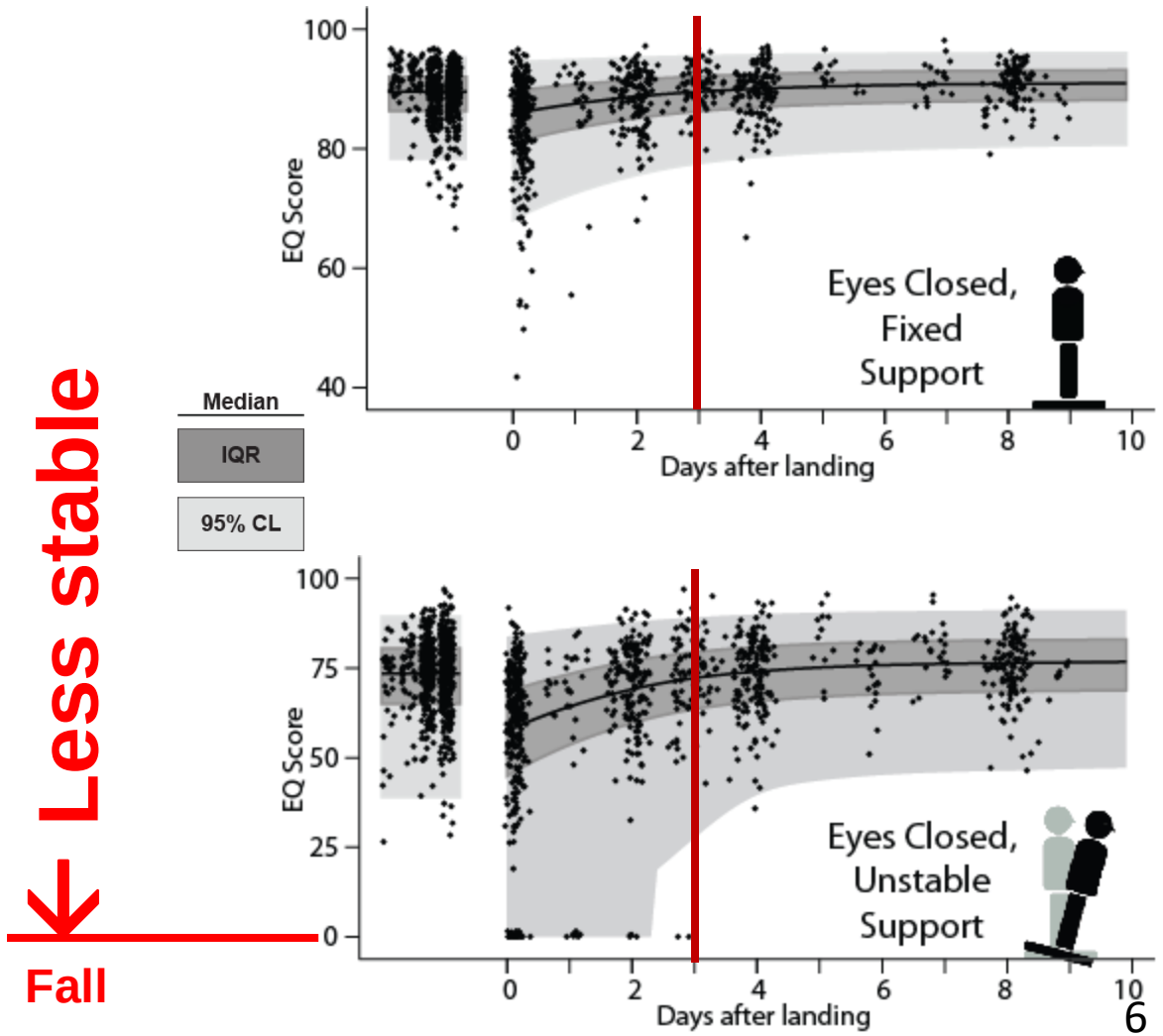
		R+0				R+3			
		None/ Normal	Mild	Moderate	Severe	None/ Normal	Mild	Moderate	Severe
1	**Headache**	94%	3%	2%	1%	97%	3%	0%	0%
2	**Dizziness/Faintness**	83%	14%	3%	0%	98%	2%	0%	0%
3	**Vertigo/Spinning**	88%	9%	2%	1%	99%	1%	0%	0%
4	**Gaze/Eye Movements** (nystagmus)	45%	51%	4%	0%	93%	7%	0%	0%
5	**Finger to Nose** (close eyes touch nose, open eyes touch finger)	81%	19%	0%	1%	99%	1%	0%	0%
6	**Drift** (close eyes, extend arms, palms up)	90%	9%	0%	1%	99%	1%	0%	0%
* 7	**Rising from Chair** (w/o using arms)	86%	11%	1%	2%	99%	1%	0%	0%
* 8	**Standing Romberg** (feet together, extend arms, close eyes; 30 sec)	78%	21%	0%	1%	97%	3%	0%	0%
9	**Hopping** (close eyes, lift leg, hop 3 times, alternate)	60%	26%	9%	3%	99%	1%	0%	0%
* 10	**Tandem Walk** (heel-to-toe; 5 m)	43%	37%	18%	2%	98%	1%	0%	0%
* 11	**Dynamic Equilibrium** (close eyes, walk 9m, turn 180°, return)	53%	41%	3%	4%	93%	7%	0%	0%

