



# **Functional Task Test (FTT)**

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Collaborative study between several labs at NASA-Johnson Space Center

## **Neuroscience Lab**

Jacob J. Bloomberg, Ph.D. (PI)  
Ajitkumar Mulavara, Ph.D.  
Brian T. Peters, Ph.D.  
Millard F. Reschke, Ph.D.  
Scott Wood, Ph.D.  
Emily Lawrence, M.S.  
Igor Koffman, B.S.

## **Exercise Physiology Lab**

Lori Ploutz-Snyder, Ph.D.  
Barry A. Spiering, Ph.D.

## **Muscle Research Lab**

Daniel L. Feedback, Ph.D.

## **Cardiovascular Lab**

Steven H. Platts, Ph.D.  
Michael B. Stenger, Ph.D.  
Stuart M.C. Lee, M.S.  
Natalia Arzeno, M.Eng.

## **Research Statistician**

Alan H. Feiveson, Ph.D.

## **Exercise Countermeasure Project**

Jeffrey Ryder, Ph.D.  
Yamil Garcia, M.S., ATC, CSCS

## **ASCR**

Mark E. Guilliams, M.A., CSCS



# Background



After space flight there are changes in multiple physiological systems:

- Cardiovascular function
- Balance, gait and eye movement control
- Muscular mass, strength and endurance



How do changes in physiological systems impact astronaut functional performance?

Functional Task Test (FTT): interdisciplinary testing regimen has been developed to evaluate astronaut postflight functional performance and related physiological changes.



# Objectives

- Develop a set of functional tasks that represent critical mission tasks for the Constellation Program.
- Determine the ability to perform these tasks after space flight.
- Identify the key physiological factors that contribute to functional decrements.
- Use this information to develop targeted countermeasures.



# Why use ISS to Answer our Research Question?

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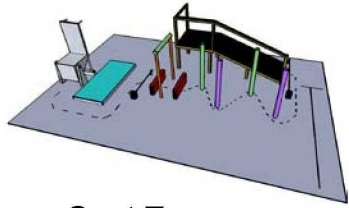


Require an assessment of how multiple physiological systems impact functional performance after long-duration space flight.

Ground based models (e.g. bedrest) do not capture the entire complement of space flight related physiological changes that impact astronaut functional performance.

Require actual space flight to map linkages between physiological changes and functional performance.

# Functional Performance



Seat Egress and Walk



Ladder Climb



Recovery from Fall/Stand



Rock Translation



Construction Activity



Torque Generation

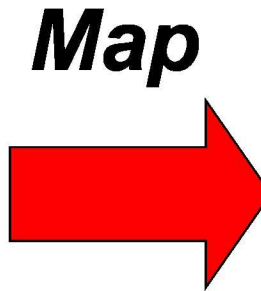


Jump Down

# Physiological Measures

## Muscle

- Strength
- Power
- Control
- Neuromuscular Drive



## Sensorimotor

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



## Cardiovascular

- Plasma Volume





# Mapping to Critical Mission Tasks

<b>Critical Mission Tasks Identified by Constellation</b>	<b>Representative Functional Test</b>
Ingress/Egress Vehicle/Habitat/CEV	<i>Seat Egress and Walk Jump Down</i>
Ladder/Climb and Descend	<i>Ladder Climb</i>
Recovery from Fall/Near Fall	<i>Recovery from Fall/Stand</i>
Lift and Carry Objects	<i>Rock Translation</i>
Open/Close Hatch	<i>Torque Generation</i>
Assembly, Construction and Repair Activities	<i>Construction Activity Board</i>



# Instrumentation for Functional Testing

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Body motion sensors on head and trunk: kinematics

Holter monitor: EKG

Portapress: continuous blood pressure





# Functional Tests

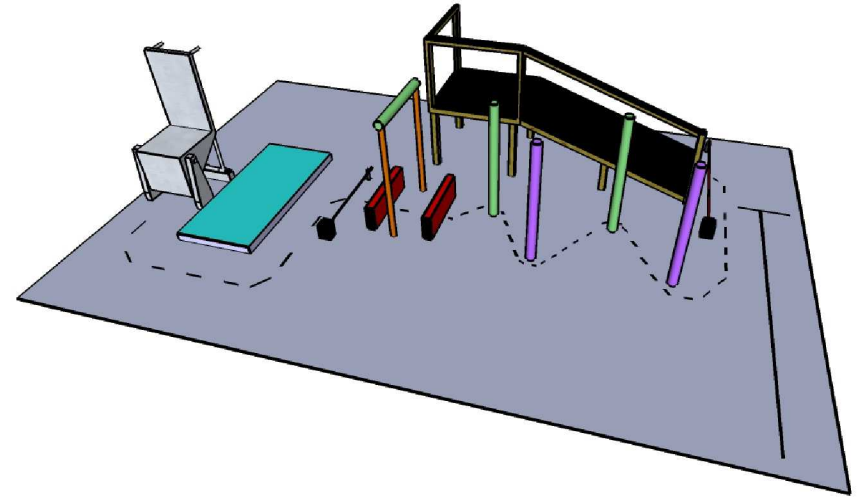


## 1) Seat Egress and Walk Test:

Unbuckle a harness, get up from a seat and complete an obstacle course. Testing will occur with:

- a) seat upright.
- b) seat positioned with its back to the floor.

