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# Gait Stability after Exposure to 3-day Simulated Microgravity and Functional Outcome of Support Afferentation

**Mari Murumets**

*MSc Space Physiology and Health*

# Introduction

- **Maladaptation of physiological systems after exposure to microgravity**
  - ⇒ Impaired functional performance
  - ⇒ Inability to perform emergency operations
  - ⇒ Increased risk of fatality

- **Increased number of errors in heel-to-toe tandem walk**
  - ⇒ 70-day bed-rest study
  - ⇒ Space flight (Reschke et al. unpublished data - NASA)

- **Support afferentation**
  - ⇒ Neuromuscular system (Kozlovskaya et al., 2006,2007)
  - ⇒ Force-velocity properties of leg muscles (Grigor'ev *et al.*, 2004; Moukhina *et al.*, 2004)
  - ⇒ Venous compliance/orthostatic intolerance (Vinogradova et al., 2002; Kozlovskaya et al., 2006)

## Functional Outcome:

- **Soviet-Cuban mission – better organised and more stable walking cyclogram**

(Hernandez-Korwo *et al.*, 1983)

- **Melnik et al. (2006) – improved locomotor stability**

- **Reschke et al. (2009) – improved time to complete the Functional Mobility Task**

# Aim and Hypotheses

The aim of the study:

1) Assess tandem walking performance and related dynamic balance parameters after exposure to simulated microgravity
2) Investigate the functional significance of support afferentation

Hypotheses:

- I hypothesized that functional deficit will be most profound immediately after the exposure to simulated weightlessness and show signs of recovery 24h later

- Mechanical stimulation of support zones would reduce the magnitude of post-immersion performance impairment and improve the rate of recovery

# Methods

Table 1. Subject Characteristics

| | N | Height (cm) | Weight (kg) |
|---|---|---|---|
| Control | 7 | 175.9±6.3 | 68.6±4.6 |
| Treatment | 6 | 177.8±3.9 | 66.7±7.6 |
| **Total** | **13** | **176.8±5.2** | **67.7±5.9** |

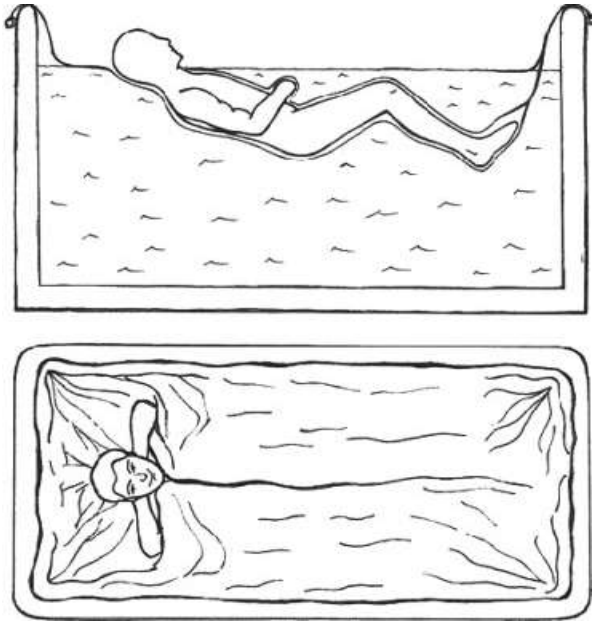


Fig. 1 Dry-immersion

Fig. 2 Mechanical foot stimulator "KORVIT"

**Protocol:**

- 3-day dry-immersion

- **Treatment group** – foot support zone stimulation in the regime of walking:
  - pressure of 0.4kg/cm$^2$
  - 20min/hour
    - 10min – 75steps/min
    - 10min – 120steps/min
  - 6 sessions/day

- **Heel-to-toe tandem walking along the line:**
  - Pre-immersion
  - Post-immersion (<3h)
  - Recovery (approx. 24h)
    - 5X eyes open
    - 5X eyes close

# Methods

## Data acquisition:

- Infrared movement analysis system
  - Four infrared cameras
  - 10 infrared markers on the body
  - 3-6 infrared markers on the floor line
- Video recording for post-testing scoring

## Measurments:

1) Errors defined as sidestepping or leaving gap between heel and toe during double support phase
2) Stance time duration
3) Veering from the straight line