Sensory Organization Tests



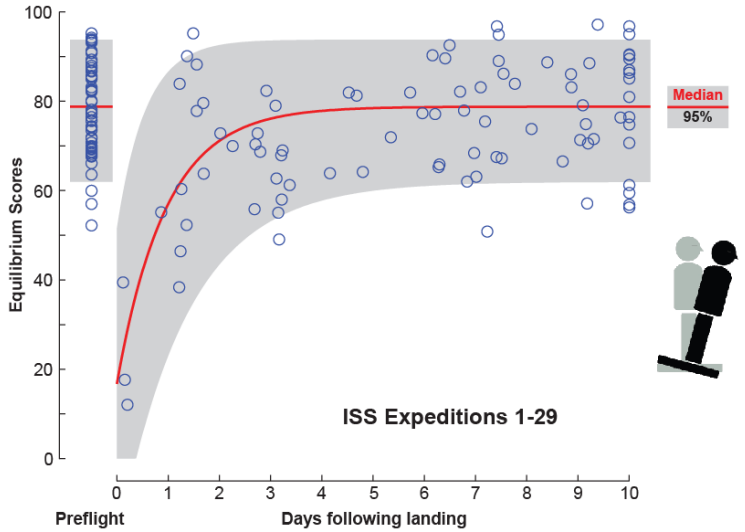
Nashner et al., J Neuroci (1982) 2:536-544

