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With:

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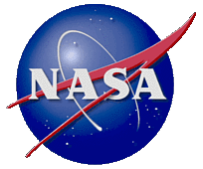


2017 NASA Human Research Program
Investigators' Workshop, Galveston, TX.
A New Dawn Enabling Human Space
Exploration

PHOTO CREDIT: NASA



General Observations

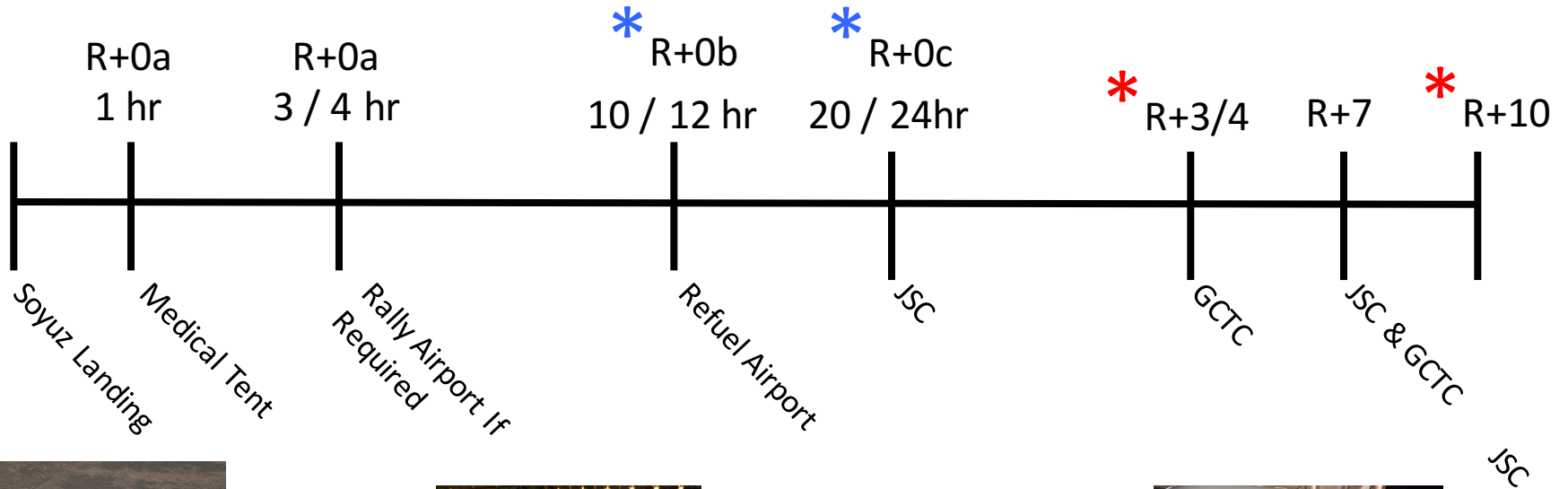


1. Every Returning Crewmember Exhibits Vestibular/Cerebellar Sensorimotor Symptoms.
2. Every Crewmember Experiences Some Degree of Reentry or Landing Motion Sickness.
3. Considerable Variance Across Crewmembers' Functional Performance.
4. Multiple Test Sessions on R+0 Appears to be Beneficial: Enhancing Readaptation.





NASA Testing Sequence - Timeline



* Unique to NASA

* Unique to IBMP



Field Test Protocols



S2S

RFF

STAND

END PT NYSTAGMUS

E/H COORD

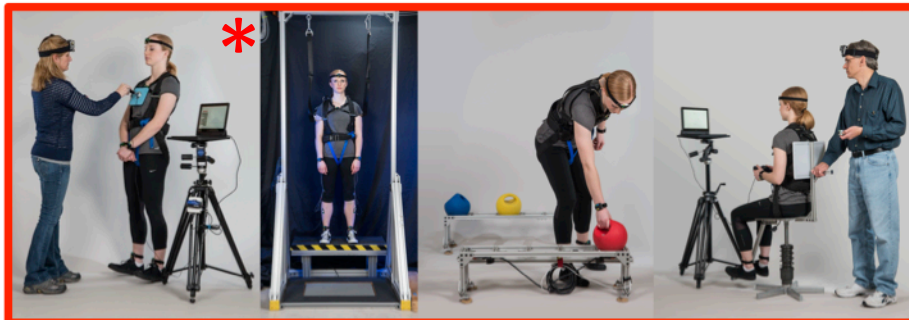


DYSMETRIA

MUSCLE FORCE/MEMORY

TANDEM

WALK/OBST



PUSH

JUMP

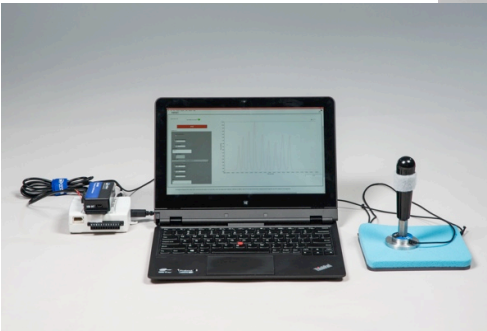
ROCK TRAN

DVA

* Indicates Tests Covered In This Presentation



Hardware and Instrumentation



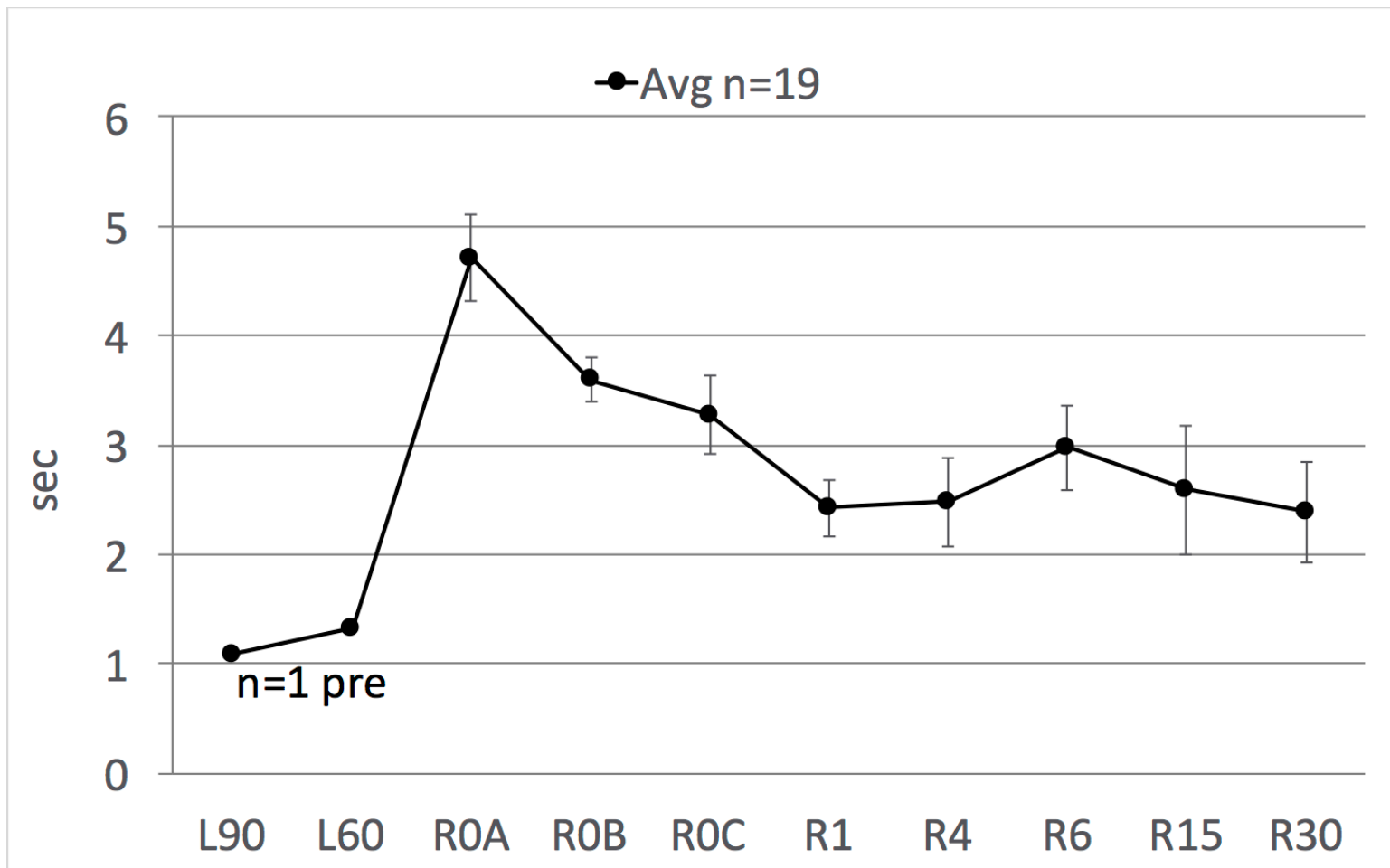
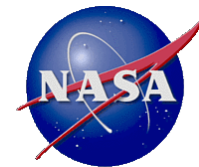