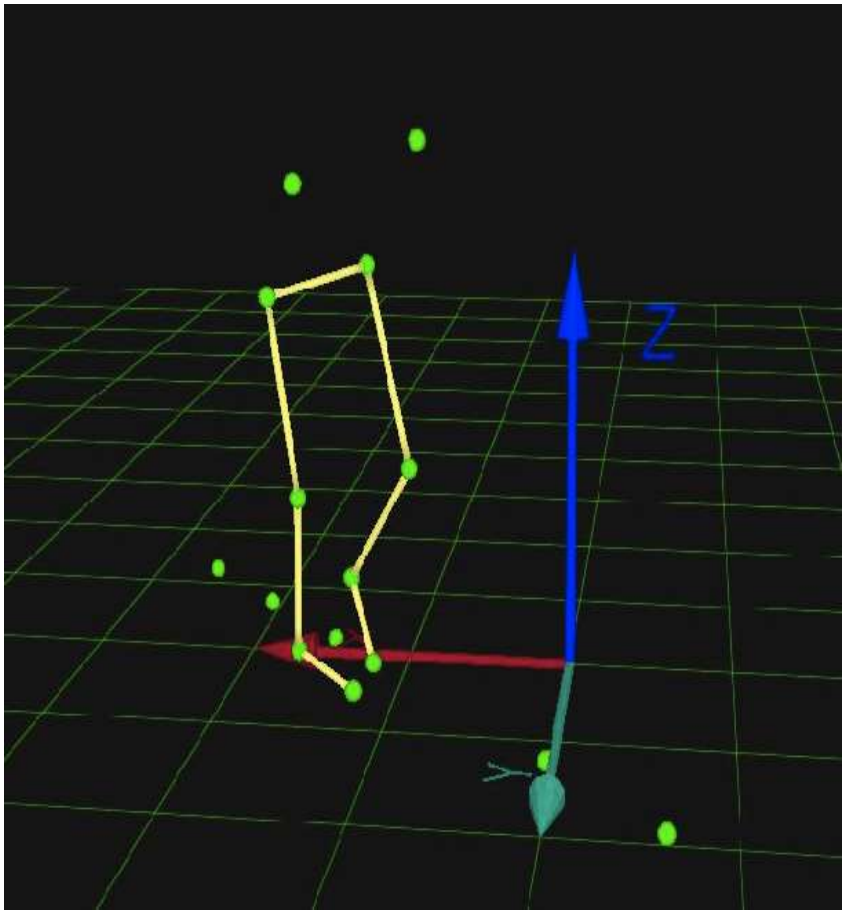
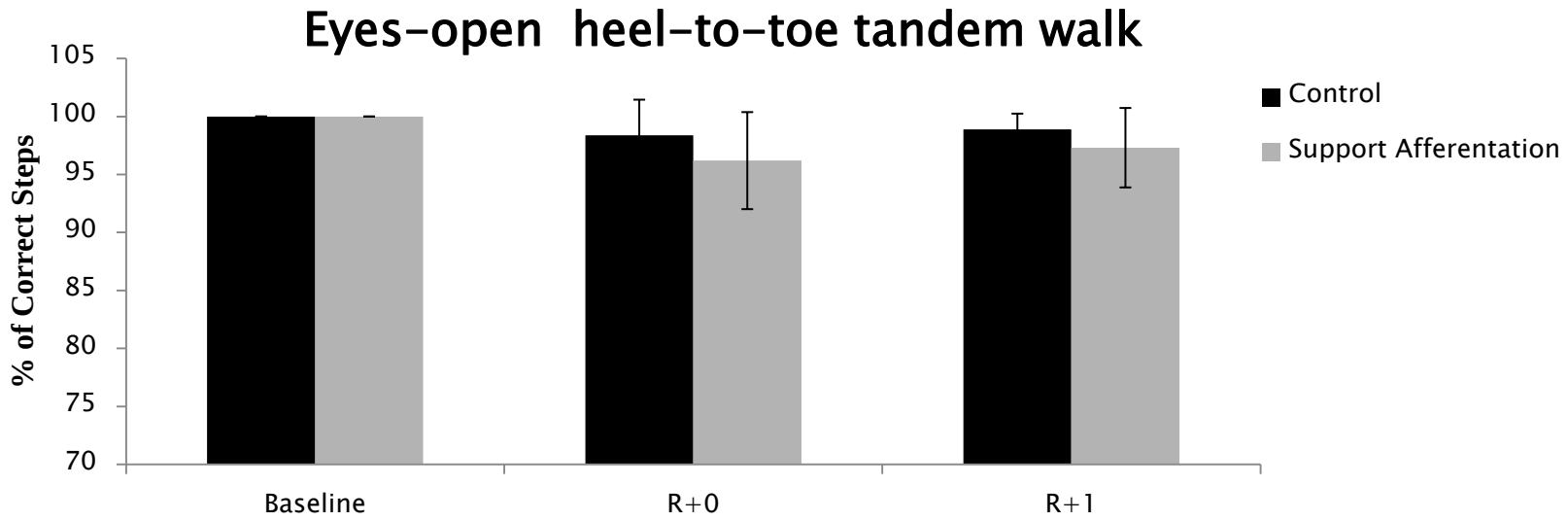