Supplement to Post-Shuttle Neuro Exam



Sharpen tests with head tilts

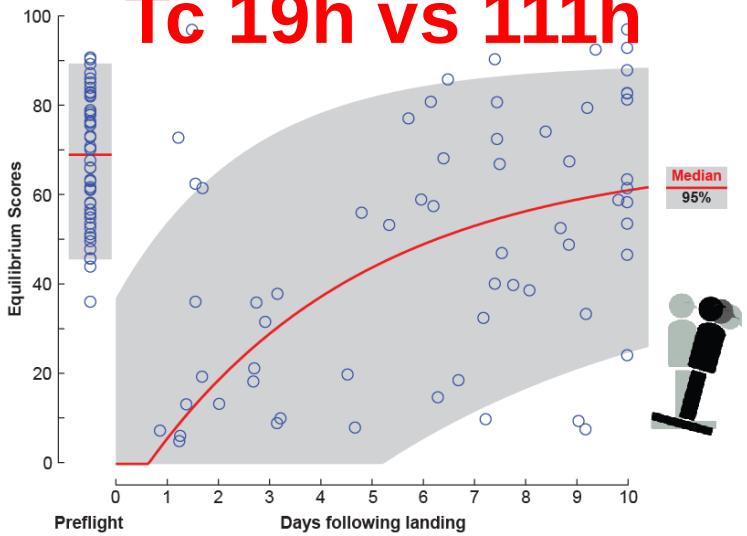
Head Erect

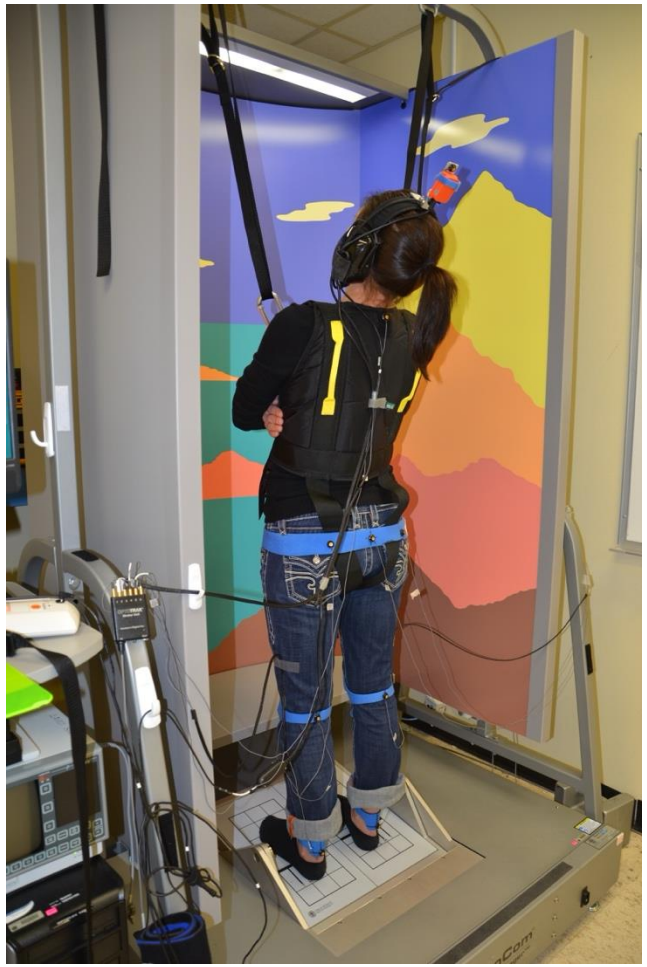