Sit-to-Stand



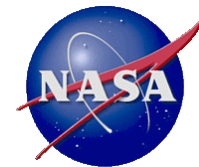


Sit-to-Stand Time To Stability



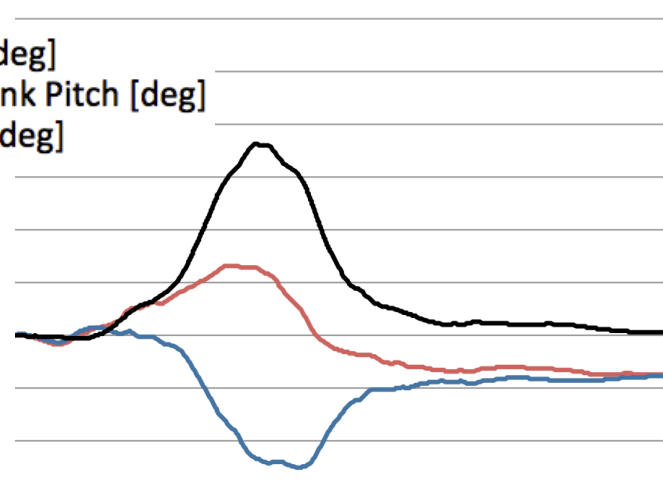
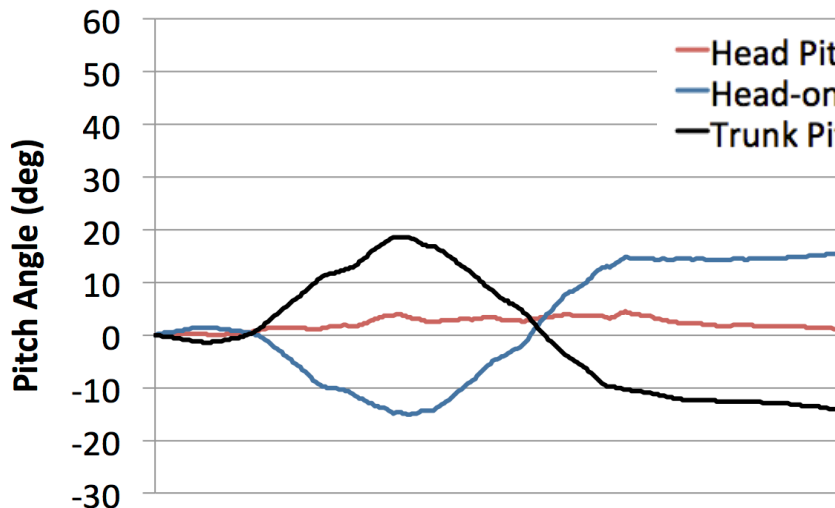


Sit-to-Stand Pitch Angles



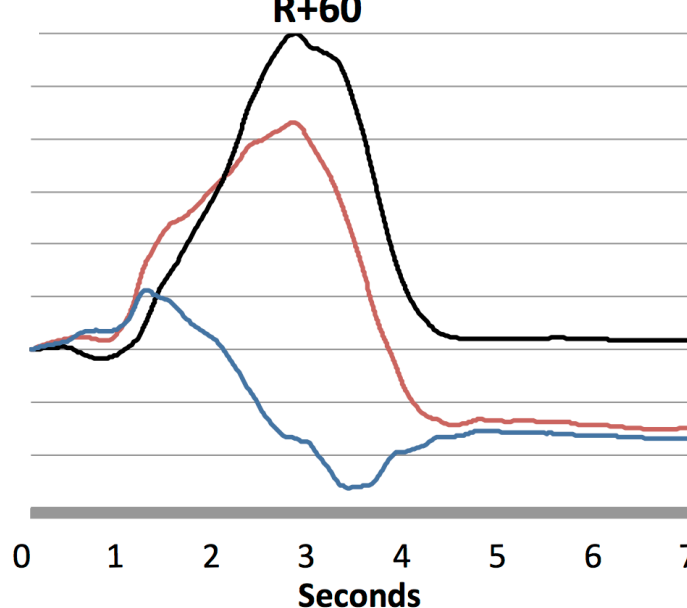
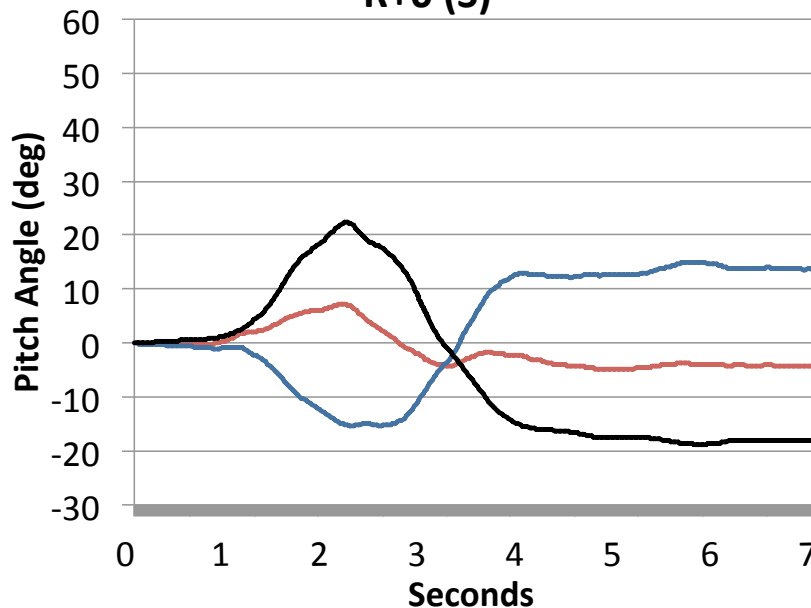
R+0 (KZ)

R+0 (ACQ)



R+0 (S)

