



FUNCTIONAL TASK TESTS IN PARTIAL GRAVITY DURING PARABOLIC FLIGHT

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BACKGROUND

- Understanding how functional tasks are performed in partial gravity (partial-g) is necessary to define effective and comprehensive countermeasure strategies for preserving crew performance during exploration-class missions, such as on the Moon or Mars.

OBJECTIVES & HYPOTHESES

- We studied the performance of well-established functional tasks during the partial-g phases of parabolic flight (**0.25g, 0.5g, and 0.75g**).
 - These tasks have been used to characterize changes in 1G performance before and after 6-month stays on the International Space Station (ISS) and 70-day bed rest.
- We hypothesized that the acute effects of partial gravity on vestibular, proprioceptive, and sensorimotor functions would negatively impact performance

METHODS

- Novespace, Mérignac, France:
 - 12 subjects (6F, 6M, 40.2 ± 8.5 yrs).
 - 4 subjects and 30 parabolas each flight:
 - 10 parabolas each partial-g level.
 - Additional testing during 1g phases.
- Data collection: Opal inertial measurement units, Bertec Forceplate, GoPros, and Polar heart rate monitors
- Separate Ground Control Group:
 - 14 subjects (6F, 8M, 29.4 ± 7.8 yrs)



Read the full publication here: doi.org/10.1038/s41526-024-00422-3 (Clément et al., *npj Microgravity*, 10(1):86, 2024)

RESULTS

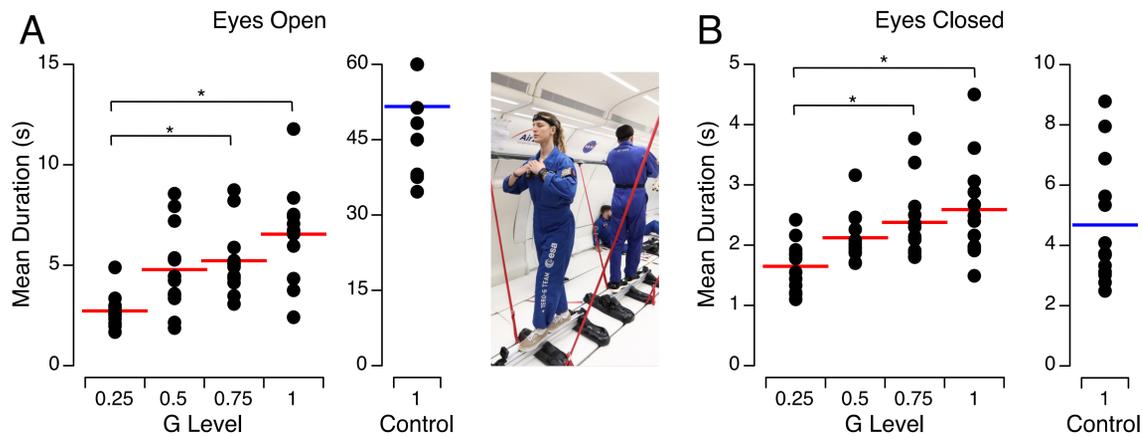


Figure 1. Tandem Stance Rail Balance (4.5cm-wide rail) with eyes open (A) and eyes closed (B). Note: different scales in durations between 1 g in the laboratory (Control, 1) and 1 g in the aircraft (G level, 1). * p < 0.05 (Bonferroni-adjusted)

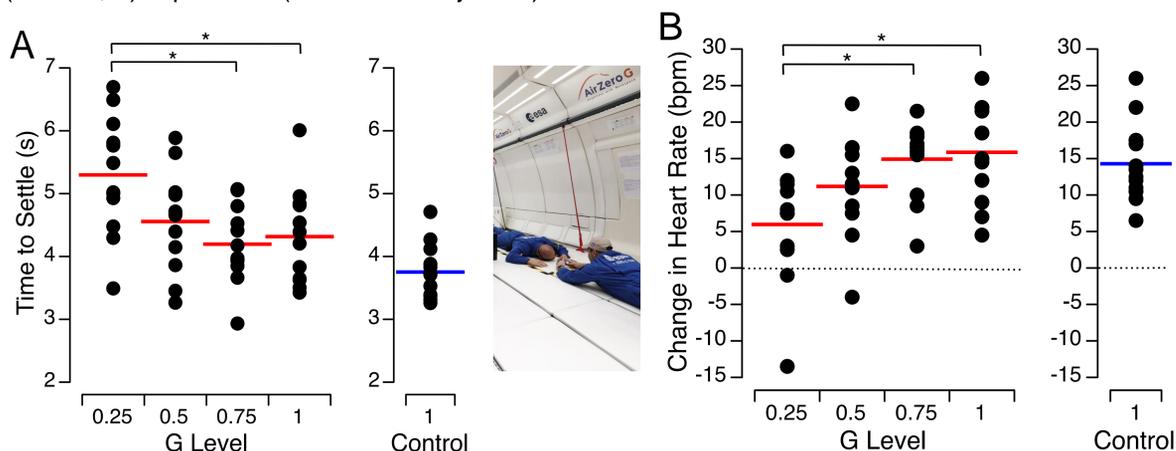


Figure 2. Recovery From Fall – lying prone to stabilizing upright stance. Time to settle (A) and change in heart rate (B). *p < 0.05.

