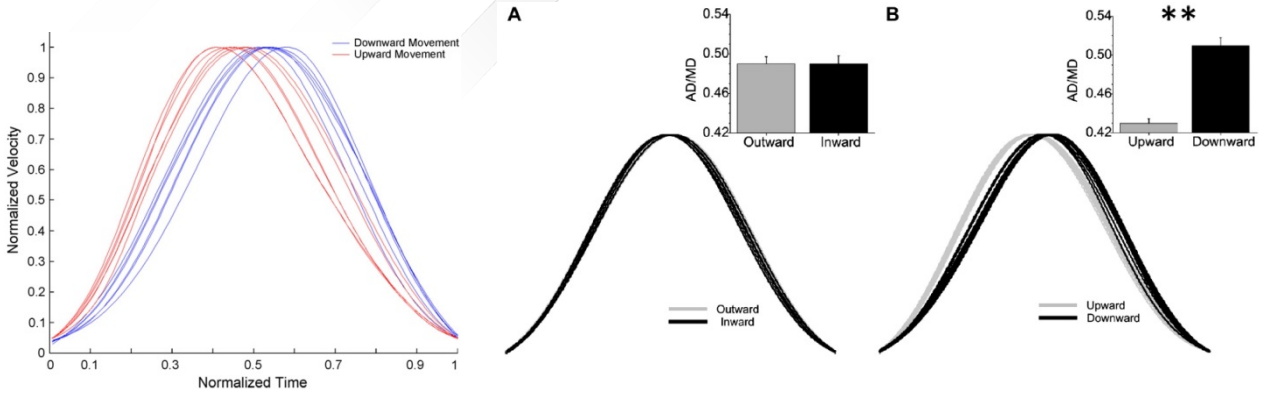
# *INITIAL STATE ESTIMATES OF g-FORCE FIELD SHAPE MOTOR CONTROL OF GOAL-DIRECTED MOVEMENTS*

**Lionel Bringoux**
lionel.bringoux@univ-amu.fr

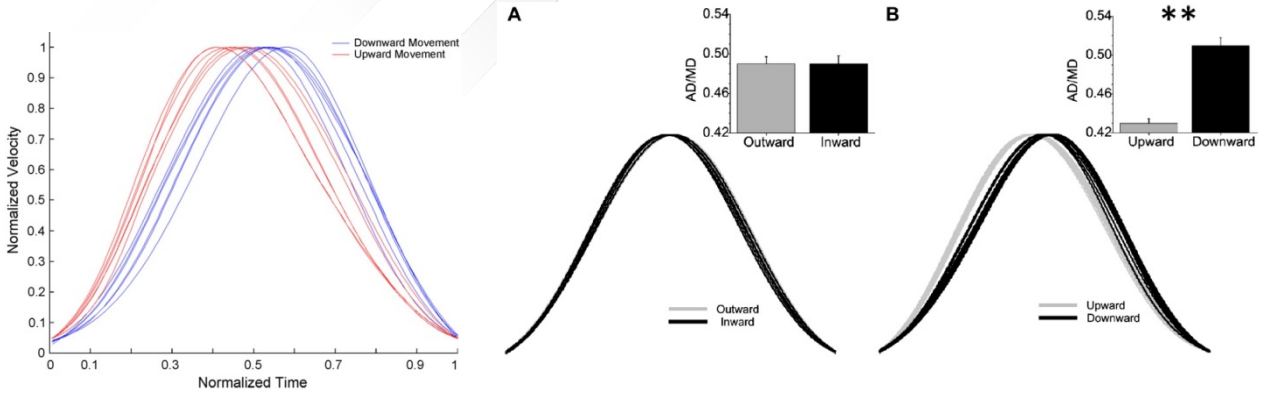
# Gravity and motor behavior on Earth

- Direction-dependent kinematic asymmetries in arm movements
  (Papaxanthis et al., 1998; 2003; Gentili et al., 2007; Le Seac'h & McIntyre, 2007; Sciutti et al., 2012; Gaveau et al., 2014)