Head Moving

Pitch
0.33 Hz
±20º

Tc 19h vs 111h



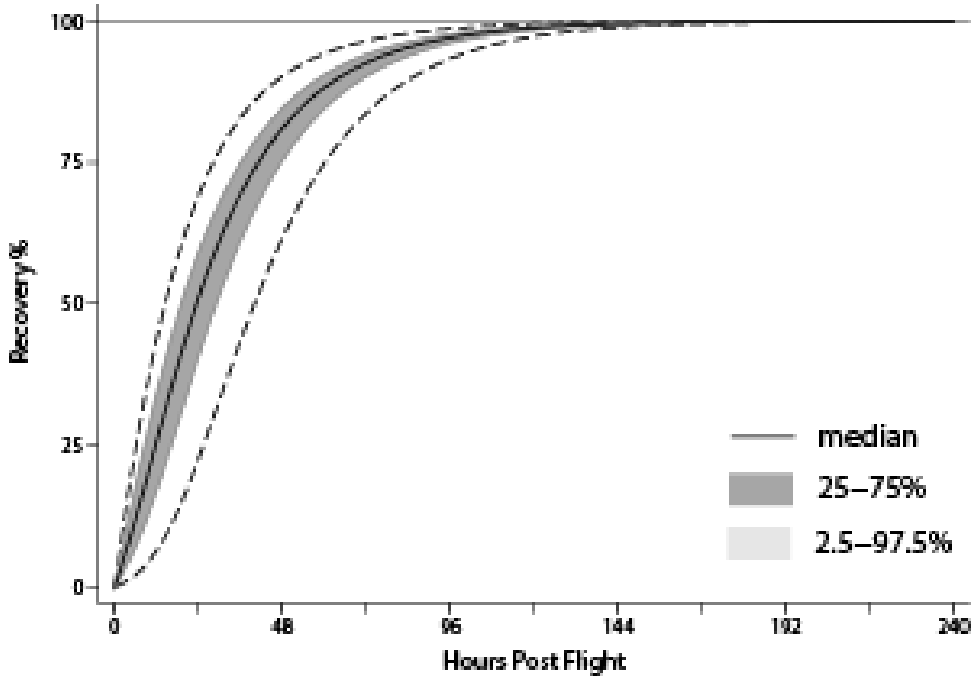


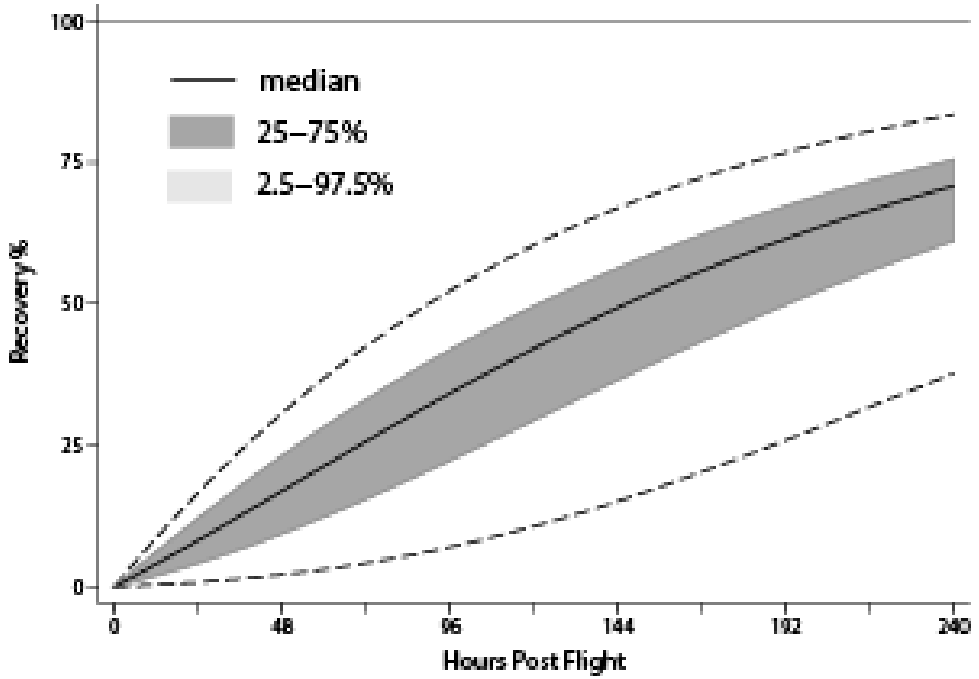
Wood et al., Aviat Space Environ Med (2015)

