THE FUNCTIONAL TASK TEST: RESULTS FROM THE ONE-YEAR MISSION

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During and after spaceflight there are changes in multiple physiological systems including:

- Cardiovascular function

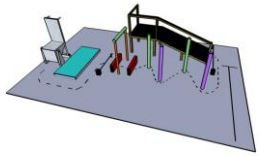
- Sensorimotor function

- Muscle function

How do changes in these physiological systems impact astronaut functional performance?

Objectives

Functional Performance



Seat Egress and Walk

Ladder Climb

Recovery from Fall/Stand

Rock Translation

Construction Activity

Torque Generation

Jump Down

Map

Physiological Measures

Muscle
- Strength
- Power
- Control
- Neuromuscular Drive

Sensorimotor
- Balance
- Gait
- Dynamic Visual Acuity
- Fine Motor Control

Cardiovascular
- Plasma Volume
- Heart Rate
- Blood Pressure

1. Determine the effects of space flight on astronaut's ability to perform mission critical functional tasks.
2. Identify the key physiological factors that contribute to decrements in functional performance to inform the design of targeted countermeasures.

Overview

- Results from spaceflight (6 months duration) and bed rest studies
- Results from the One-Year Mission

Subject Groups

Spaceflight (ISS)

13 subjects,
6-month flights

Bed Rest

Controls: 10 subjects
Exercise: 9 subjects

70 days bed rest