R+60

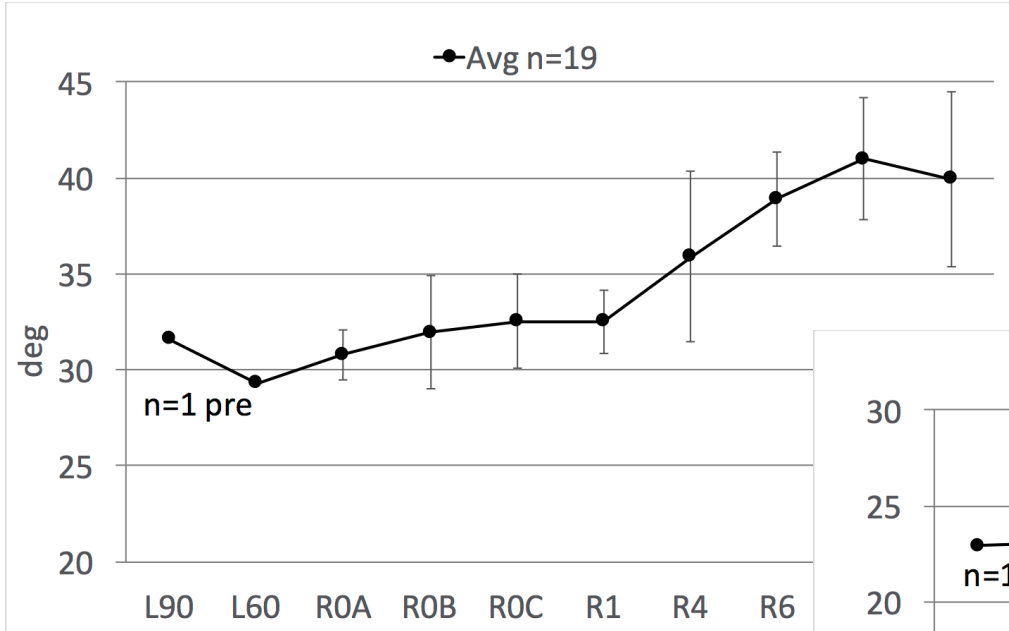




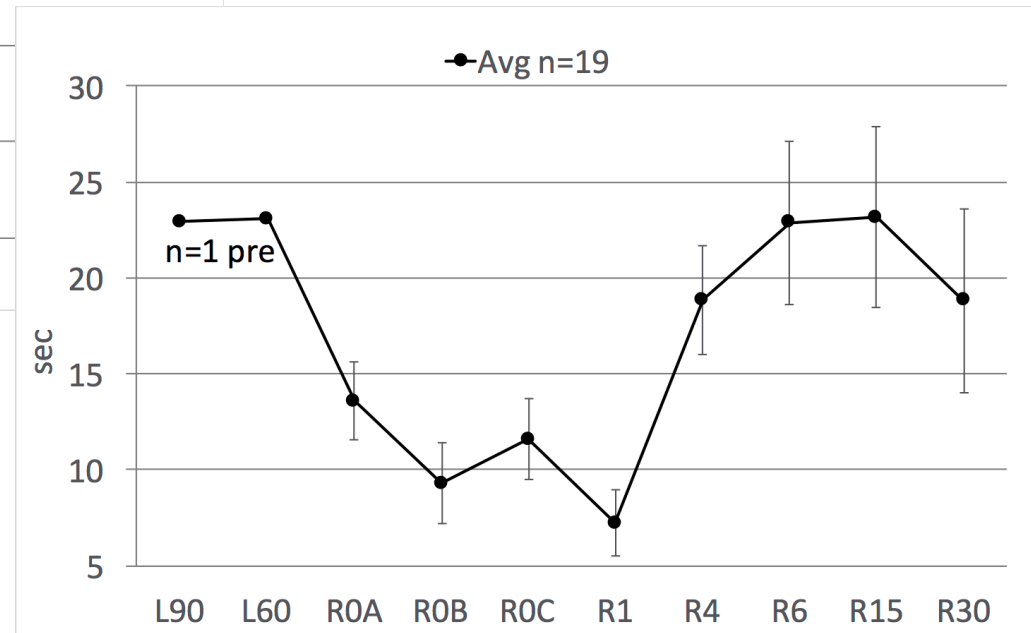
Sit to Stand



Head Pitch Range

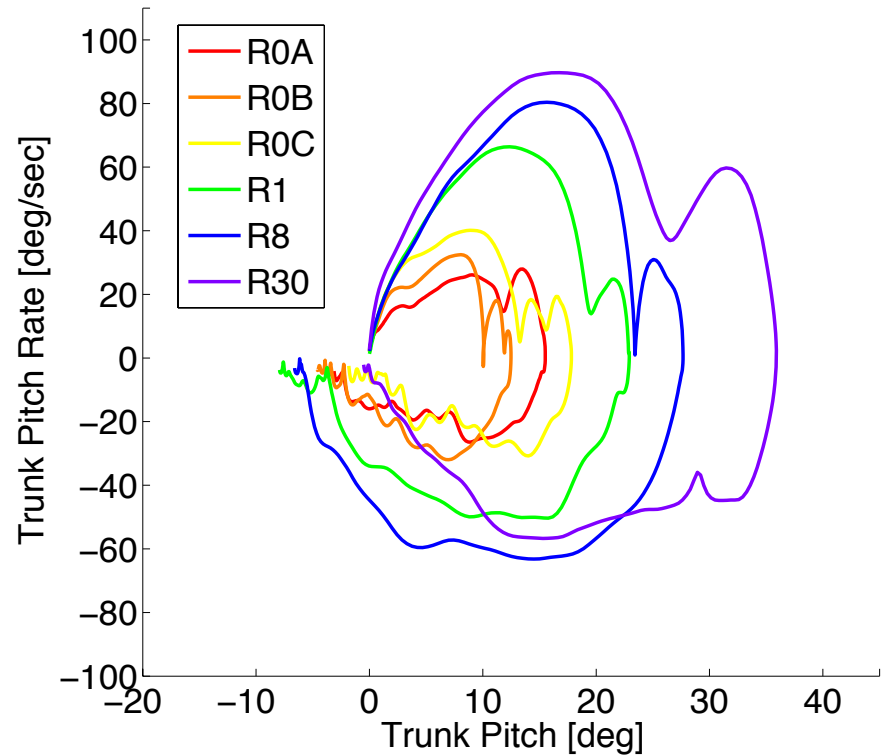
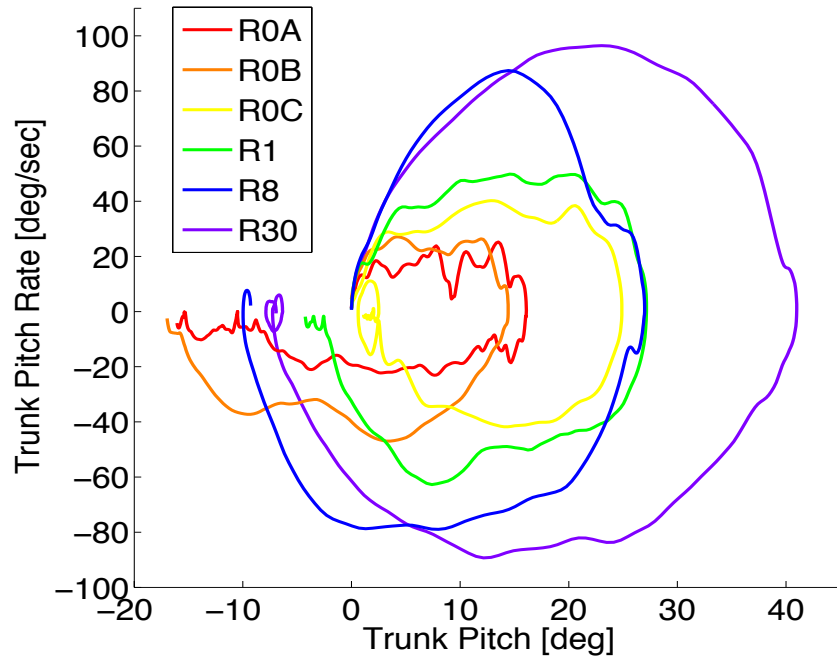
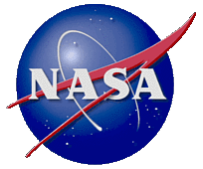