RESULTS

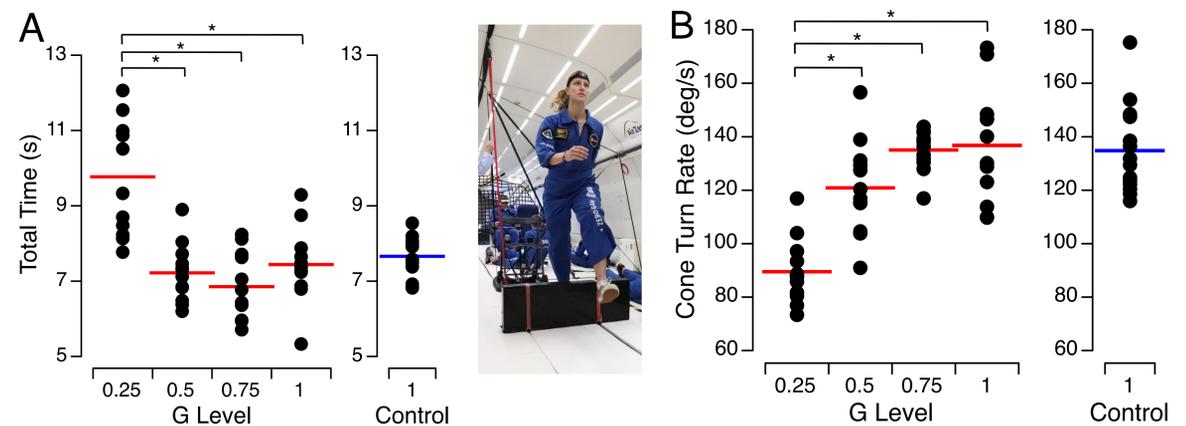
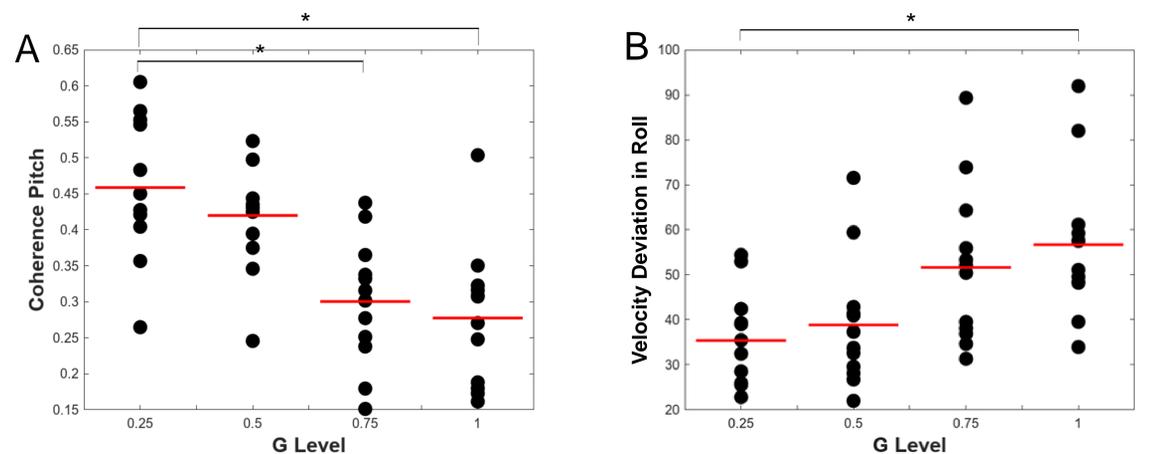


Figure 3. Seat Egress and Walk (4m walk, 30cm-tall obstacle). Time to complete (A) and 180-degree cone turn rate (B). * p < 0.05 (Bonferroni-adjusted)



(New Results) Figure 4. Head-trunk coordination measures during the Seat Egress and Walk task. Magnitude-squared coherence (MSQ) in pitch (A) and velocity root mean square deviation (RMSD) in roll (B). *p < 0.05.

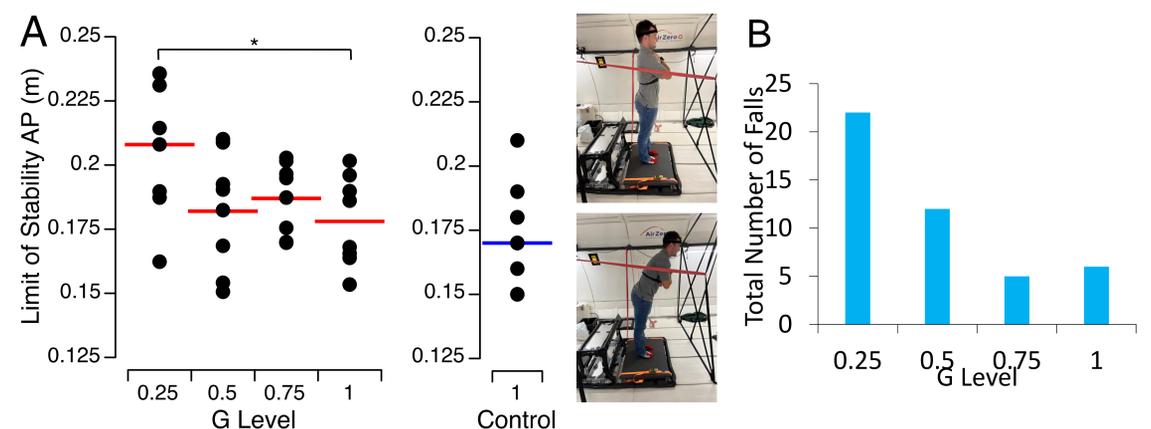


Figure 4. Limits of stability test – maximum lean about the ankle in the anterior and posterior directions (A). *p < 0.05. Total number of falls across subjects/trials during this test (B).

DISCUSSION

- Assess performance risks (e.g., gravitational dose-response curve).
 - At lower gravity levels, there is a lack of gravitational reference for the perception of upright.
- Determine the minimum g-level for artificial gravity - performance was similar in 0.75g and 1g.
- Inform the design of countermeasures for exploration-class human missions.

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