Testing Schedules

6 months

Pre-flight

L-180 **L-60** **L-30**

Post-flight

R+1 **R+6** **R+30**

Pre-bedrest

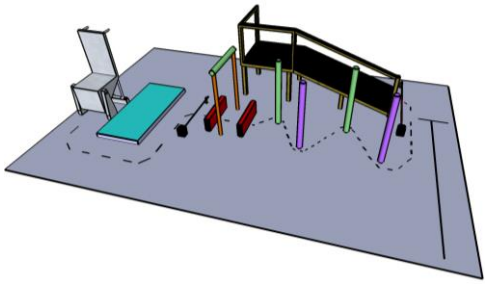
BR-12 **BR-7** **BR-1**

Post-bedrest

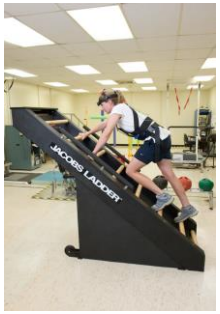
BR+0 **BR+1** **BR+6** **BR+12**

70 days in bedrest

Functional Tests



Seat Egress and Walk



Ladder Climb

Hatch Opening

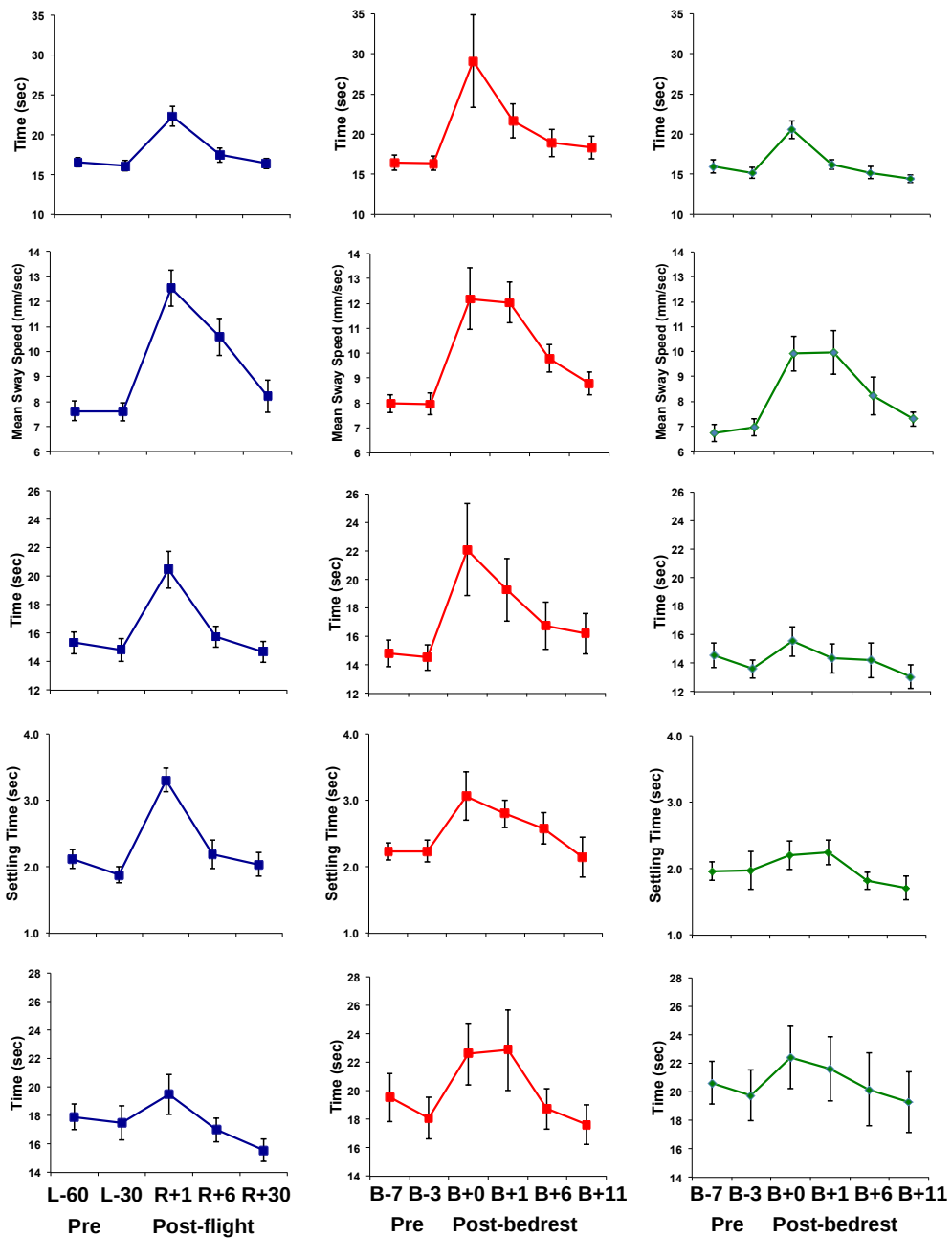
Object Translation

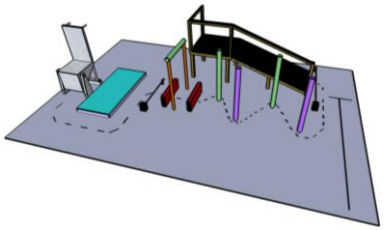
Recovery from Fall/Stand

Construction Activity

Jump Down

Functional Tasks





Seat Egress and Walk

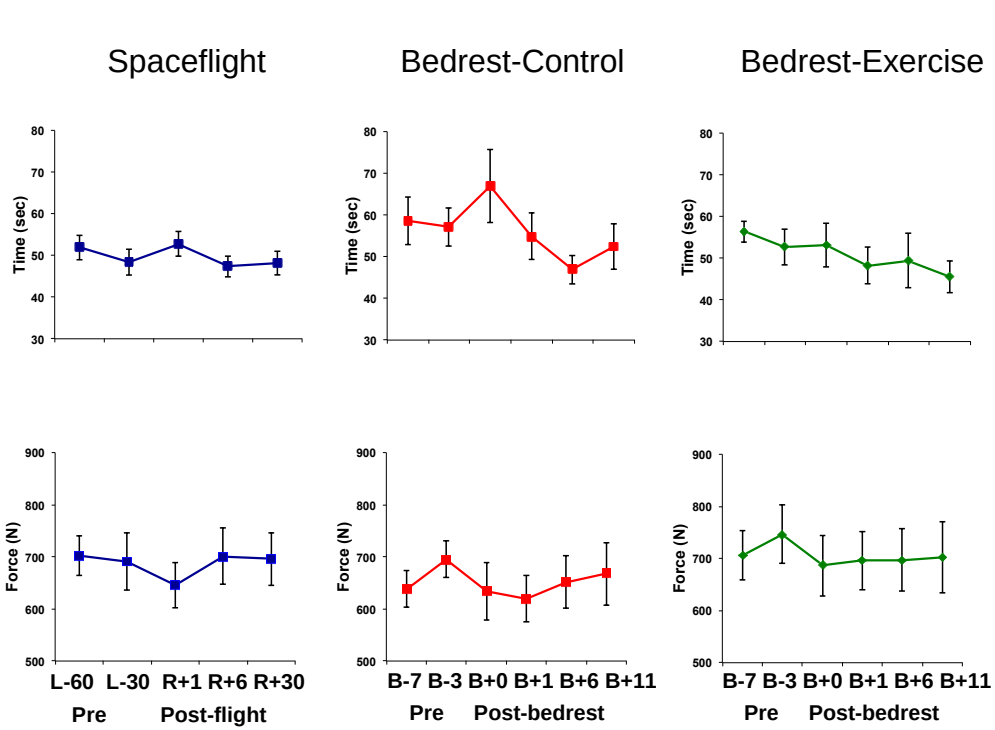
Recovery from Fall/Stand

Object Translation

Jump Down

Ladder Climb

Functional Tasks (cont.)

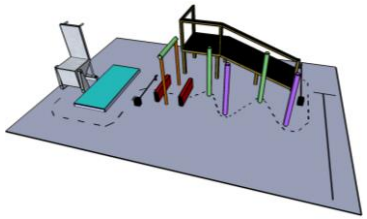


Construction Activity

Hatch Opening

Functional Tests: 6-month flight duration

Higher Demand for Postural Stability Control

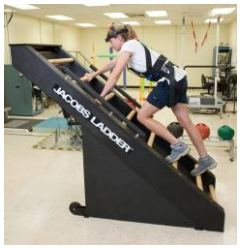


Seat Egress and Walk

Object Translation

Recovery from Fall/Stand

Jump Down



Ladder Climb

Lower Demand for Postural Stability Control

Hatch Opening

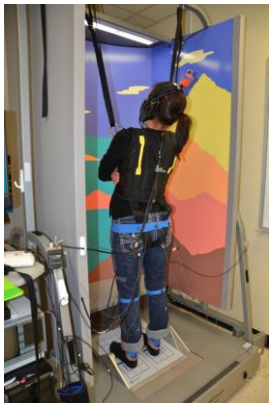
Construction Activity

Both space flight <u>and</u> bed rest subjects (control and exercisers) showed greatest deficits in functional tests with higher demand for postural stability control.