Trunk Pitch Range





Sit to Stand: Phase Plane



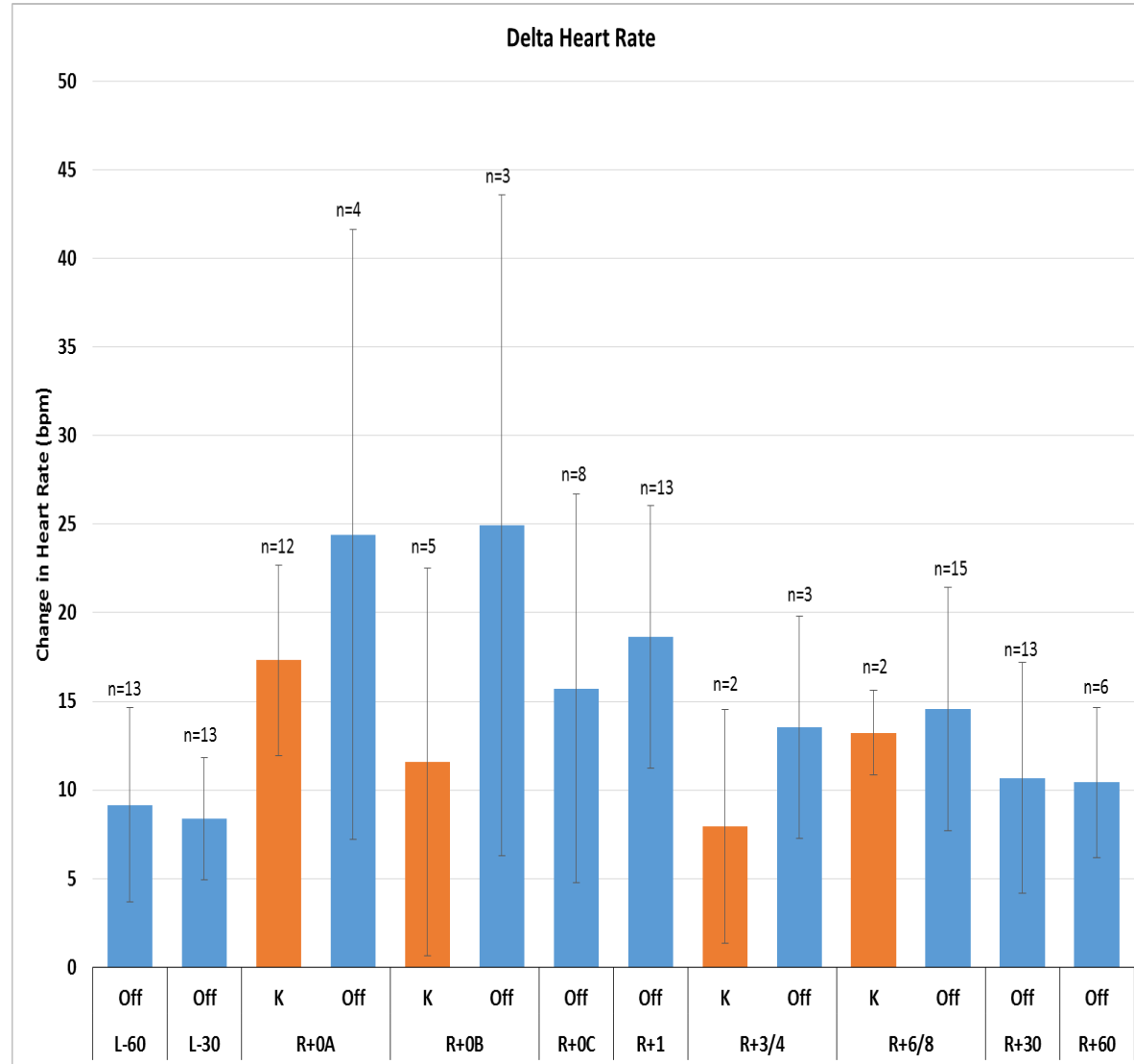


Recovery From Fall



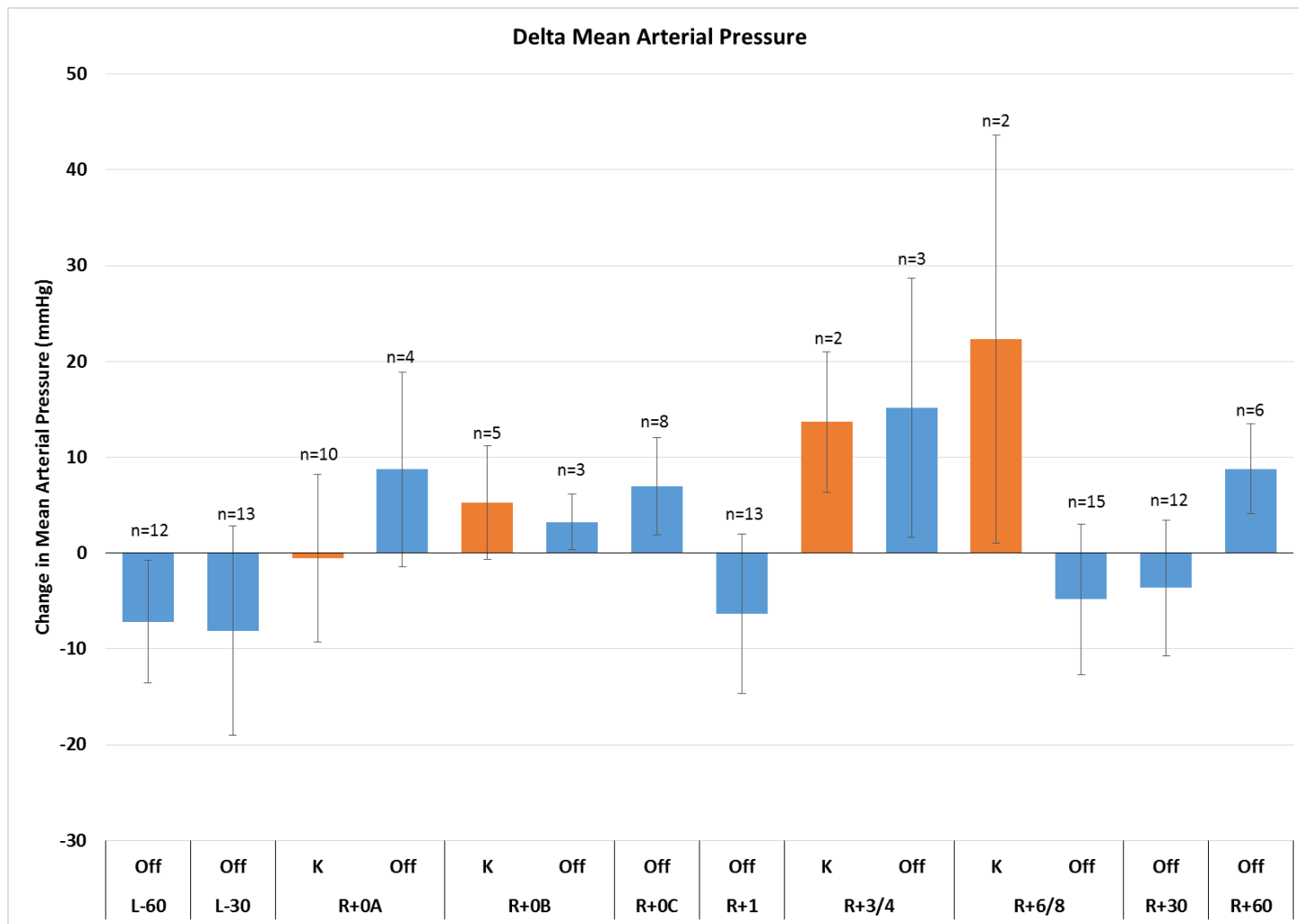
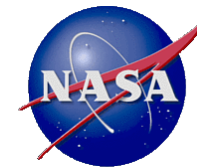