Short

SOT-5M
Eyes Closed,
Unstable support,
Head moving

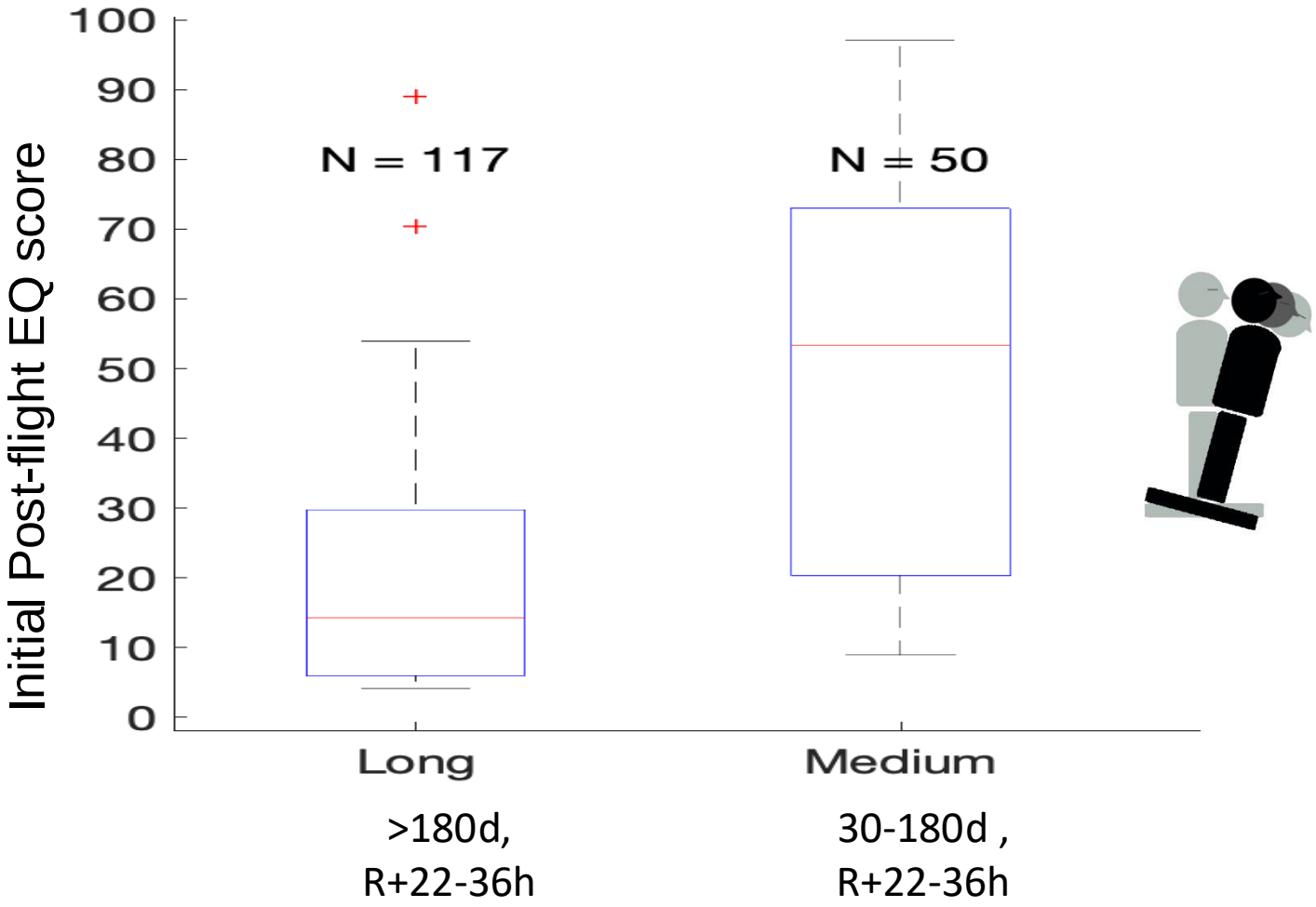
Long





Postflight dynamic posturography

Effect of duration



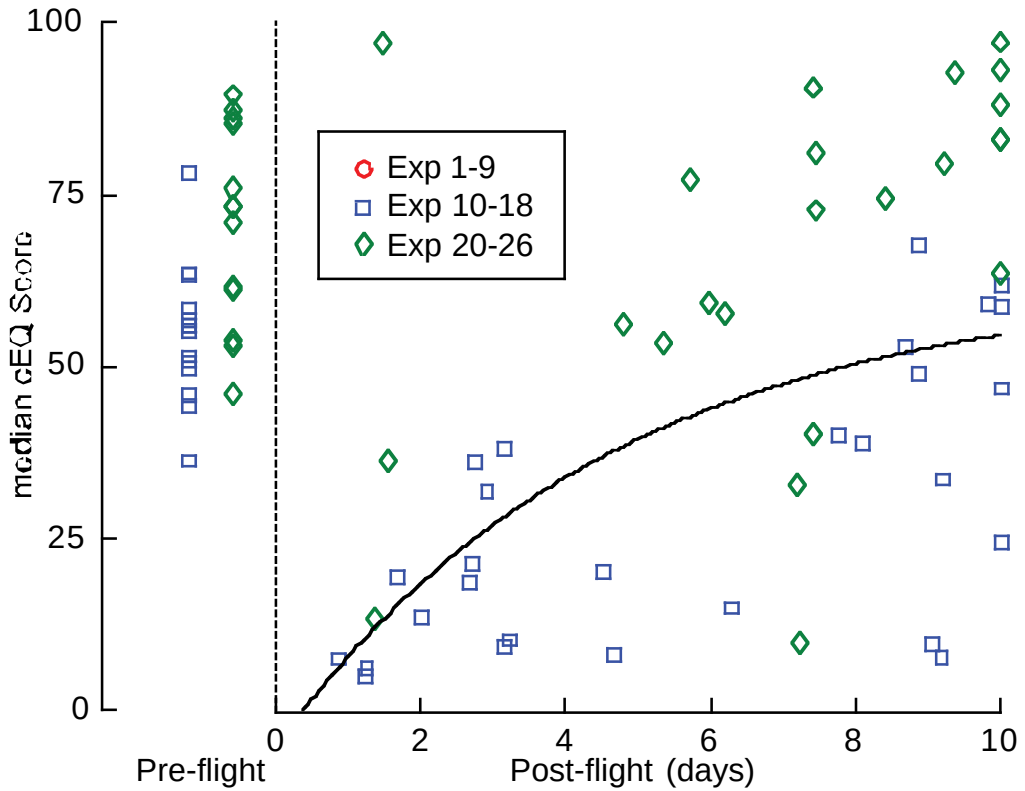