Physiological Tests

Sensorimotor

- *Postural stability*
- *Gait control*
- *Fine motor control*



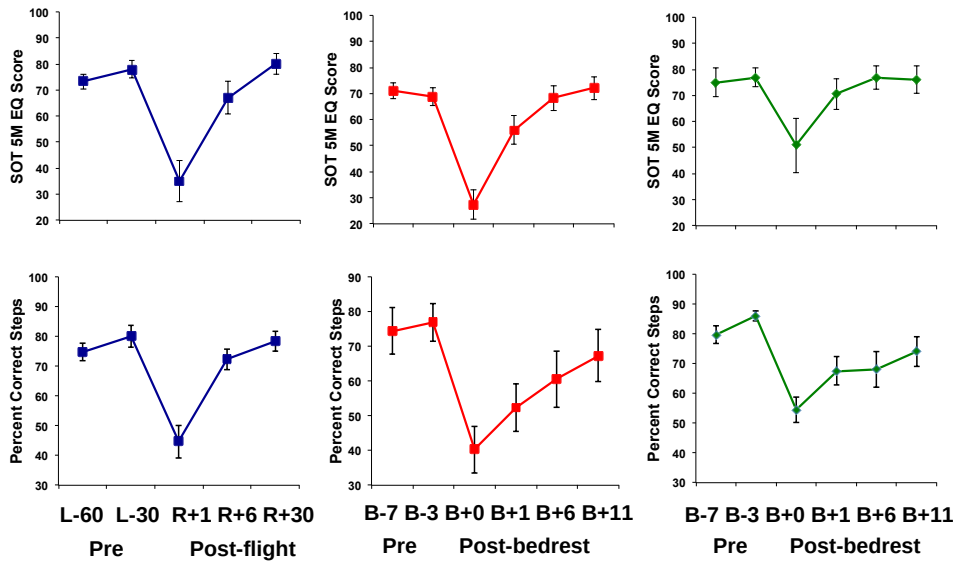
Muscle Performance

- *Force*
- *Power*
- *Work*

Cardiovascular

- *Plasma volume*
- *Heart rate*
- *Blood pressure*

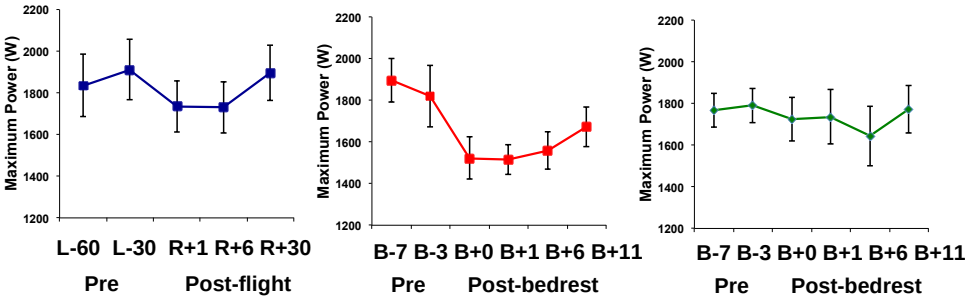
Balance Function



Postural Equilibrium

Tandem Walk

Muscle Function



Lower Limb Power

Bed rest exercise subjects show <u>no</u> decrement in muscle performance <u>but</u> still show postural instabilities

Exercise *<u>alone</u>*** was not sufficient to mitigate decrements in postural control**

Countermeasure Implications

- Spaceflight and bed rest subjects showed deficits in functional tests with postural challenges and sensorimotor tests of balance and locomotor control.
- Aerobic and resistive exercise ***alone*** was not sufficient to maintain performance.

Require an integrated sensorimotor countermeasure to mitigate postflight balance and locomotor dysfunction