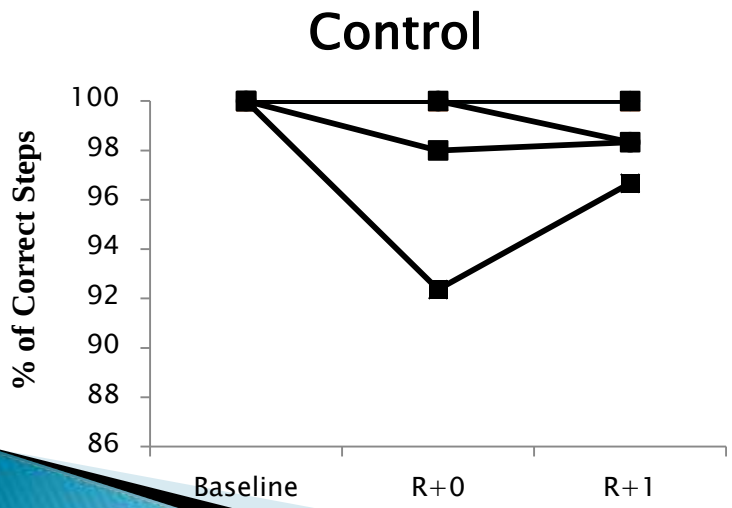
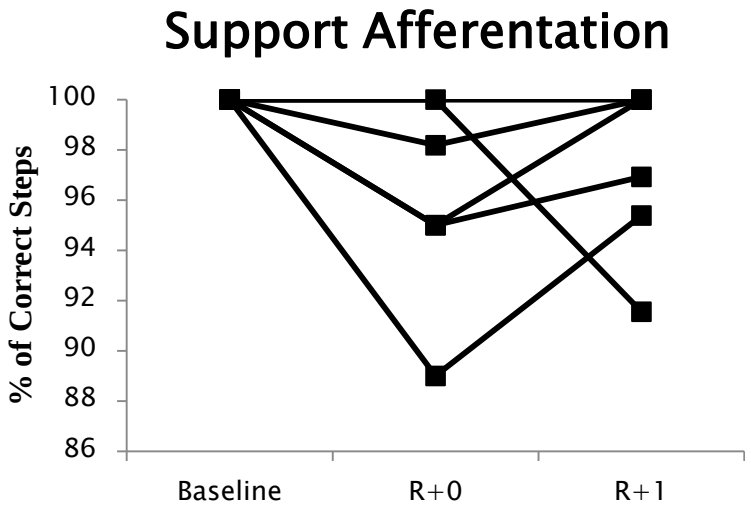