Cardiovascular Stand Test: Recovery From Fall



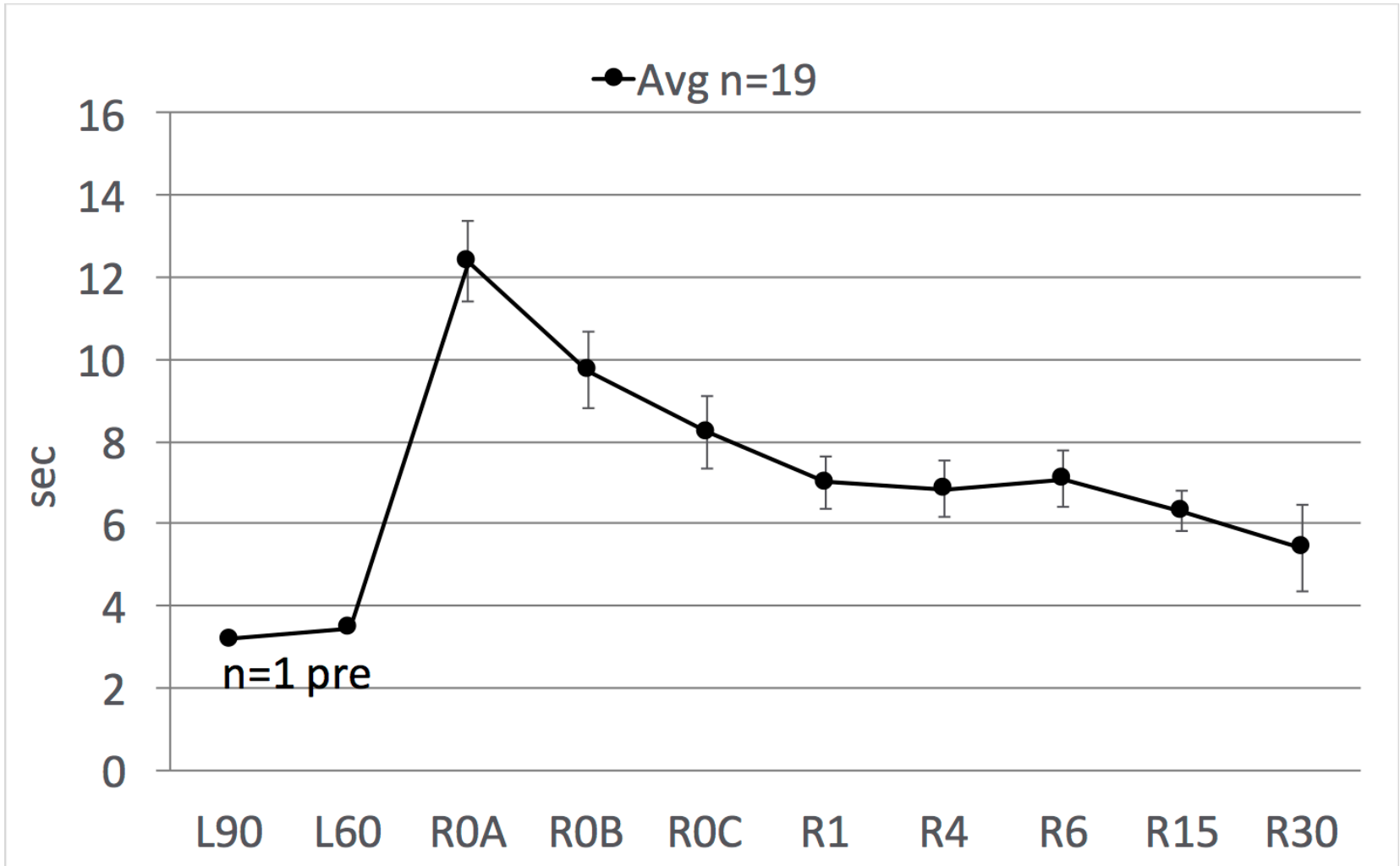


Cardiovascular Stand Test: Recovery From Fall



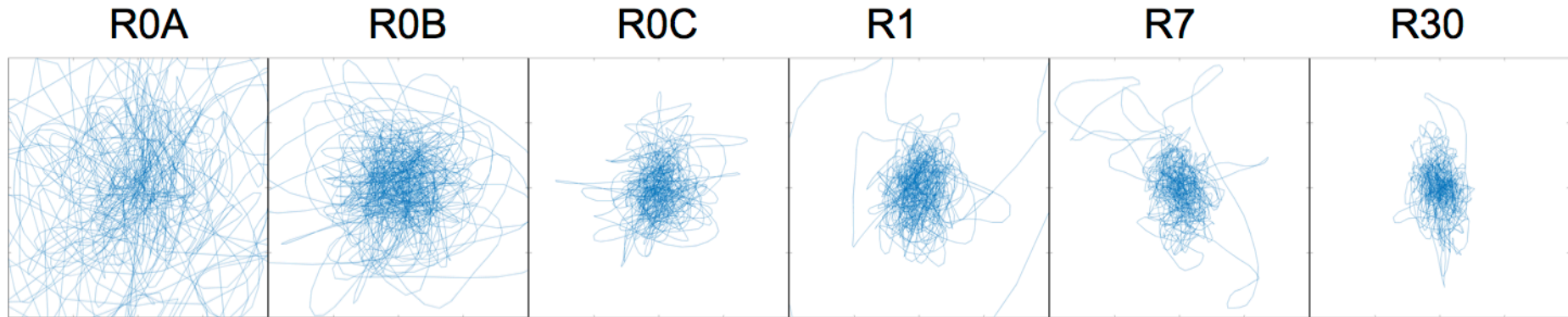


Recovery from Fall: Time to Stability





Stabilograms During Recovery From Fall and Quiet Stance

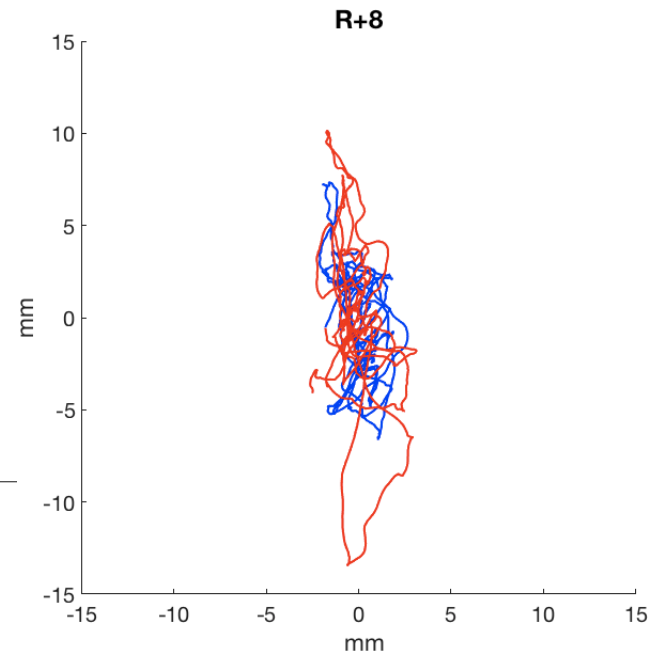
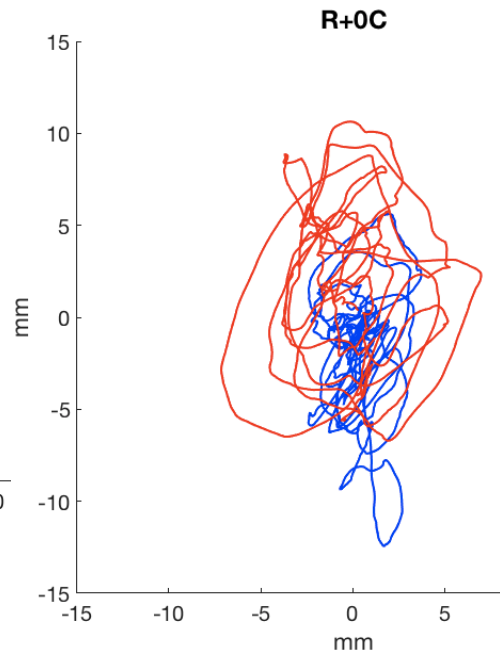
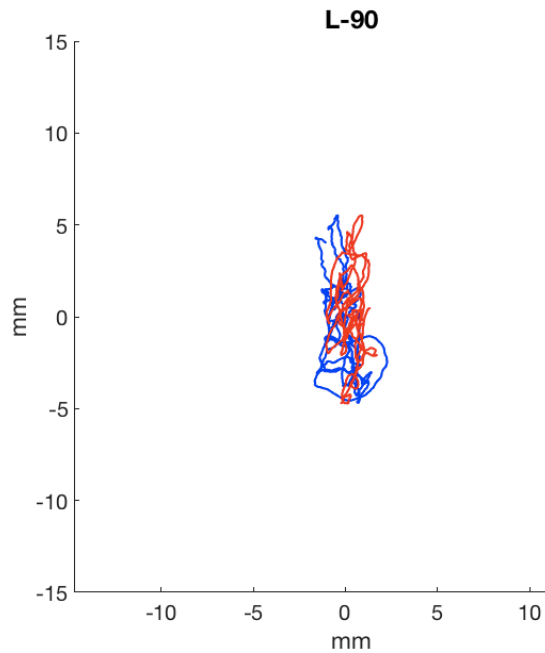
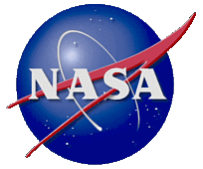


0.1 m/s²
A/P
0.1 m/s²
M/L

Stabilograms from lumbar acceleration traces (mediolateral [ML] vs. anteroposterior [AP]) recorded on one crewmember over a 30-day postflight period. Each panel shows the first 20 seconds of quiet stance accelerations filtered using a 2nd order Butterworth filter with 10-Hz cutoff frequency.