One-Year Flight

1-year duration

Pre-flight

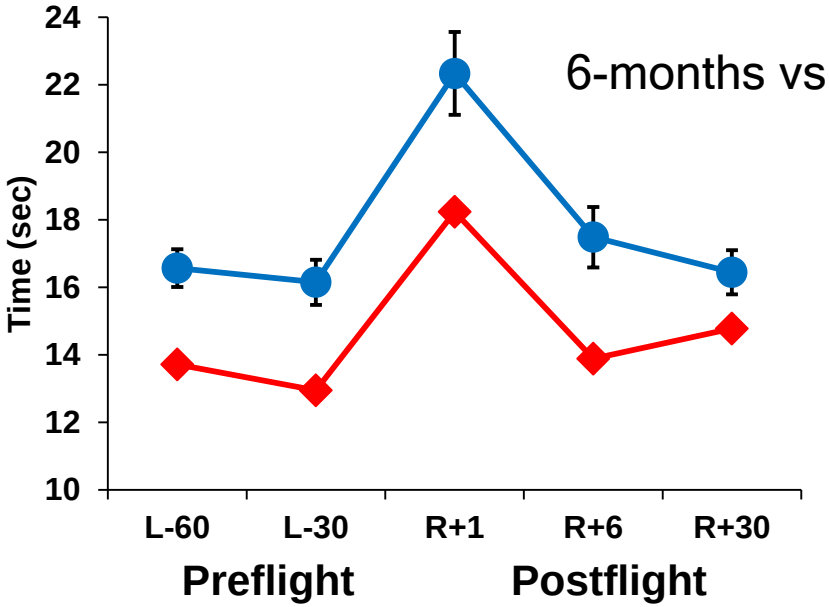
L-180 L-60 L-30

Post-flight

R+1 R+6 R+30

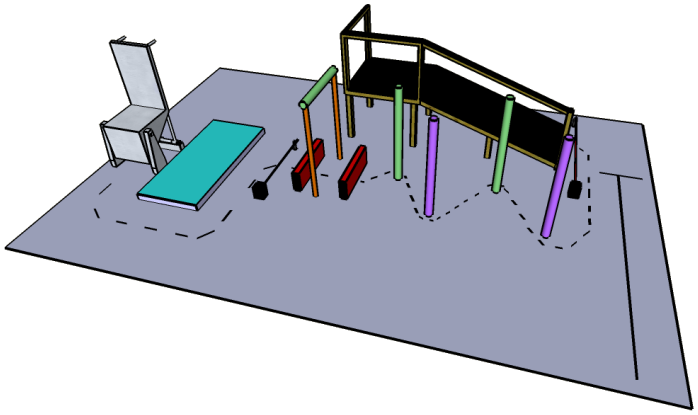
1 subject

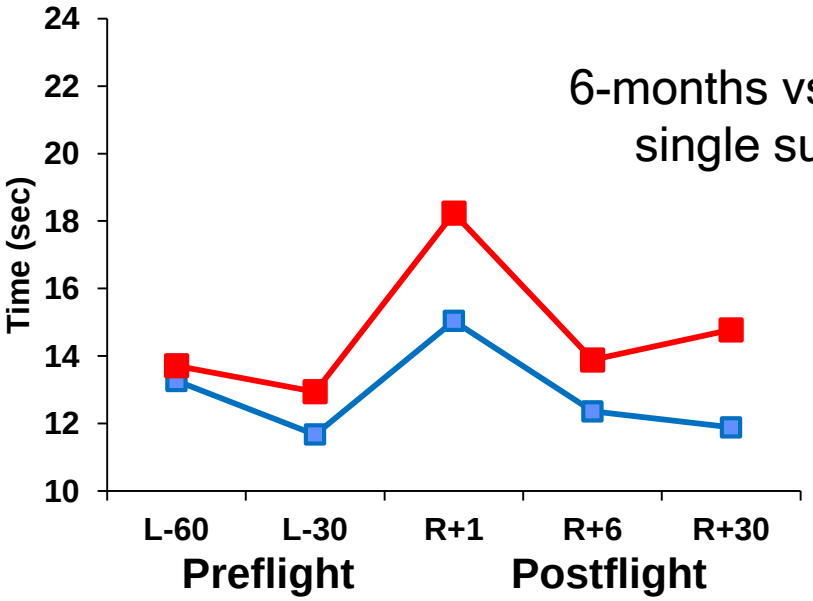
Seat Egress and Walk Test



6 months, n=13

1 year, n=1

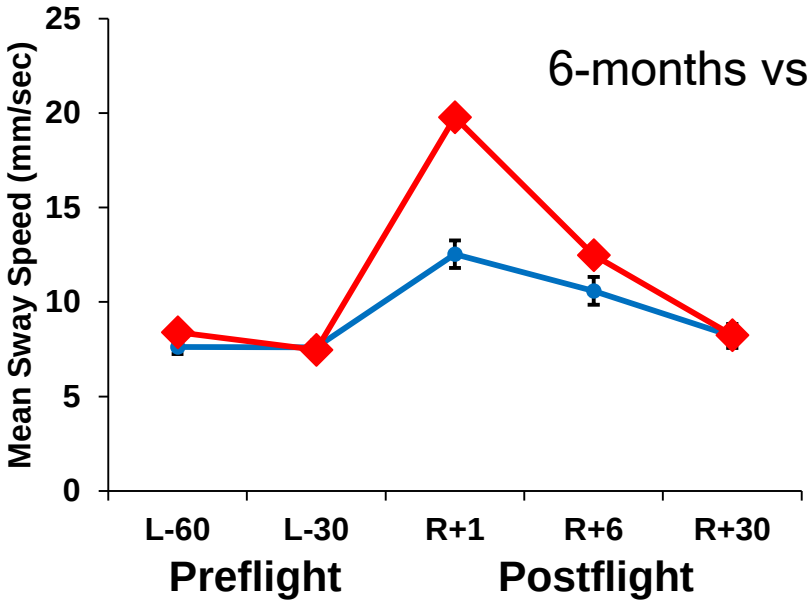




6 months, n=1

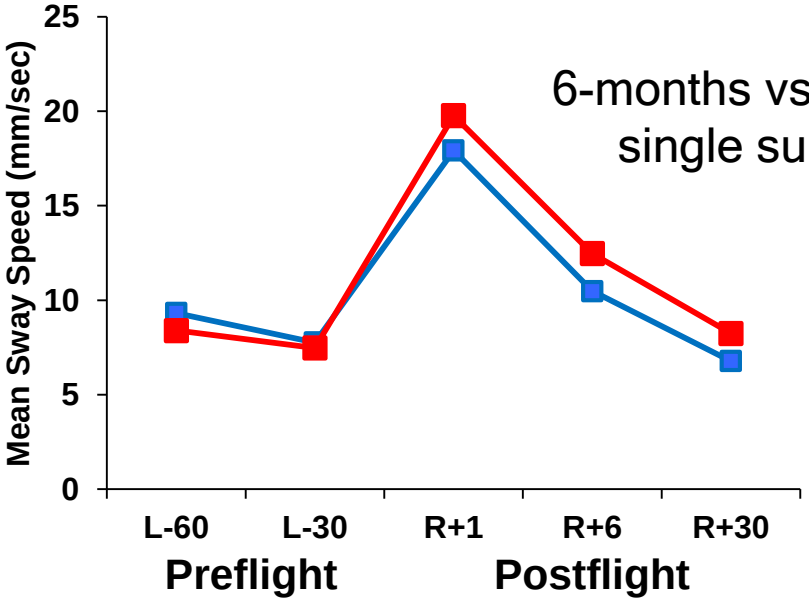
1 year, n=1