>180d,
R+22-36h

30-180d ,
R+22-36h

SOT-5M
Eyes Closed,
Unstable support,
Head moving

Effect of inflight countermeasures

Head Moving, Eyes Closed, Unstable Support

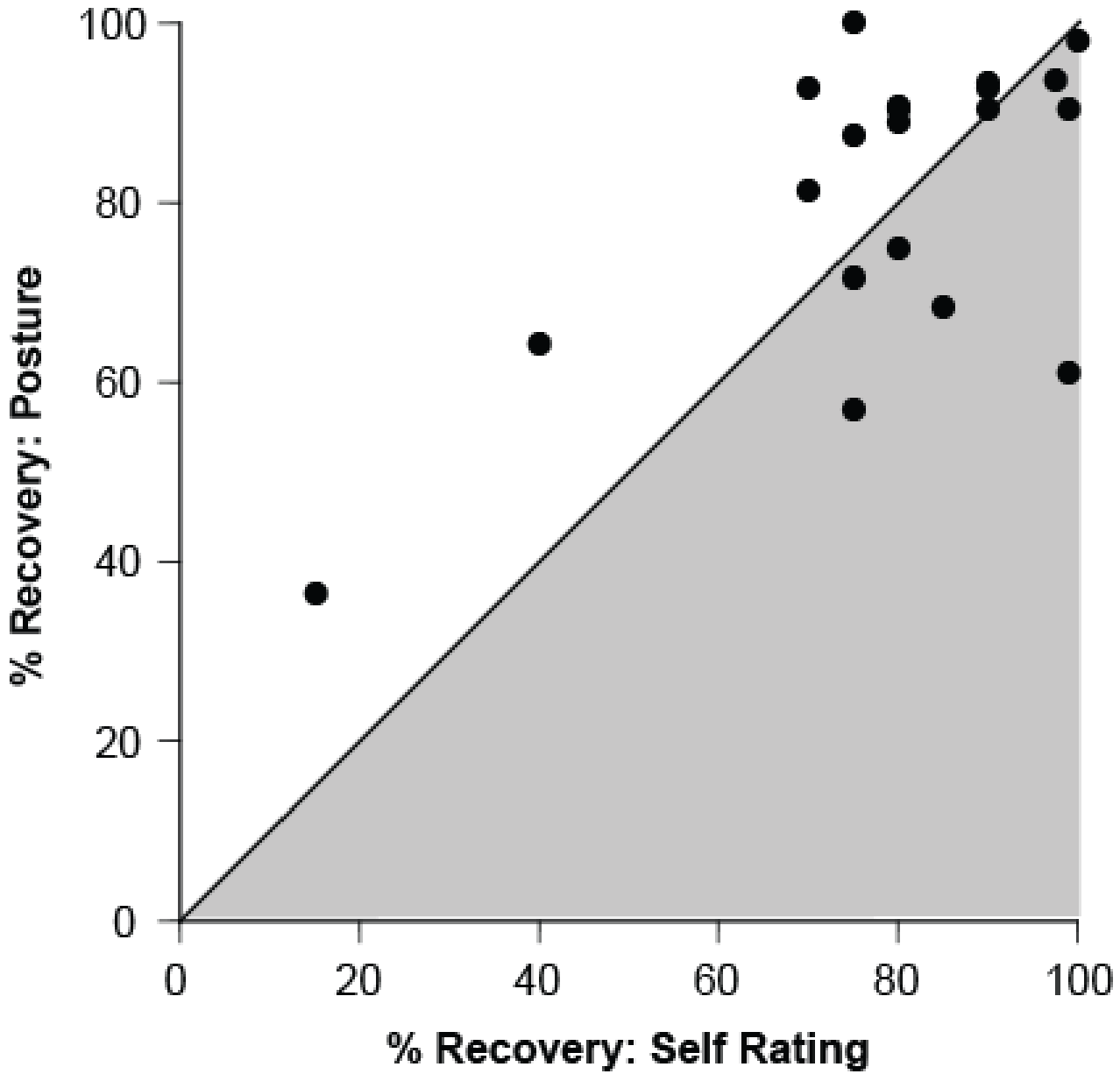


Interim Resistive Exercise Device

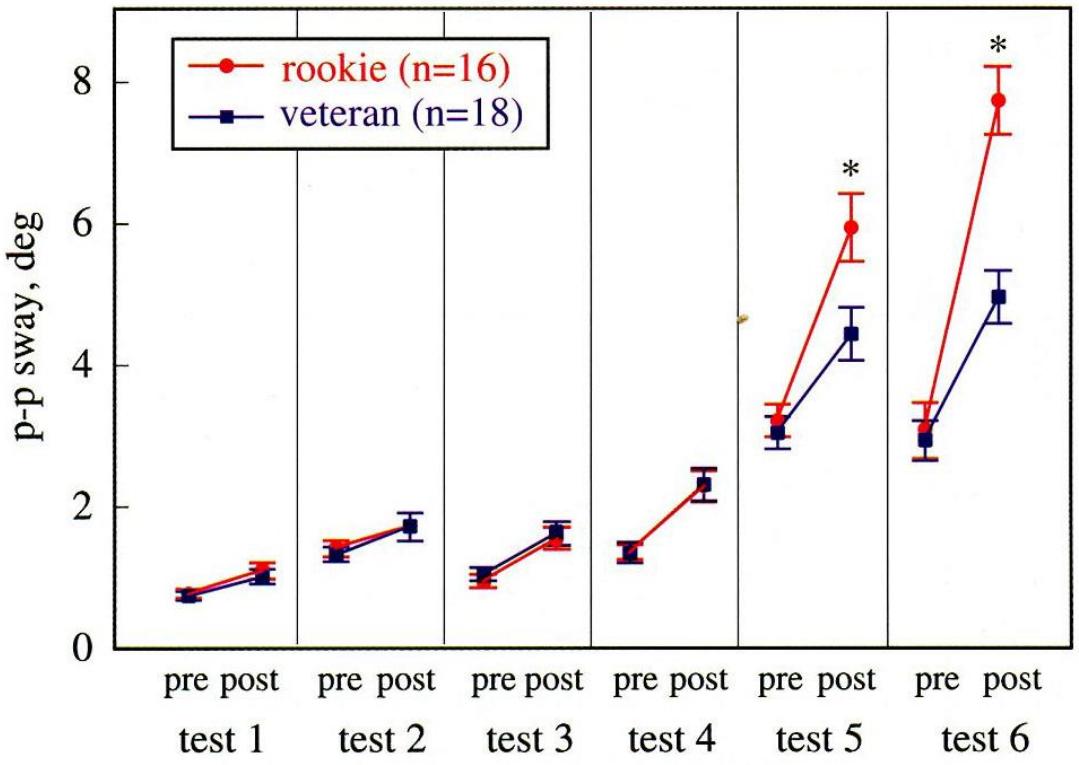
Advanced Resistive Exercise Device

Wood et al., Aviat Space Environ Med (2015)