Stabilographic Response During Quiet Stance: Closed and Open Loop



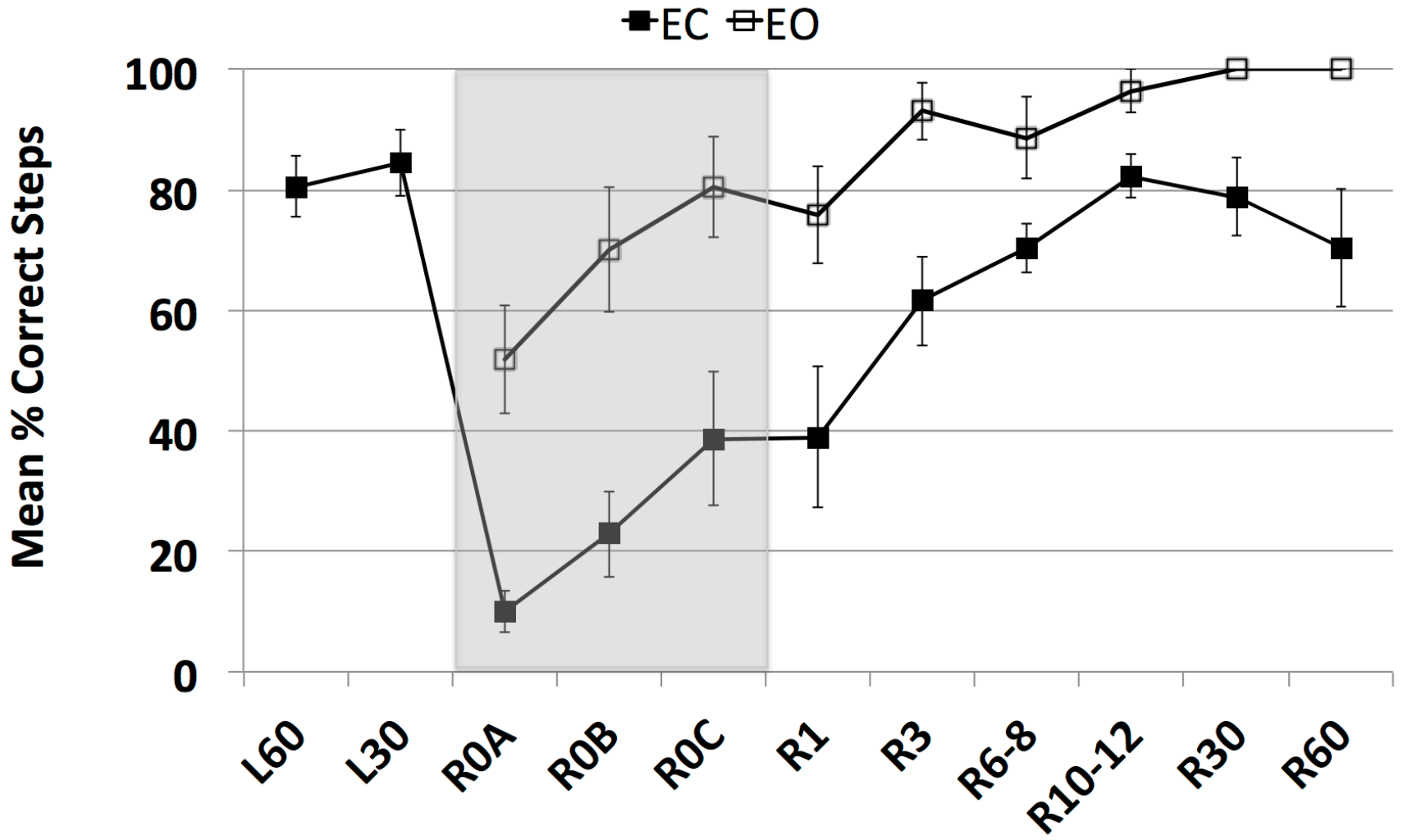


Tandem Walk





Tandem Walk: Percent Correct Steps Eyes Closed vs. Eyes Open

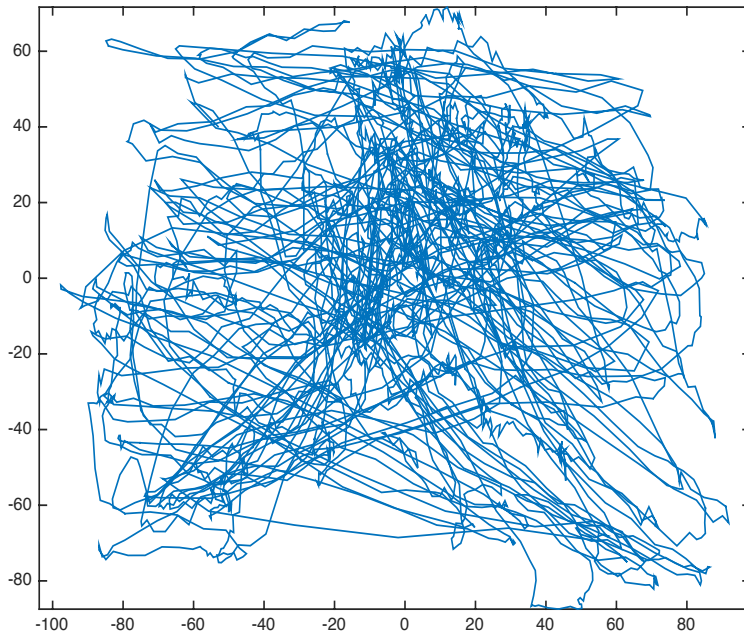




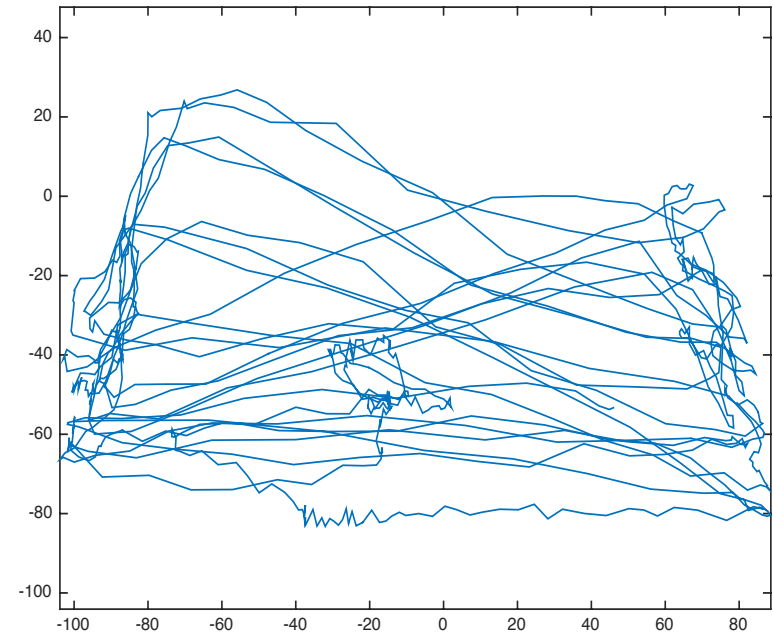
Tandem Walk-Step Organization Depicted As Median Force (COP) Over Time



R+0A

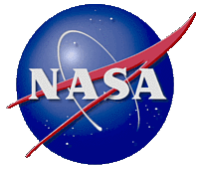


R+24



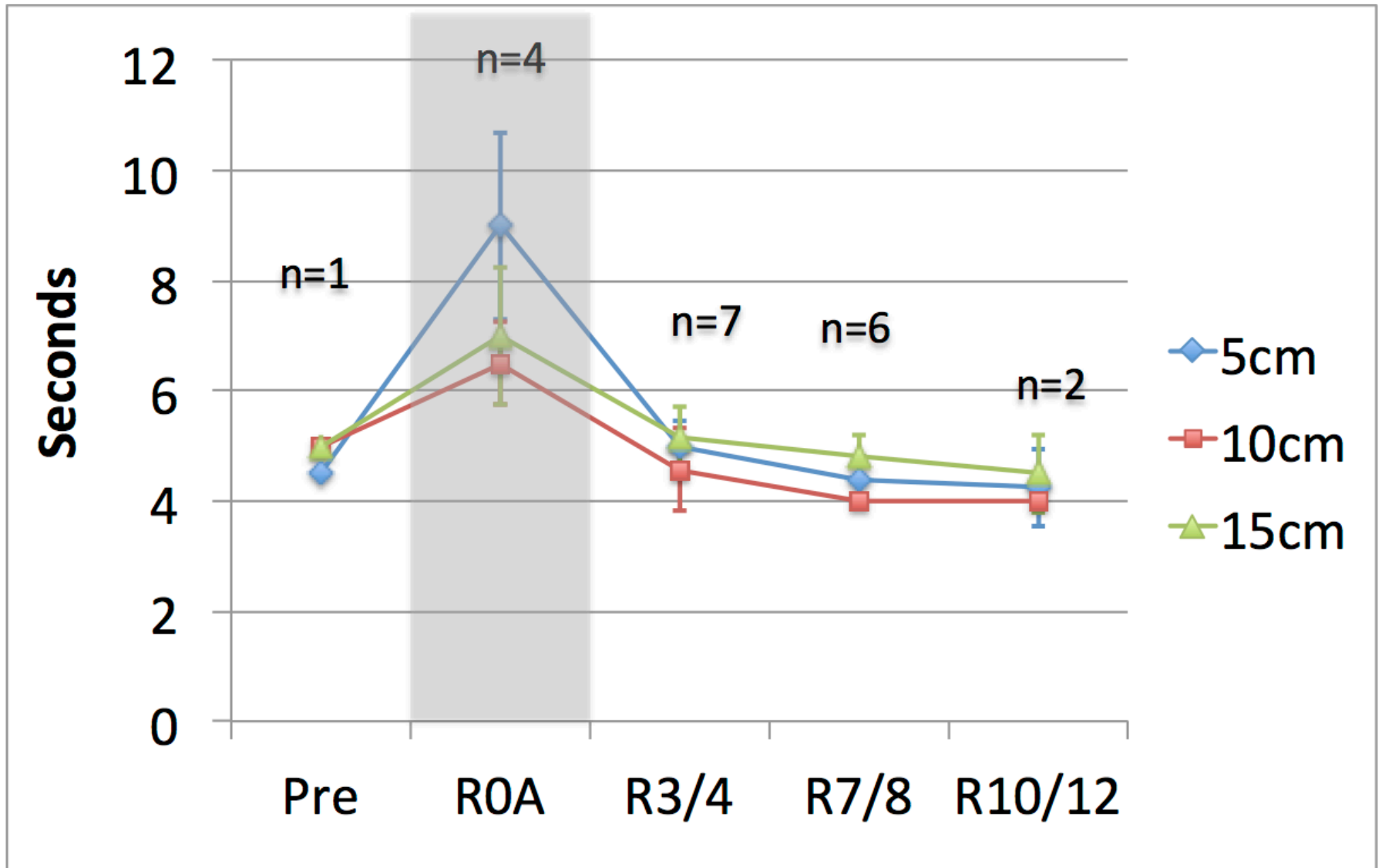
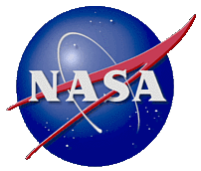


Walk With Obstacle



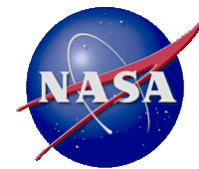


Step Over: Time to Completion





Walk and Step Over



5 cm

15 cm



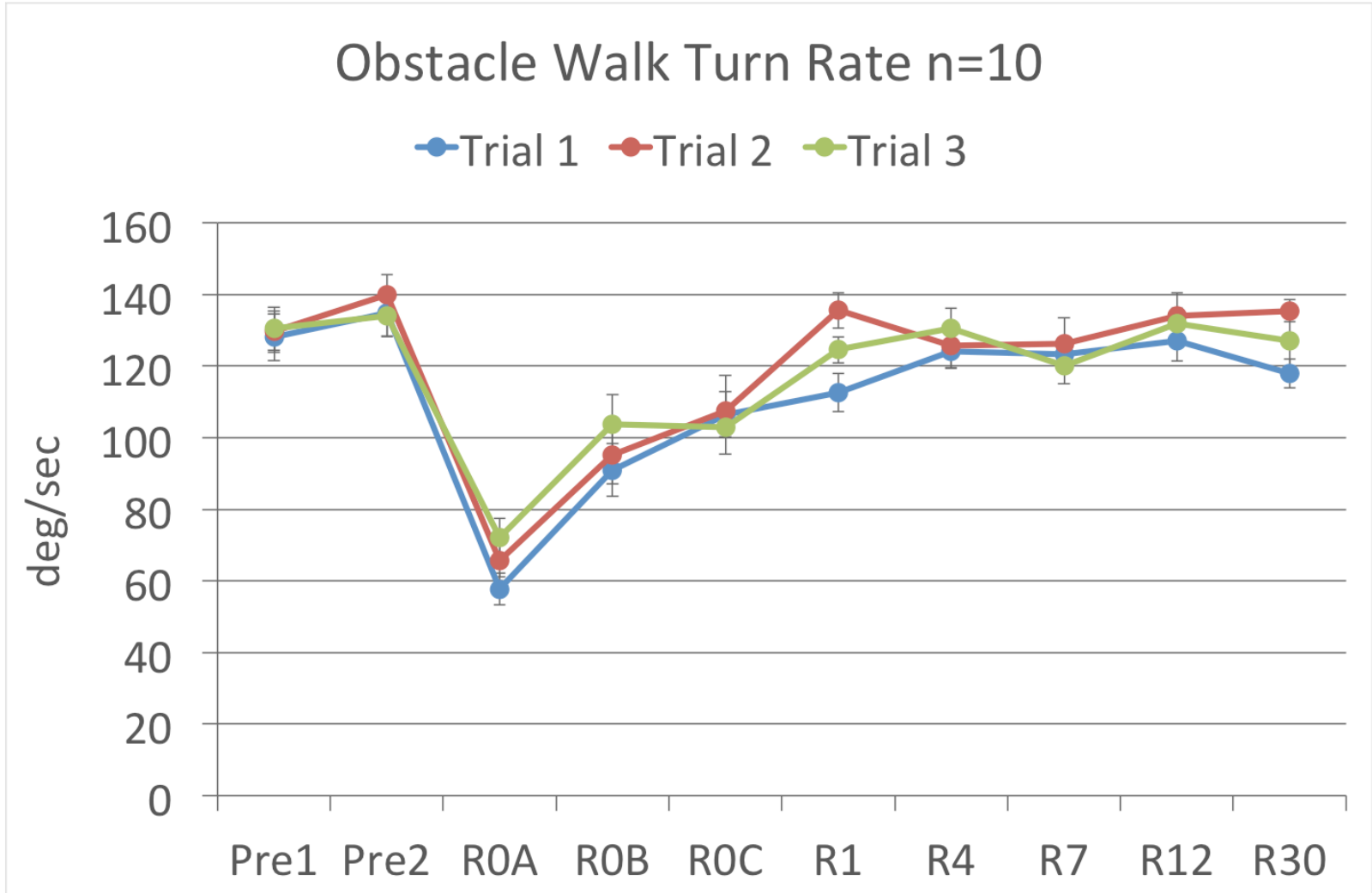
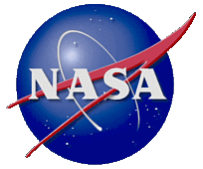