Recovery from Fall: Mean Sway Speed



6 months, n=13

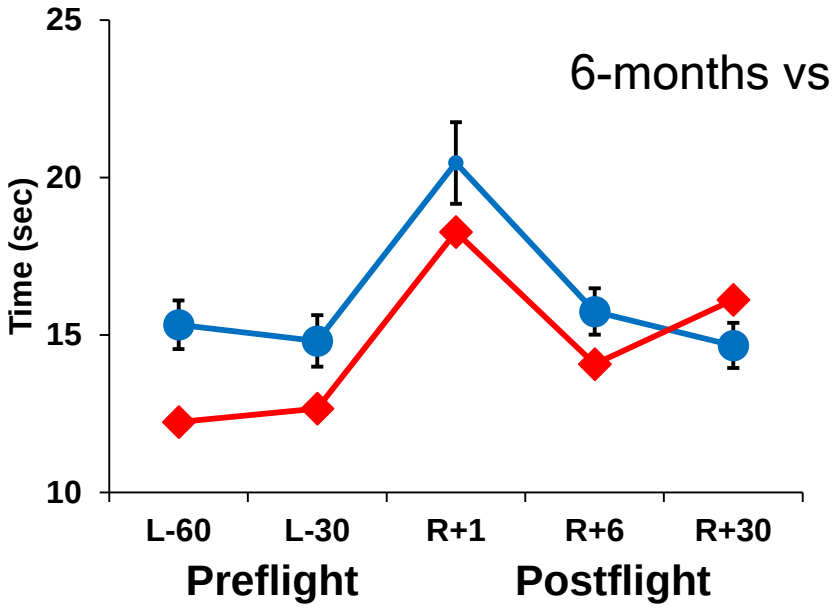
1 year, n=1



6 months, n=1

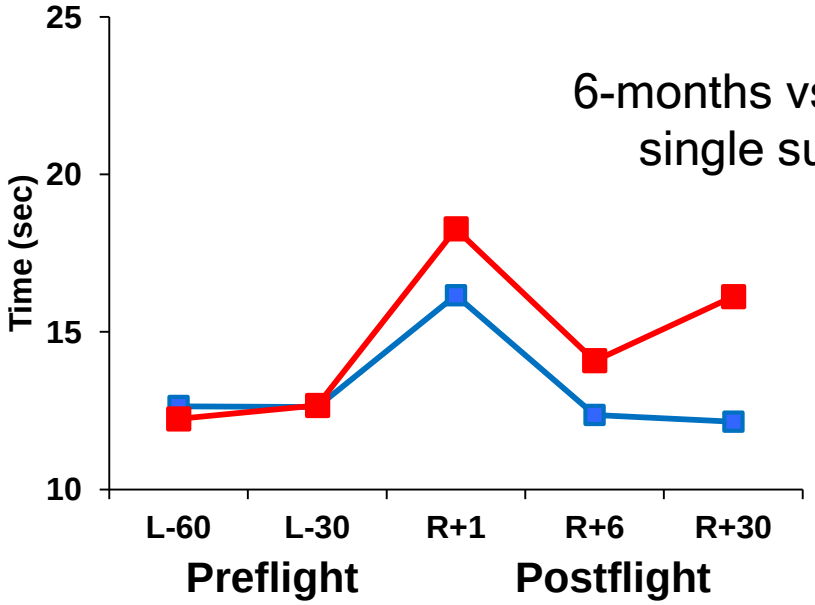
1 year, n=1

Object Translation Test



6 months, n=13

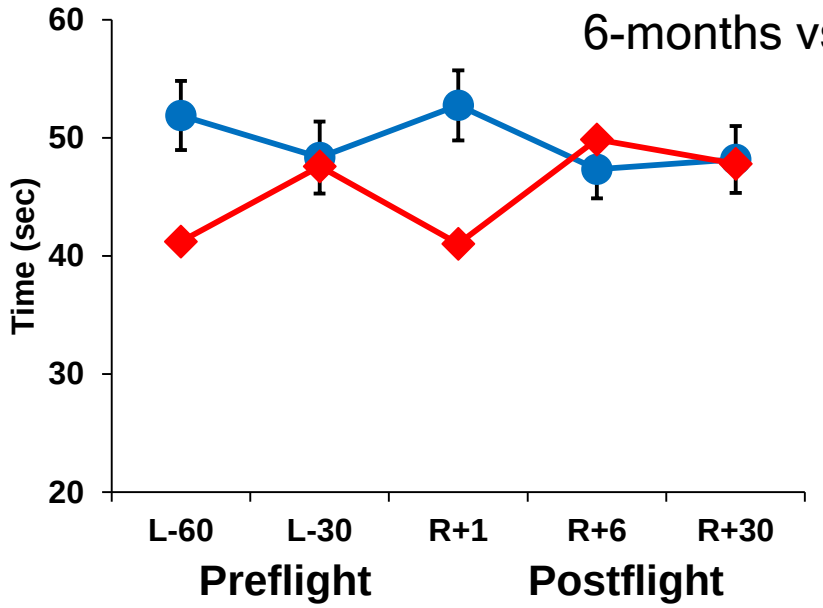
1 year, n=1



6 months, n=1

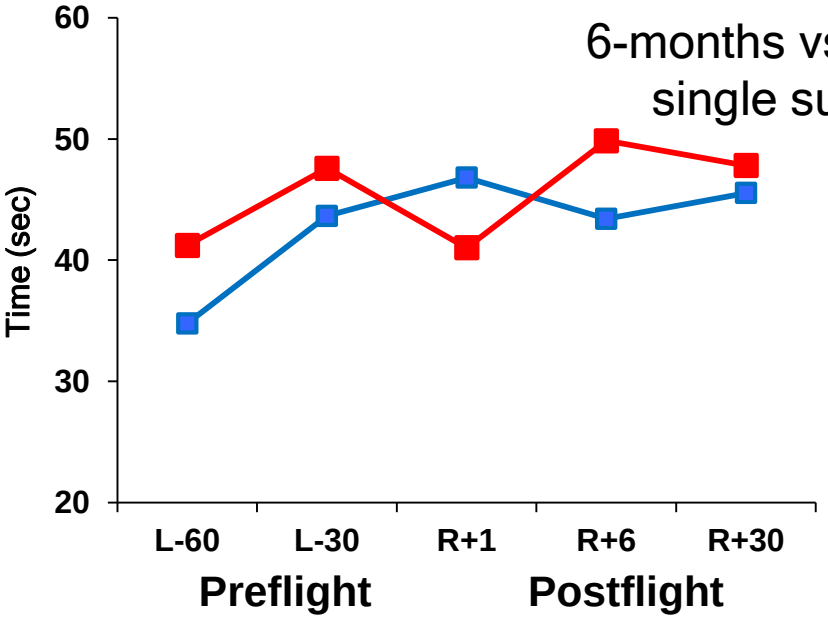
1 year, n=1

Construction Activity Board



6 months, n=13