Tandem heel-to-toe walk test with eyes closed.



## 2) Recovery from Fall/Stand Test:

Stand up as quickly as possible and then step on a solid floor and remain standing for 3 minutes.







# Functional Tests (cont.)



### 3) Ladder Climb:

Climb 40 rungs on a passive treadmill ladder at a self-generated pace.



### 4) Torque Generation:

Apply torque to a wheel assembly while standing:

- Wheel fixed: Apply peak torque.
- Wheel is free to move with constant resistance. Subject turns wheel as many times in 20 s. (50% preflight peak).



### 5) Rock Translation:

Transfer three weights (6, 10, 20 lbs) with handles, one at a time, a distance of 8 feet and place in a receptacle and then transfer the weights back to the initial receptacle.





# Functional Tests (cont.)



## 6) Construction Activity Board:

Connect hoses to receptacles and mate a series of electrical connectors to the appropriate receptacles. Remove and replace bolts on a handle assembly using a cordless power tool.



## 7) Jump Down:

Jump down from a platform with a height of 30 cm onto a force plate. Surface electromyographic electrodes will be placed on the leg to assess neuromuscular activation patterns.





# Physiological Tests



## Sensorimotor Tests

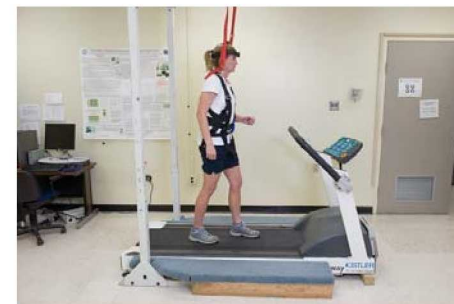
1) **Postural Stability**: Maintain balance on sway-referenced support surface with eyes closed. This test will be performed with and without head movements.



2) **Fine Motor Control**: Place 25 keyed pegs into their corresponding slots while seated.



3) **Gait Control/Dynamic Visual Acuity**: Walk at 6.4 km/h for 90 s on a treadmill while performing a dynamic visual acuity (DVA) test consisting of identifying gaps in the letter C presented on a computer screen.





# Physiological Tests (cont.)



## Cardiovascular Test

### 4) Plasma Volume

Determined using a carbon monoxide rebreathing method.

Safe and reliable method; used by the JSC Cardiovascular Laboratory since 1992.

### **Methods**

- 1) Initial blood sample of 3 ml drawn.
- 2) Breathe 100% oxygen on a closed breathing circuit for 2 minutes.
- 3) Sixty ml of carbon monoxide injected into the breathing circuit.
- 4) Rebreathe this mixture for 10 minutes.
- 5) Second blood sample of 3 ml drawn.





# Physiological Tests (cont.)



## Muscle Performance Tests

### 5) *Leg Press: Lower Body Force, Power and Endurance*

- a) Maximum Isometric Force: Subject pushes against a fixed force plate.
- b) Power/Endurance: Subject pushes a weight away as fast as possible (40% max force, 21 repetitions, ballistic, concentric only, magnetic brake catches weight).





# Physiological Tests (cont.)



## Muscle Performance Tests

### **6) *Knee Extension: Lower Body Force Control and Neuromuscular Drive***

a) Force Control: Subject matches leg force with a reference force displayed on computer screen during isometric leg extension (5% max force).

b) Neuromuscular Drive: Twitch interpolation method; electrical muscle stimulus is provided to thigh muscle during isometric leg extension.





# Physiological Tests (cont.)



## Muscle Performance Tests

### **7) *Bench Press: Upper Body Force, Power and Endurance***

- a) Maximal Isometric Force: Subject pushes against fixed bar.
- b) Power/Endurance: Subject pushes a weight away as fast as possible (30% max force, 21 repetitions, ballistic, concentric only, magnetic brake catches weight).
- c) Force Control: Match isometric arm force with a reference force displayed on a computer screen (5% maximal force).





# Testing Schedule



<b>Preflight</b>	<b>Postflight</b>
L-180, L-60, L-30	<u>Shuttle</u> : R+0, R+1, R+6, R+30  <u>ISS</u> : R+1, R+6, R+30

## Current Crew Participation:

Shuttle Flights: STS-128, 129, 131

ISS Flights: 22/23, 23/24





# Earth Benefits



This research has direct application in the design of clinical interventions and rehabilitation programs for patient populations that experience alterations in multiple physiological systems leading to decline in functional performance (e.g. the elderly).

Interventions can be tuned to target the specific physiological systems responsible for changes in functional performance.