Walk With Corner Turn and Step Over



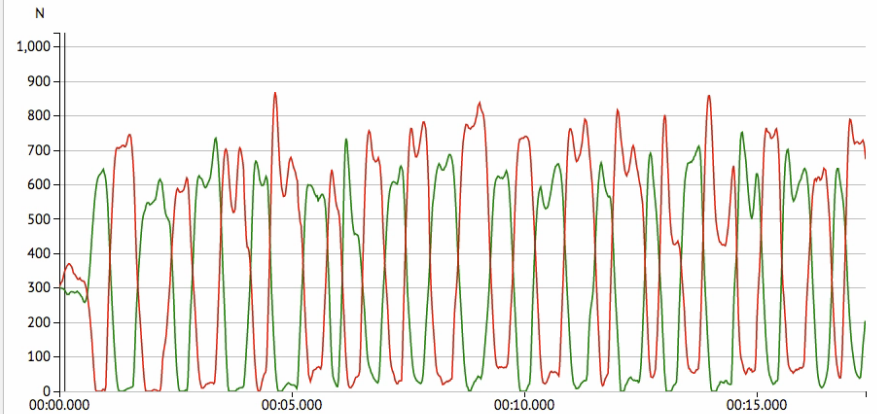
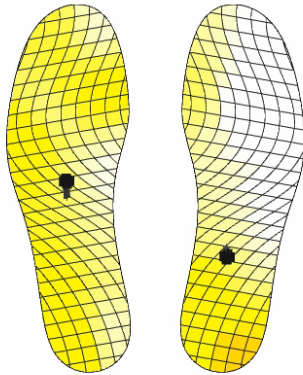
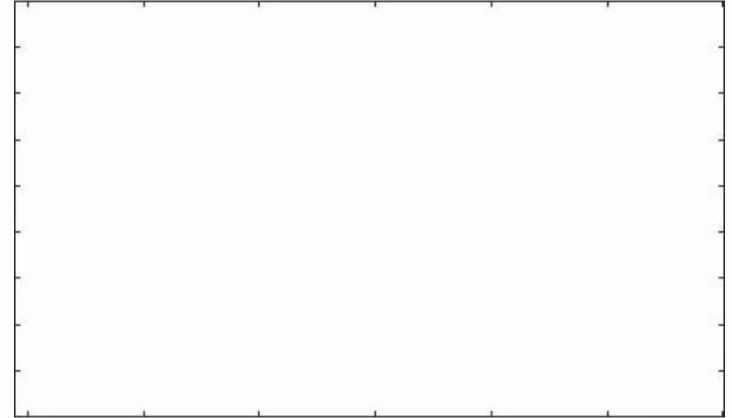