1 year, n=1

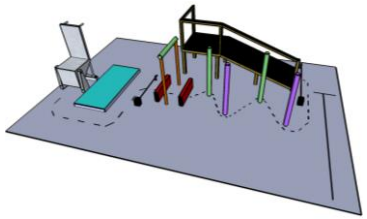


6 months, n=1

1 year, n=1

Functional Tests: 1-year flight duration

Higher Demand for Postural Stability Control

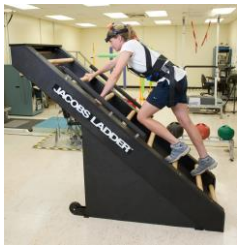


Seat Egress and Walk

Object Translation

Recovery from Fall/Stand

Jump Down



Ladder Climb

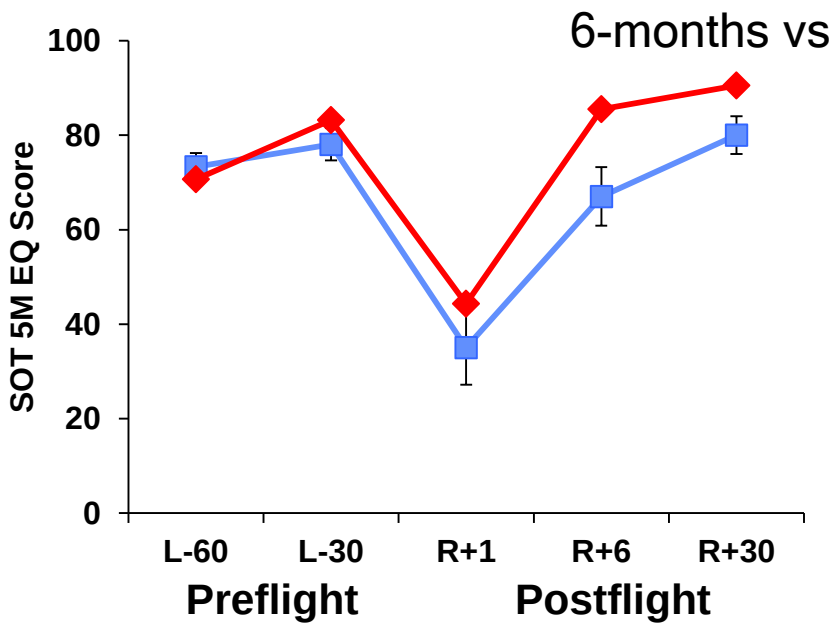
Lower Demand for Postural Stability Control