**Fig. 3** Qualisys Track Analysis

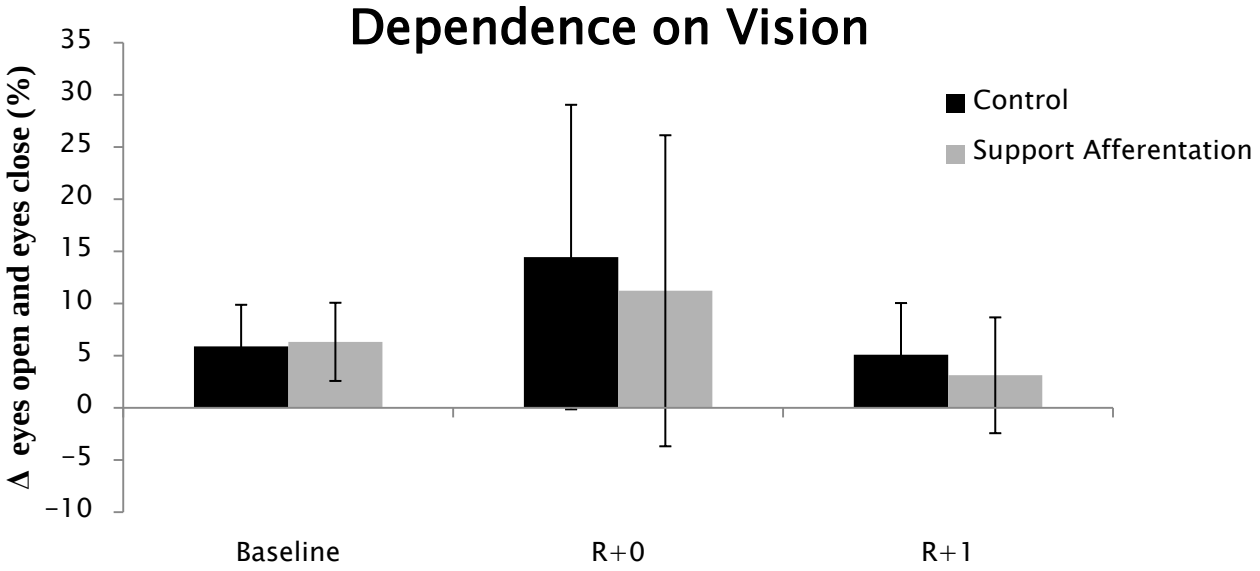
# Results

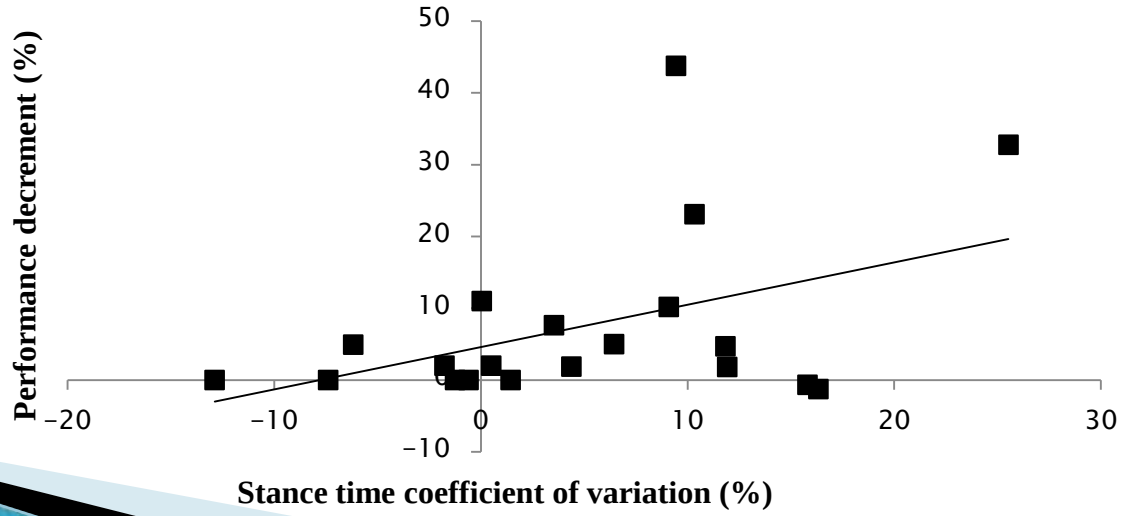

Eyes-open heel-to-toe tandem walk
% of Correct Steps
105
100
95
90
85
80
75
70
Baseline
R+0
R+1
Control
Support Afferentation


Control
% of Correct Steps
100
98
96
94
92
90
88
86
Baseline
R+0
R+1


Support Afferentation
% of Correct Steps
100
98
96
94
92
90
88
86
Baseline
R+0
R+1

# Results


Dependence on Vision
Control
Support Afferentation
Δ eyes open and eyes close (%)
35
30
25
20
15
10
5
0
−5
−10
Baseline
R+0
R+1


Performance decrement (%)
50
40
30
20
10
−10
−20
−10
0
10
20
30
Stance time coefficient of variation (%)

# Discussion

**3-day dry-immersion has no significant effects on heel-to-toe tandem walk**

=> Contradicting preliminary bed-rest and space flight data (Reschke et al. unpublished – NASA)

- **Great variability between individuals**

=> Some crew members might experience functional deficits even after short-duration flights

**No effect of support afferentation**

=> Could improve dependence on vision
=> Could facilitate recovery

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