Corner Turn Rate



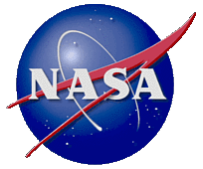


Walk With Obstacle



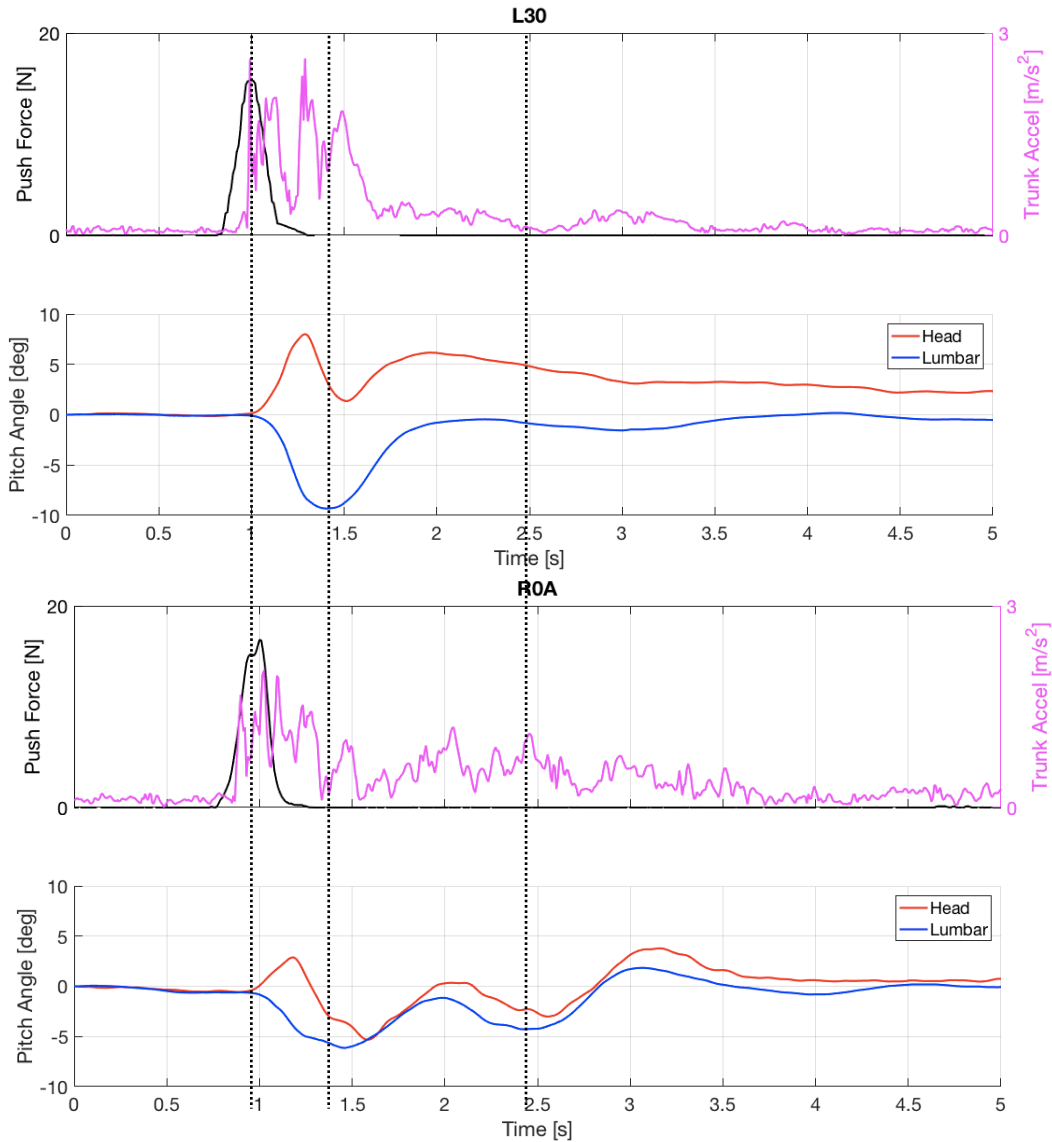


Chest Pushes





Reaction to Chest Pushes





Postflight Motion Sickness



A Whiter
Shade of
Pale

PROCOL HARUM, 1967

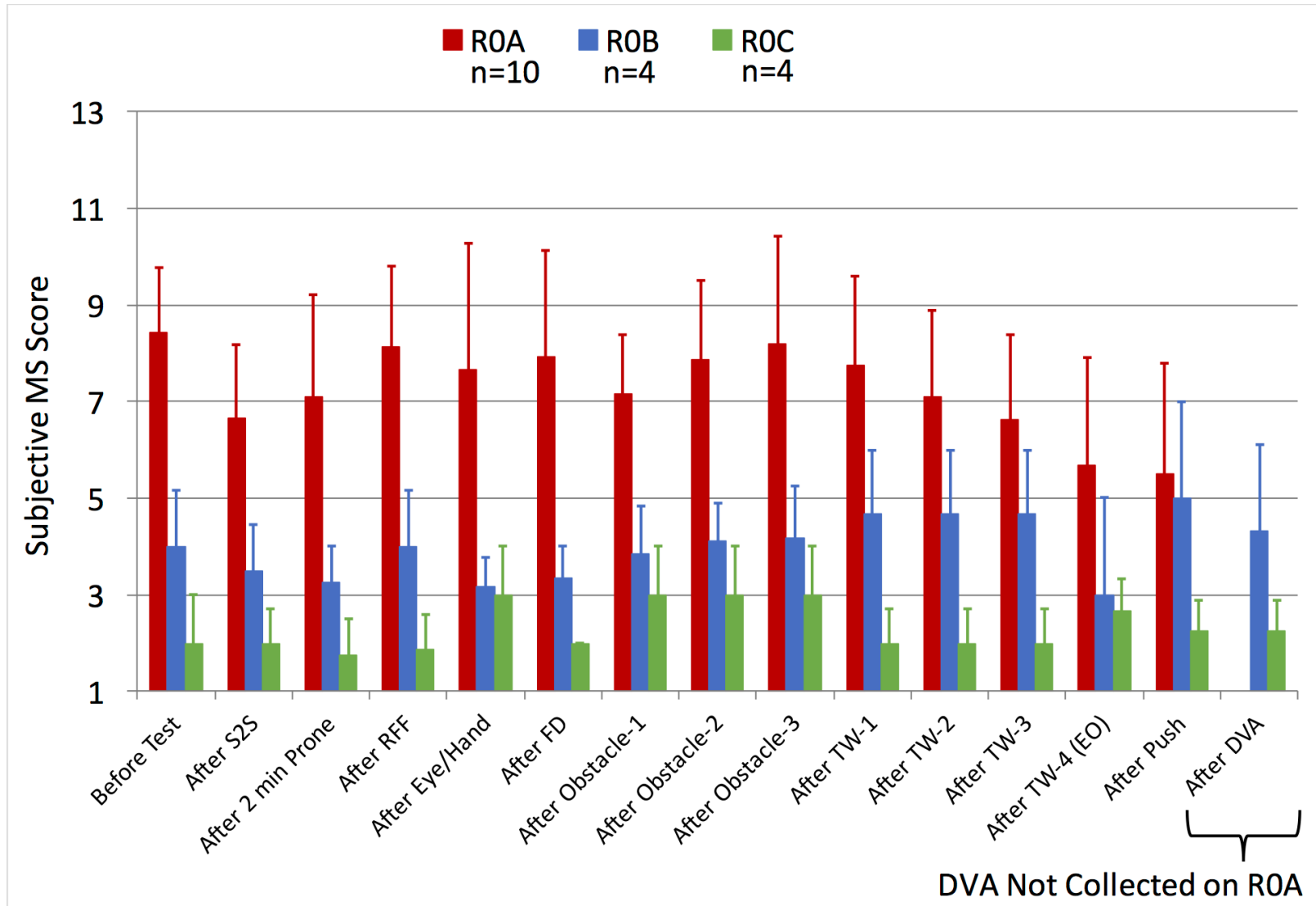
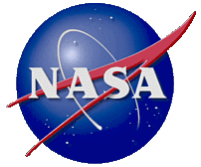
I was feeling kinda space sick
But the scientists called out for more
The spacecraft was humming harder
As the stars flew away
And the astronaut told his tale
That his face, at first just ghostly,
Turned a whiter shade of pale*

**Lyrics Modified From Original Procol Harum Song*

100% of Returning Crews Presented
With Variable **Entry or Post Flight**
Motion Sickness



Entry / Landing Sickness Scores



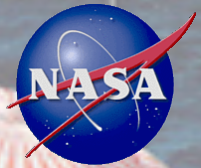


PFT Protocols: Performance



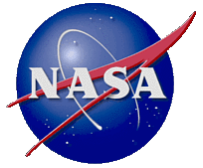
Tests Completed in Field/KZ AP on R+0	Subject Count
Sit-to-Stand, Recovery from Fall, Tandem Walk	9
Sit-to-Stand, Recovery from Fall	6
Sit-to-Stand	1
No tests completed	2
	18

IN ADDITION, 4 OF 7 COSMONAUTS WERE ABLE TO COMPLETE 2 ADDITIONAL TESTS IN THE FIELD (PUSH TEST AND SEAT EGRESS OBSTACLE TEST).



Field Test Intent and Relevance

- 1) Allows development of a time constant for functional performance in the hours and days following long duration spaceflight.
- 2) Allows evaluation of NASA's GCG and the Russian Kentavr garment for protection against landing orthostatic intolerance.
- 3) Allows development of a knowledge base from which programmatic risks for interplanetary travel can be developed:
 - a. Safety and functional performance upon landing on a planetary (Mars?) surface.
 - b. Water landing in the Orion capsule.
 - c. More immediate: Soyuz egress following a ballistic entry beyond anticipated landing point.

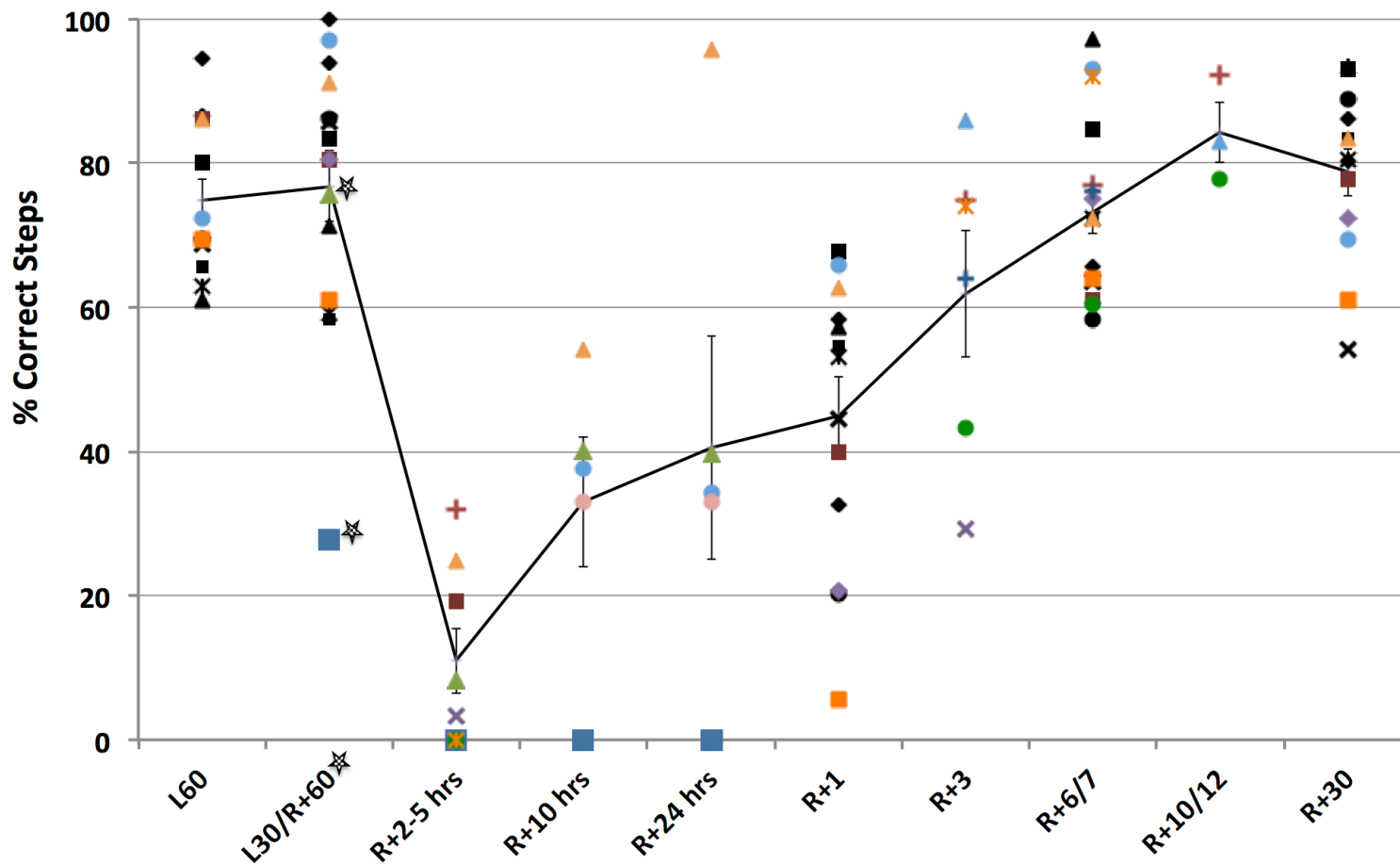


BACK-UP MATERIAL



Tandem Walk

% Correct Steps ISS n=22



Jump Down Task