Hatch Opening

Construction Activity

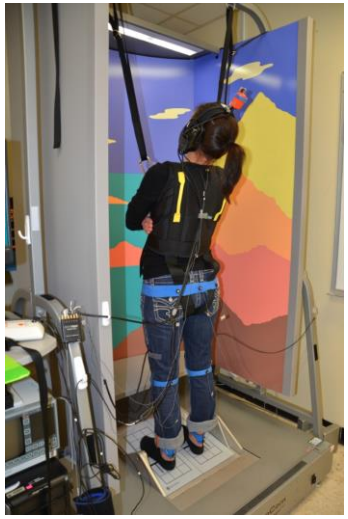
Similar to 6-month flights, the 1-year subject showed greatest deficits in functional tests with higher demand for postural stability control.

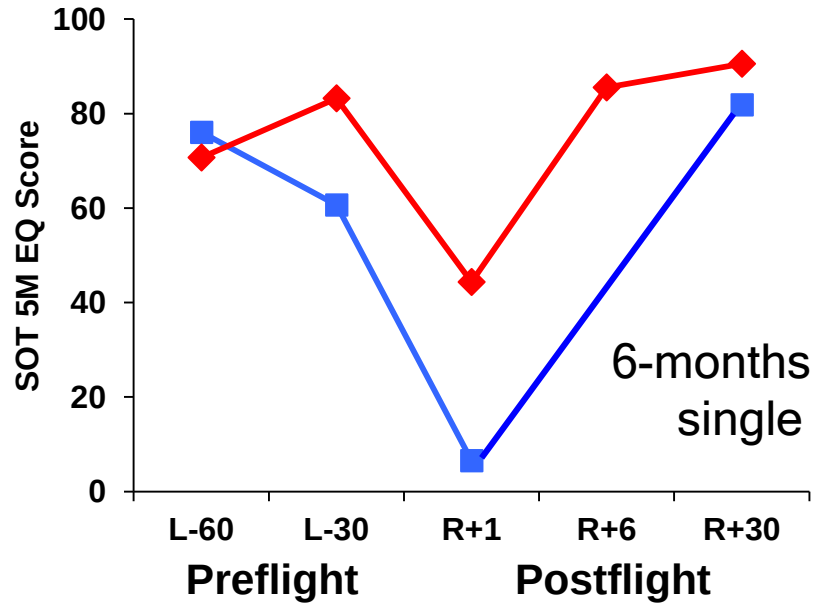
Postural Equilibrium Control



6 months, n=13

1 year, n=1



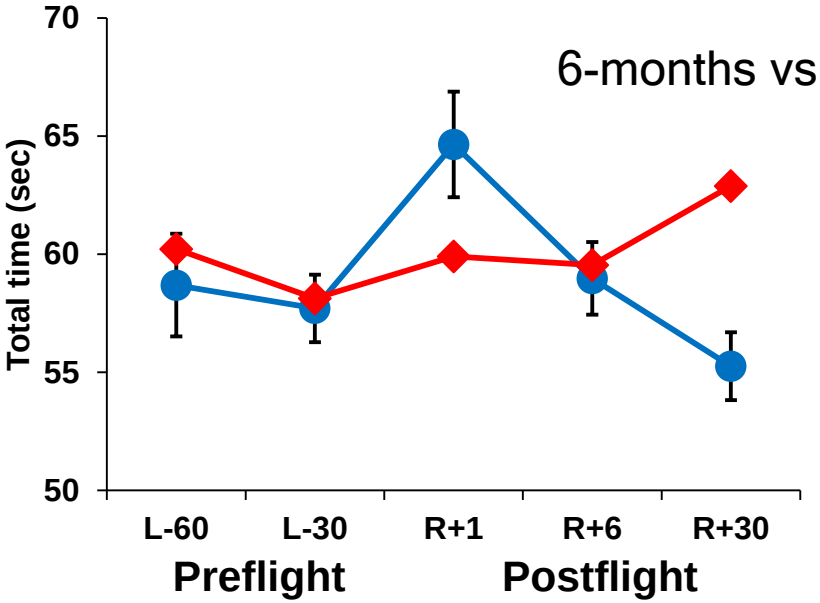


6-months vs. 1-year
single subject

6 months, n=1

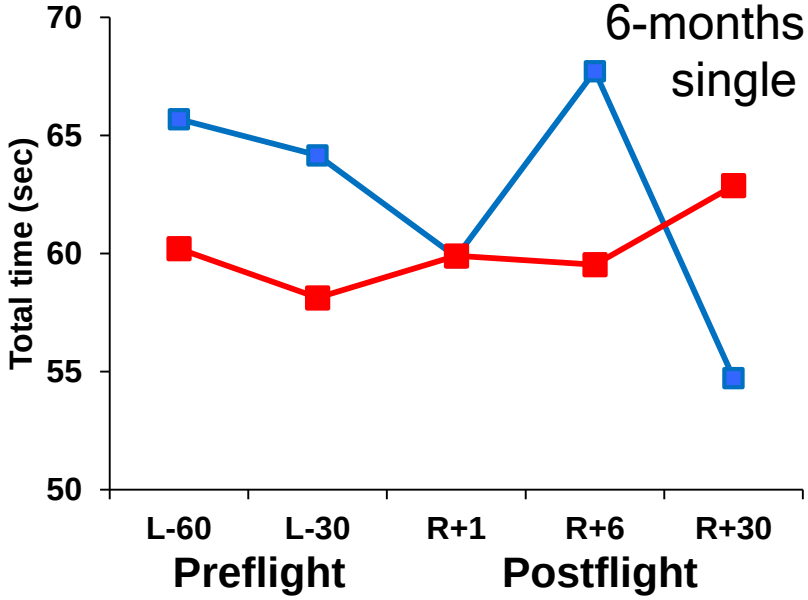
1 year, n=1

Fine Motor Control Test



6 months, n=13

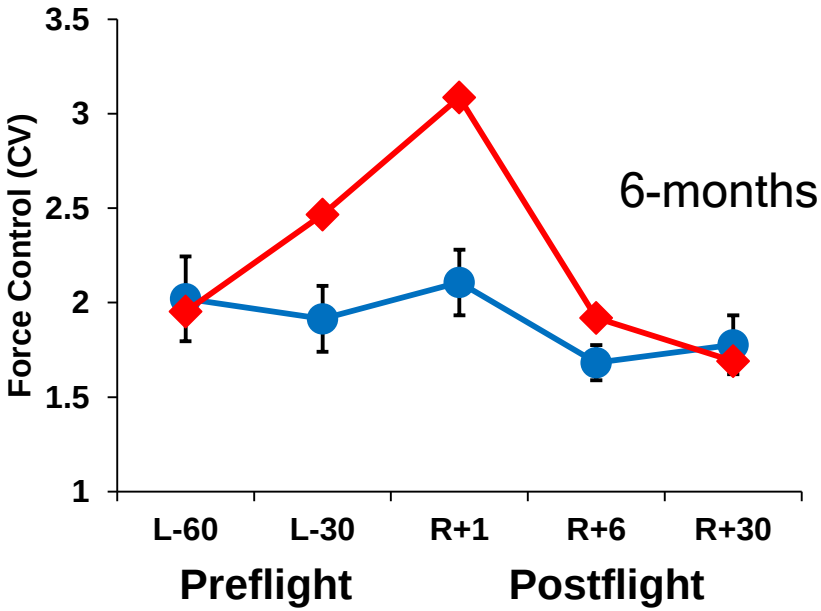
1 year, n=1



6 months, n=1

1 year, n=1

Force Control: With Visual Feedback

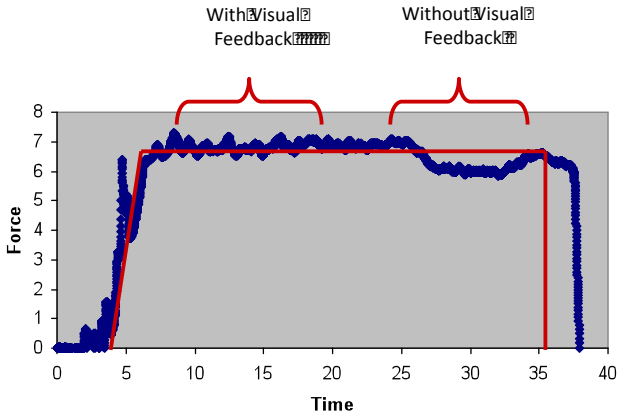


Subject matched leg or arm force with a reference force displayed on computer screen (5% max force)