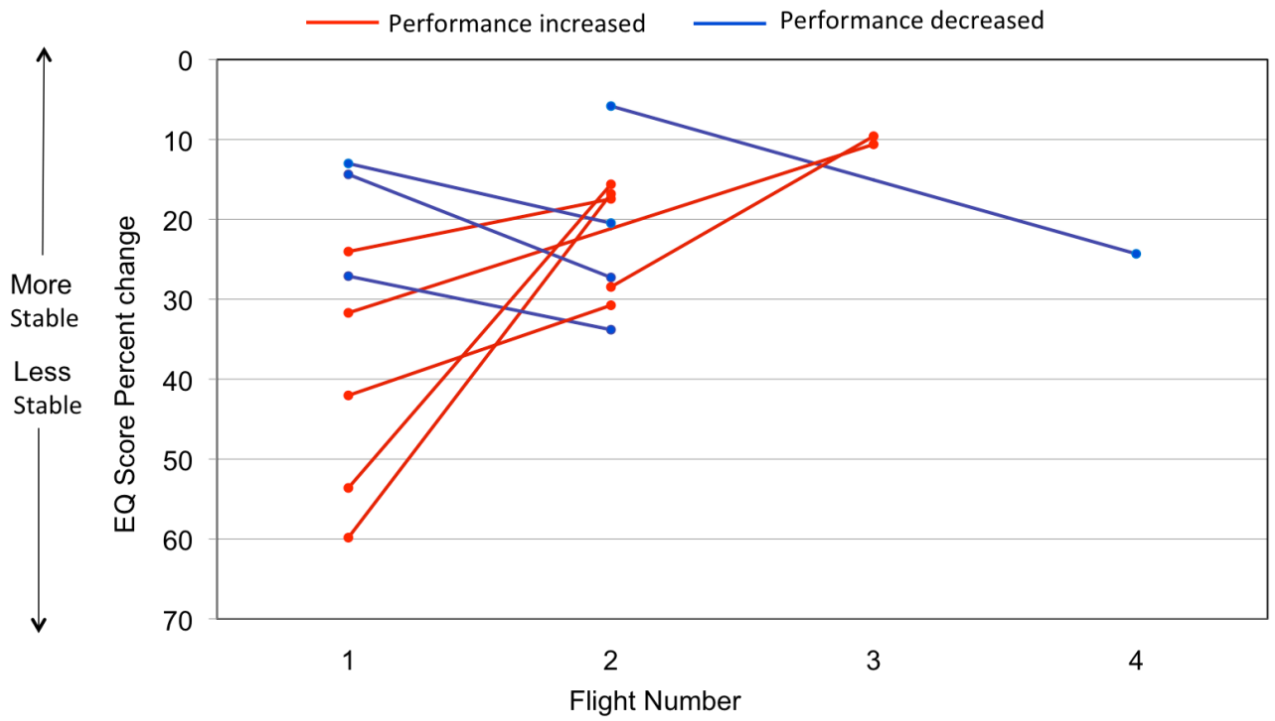
Self-ratings



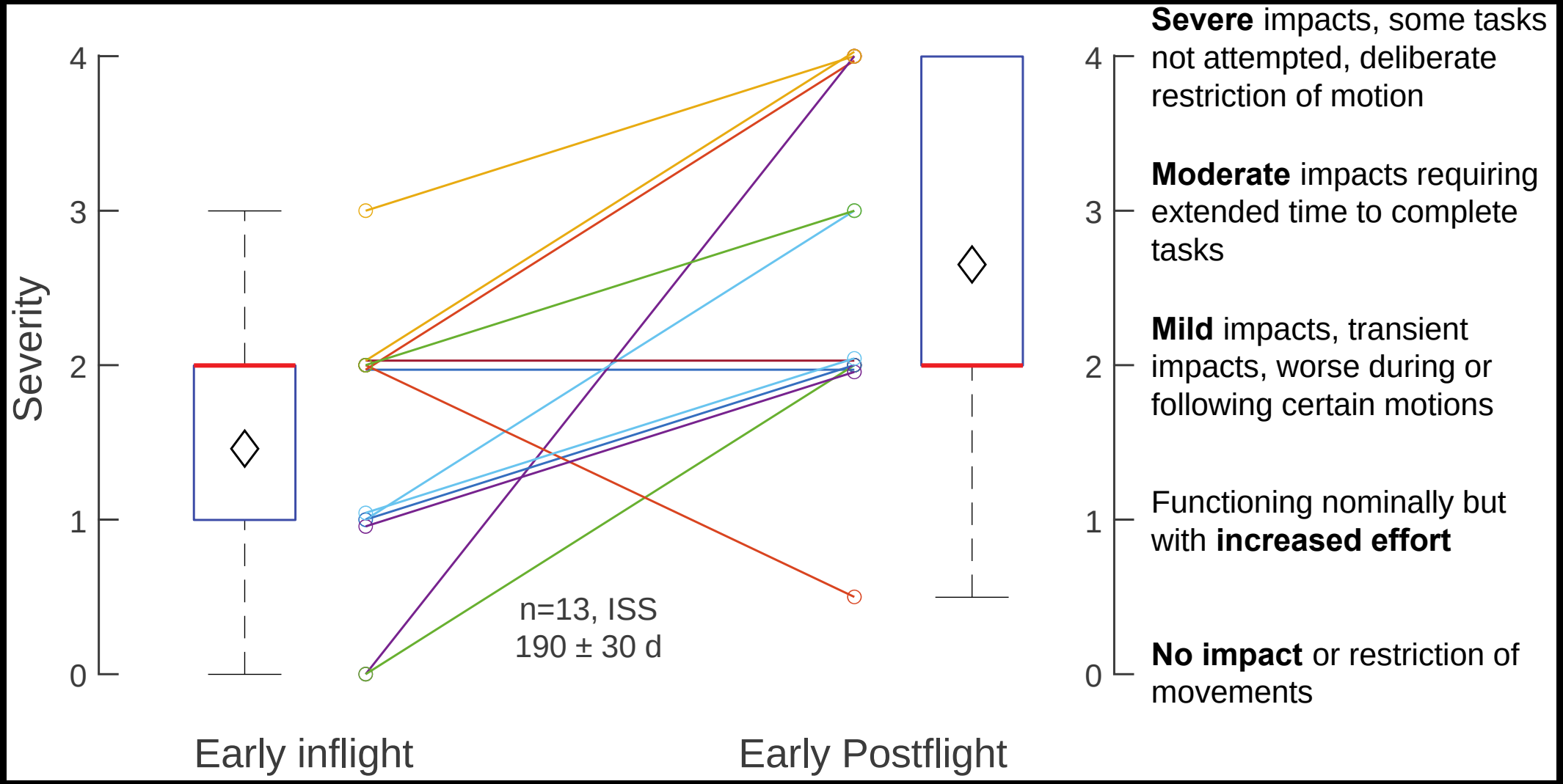
Naïve versus repeat flyers - posture



Paloski et al., EDOMP Report, 1999



Inflight versus reentry: Functional impacts



Conclusions

- The duration of microgravity exposure has a significant effect on both the magnitude of the sensorimotor decrements and the time course of recovery to preflight performance levels.
- While there have been reports of otolith-mediated reflexes being modified by prior flight experience, the postflight functional performance as assessed by computerized dynamic posturography does not appear consistently altered with prior flight experience.
- The early sensorimotor decrements have implications for the completion of critical mission tasks during and following g-transitions. Interventions are necessary to optimize crew performance for success on upcoming exploration missions.


EXPLORE
MOON to MARS

Motor control