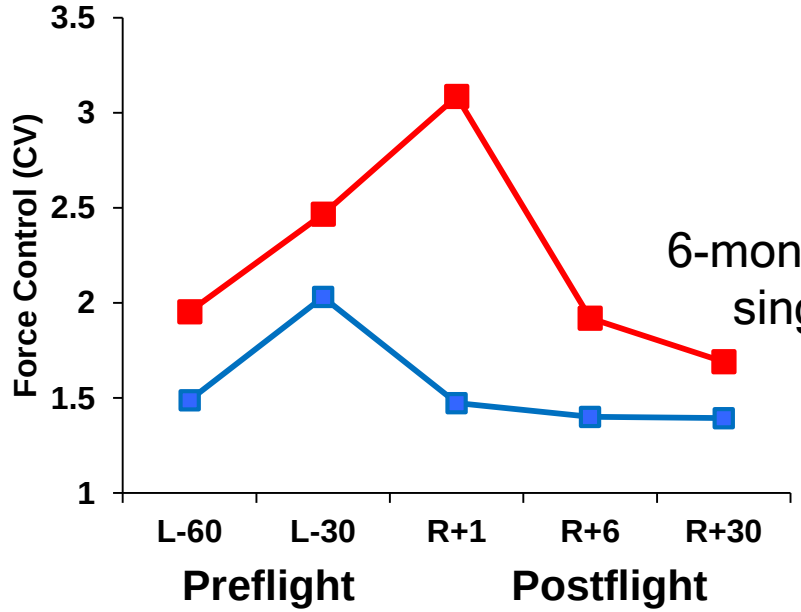
6-months vs. 1-year

6 months, n=13

1 year, n=1



COV = SD force output / mean force output

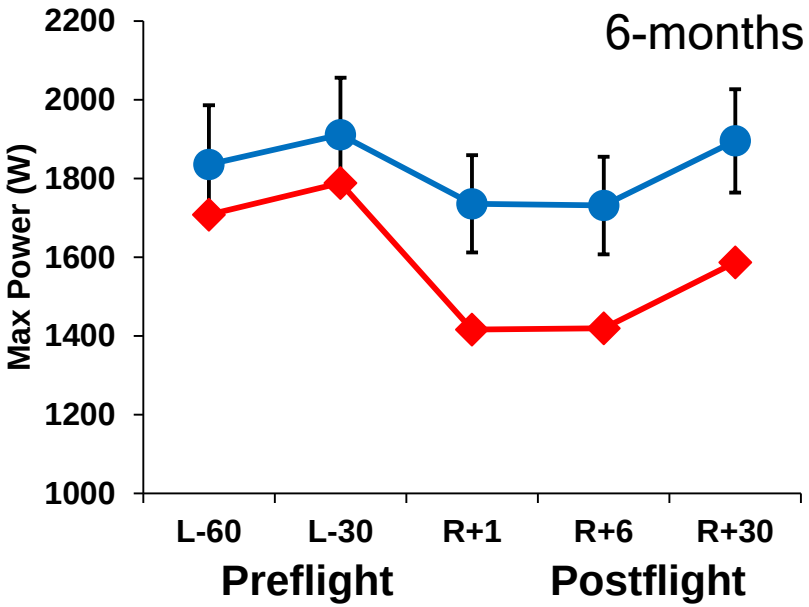


6-months vs. 1-year single subject

6 months, n=1

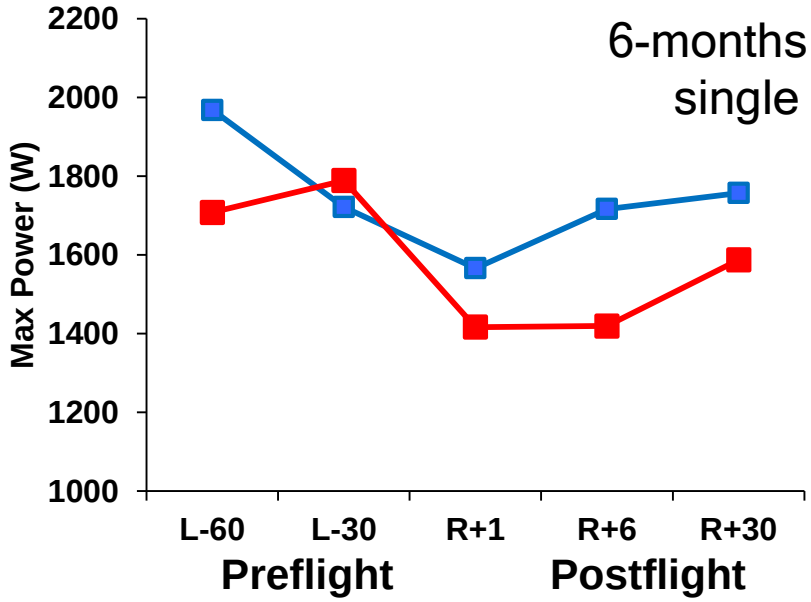
1 year, n=1

Lower Body: Maximum Power



6 months, n=13

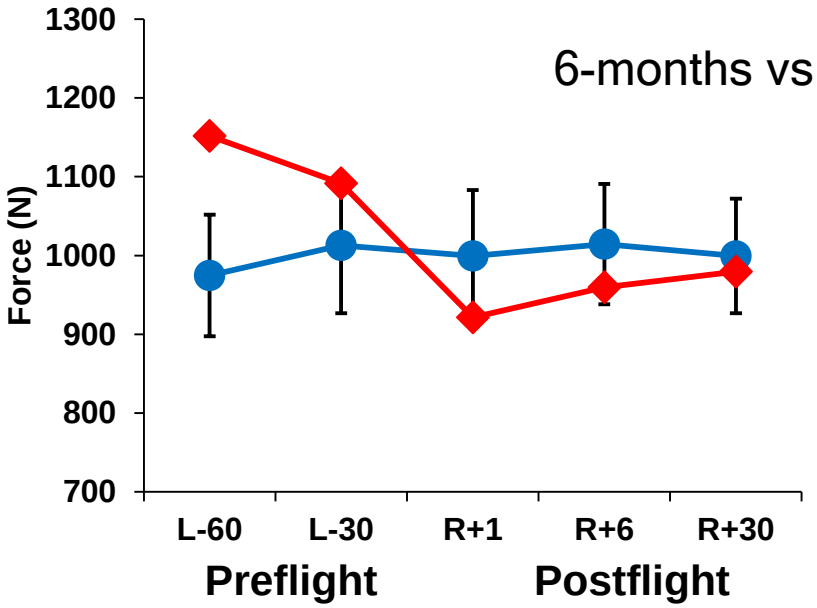
1 year, n=1



6 months, n=1

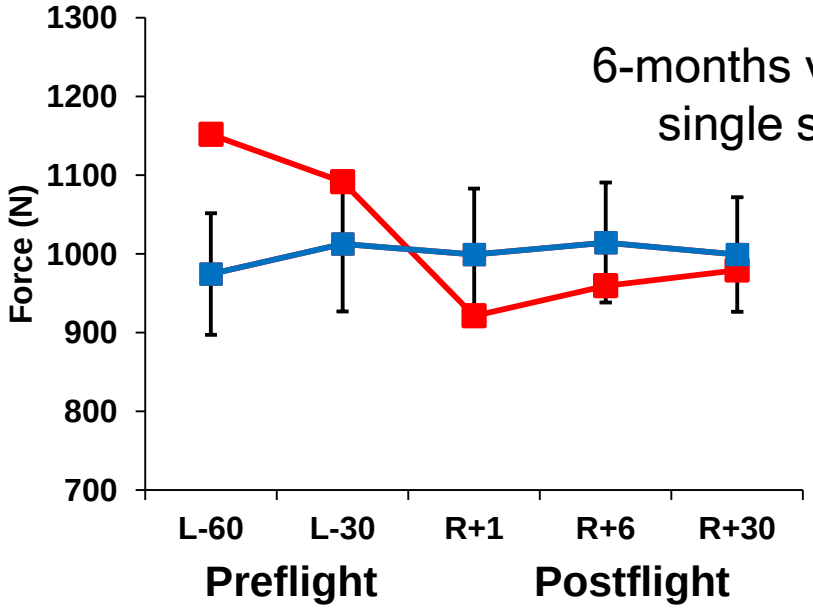
1 year, n=1

Upper Body: Maximum Isometric Force



6 months, n=13

1 year, n=1



6 months, n=1

1 year, n=1

Preliminary Observations

1. One-year subject showed the greatest deficits in functional tests with postural challenges and in sensorimotor tests of balance control.
2. Differences did occur in some measures (postural sway speed, force control, muscle performance) but most measures did not show substantial differences between 6-month and 1-year flight durations.
3. For a single subject there does not appear to be precipitous drop in functional performance after one year – needs to be confirmed with additional subjects.

Acknowledgements

Neuroscience Laboratory

- Elisa Allen
- Crystal Batson
- Eddy Beltran
- Erin Caldwell
- David Campbell
- Jody Cerisano
- Janet Cook
- Elizabeth Fisher
- Nicole Gadd
- Igor Kofman
- Chris Miller
- Ajitkumar Mulavara
- Brian Peters
- Millard Reschke
- Darcy Szecsy
- Laura Taylor
- Scott Wood

Cardiovascular Laboratory

- Natalia Arzeno-Gonzalez
- Susan Bourbonais
- Angela Brown
- Steven Laurie
- Stuart Lee
- Tiffany Phillips
- Steven Platts
- Chris Ribeiro
- Sydney Stein
- Michael Stenger
- Michael Willig

Biostatistics Laboratory

- Alan Feiveson
- James Fiedler
- Robert Ploutz-Snyder

Exercise Physiology Laboratory

- Roxanne Buxton
- Kirk English
- Elizabeth Goetchius
- Jamie Guined
- Lori Ploutz-Snyder
- Jeffrey Ryder
- Joe Sinka