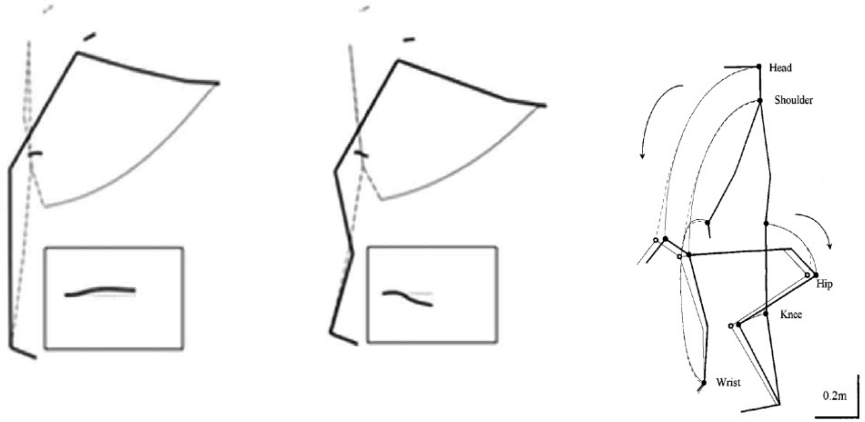


# Gravity and motor behavior on Earth

- Direction-dependent kinematic asymmetries in arm movements
  (Papaxanthis et al., 1998; 2003; Gentili et al., 2007; Le Seac'h & McIntyre, 2007; Sciutti et al., 2012; Gaveau et al., 2014)




- Control of Center of Mass projection
  (Babinski, 1899; Massion et al., 1992; 2004; Vernazza et al., 1996)



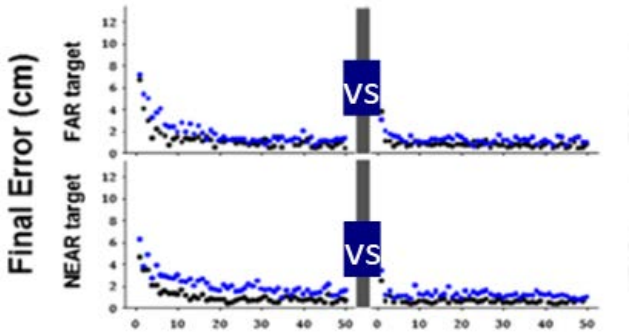

Spatiotemporal structure of focal component

**Gravity =**
Ubiquitous force playing a major role in motor control

Postural settings and synergies

# Pending questions…

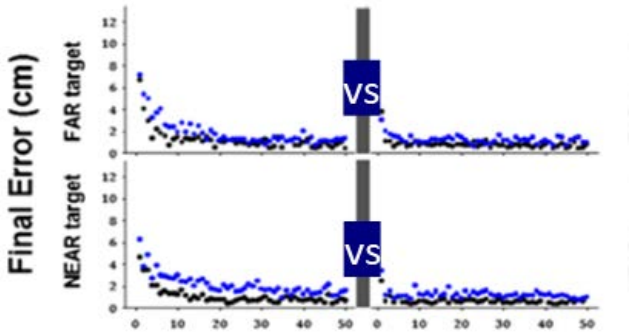
- Adaptation to a novel g-force field?




- Slow/fast adaption vs recalibration?
- Contextual?

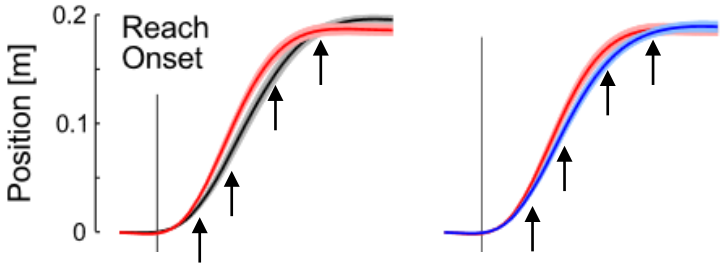
# Pending questions…

- Adaptation to a novel g-force field?



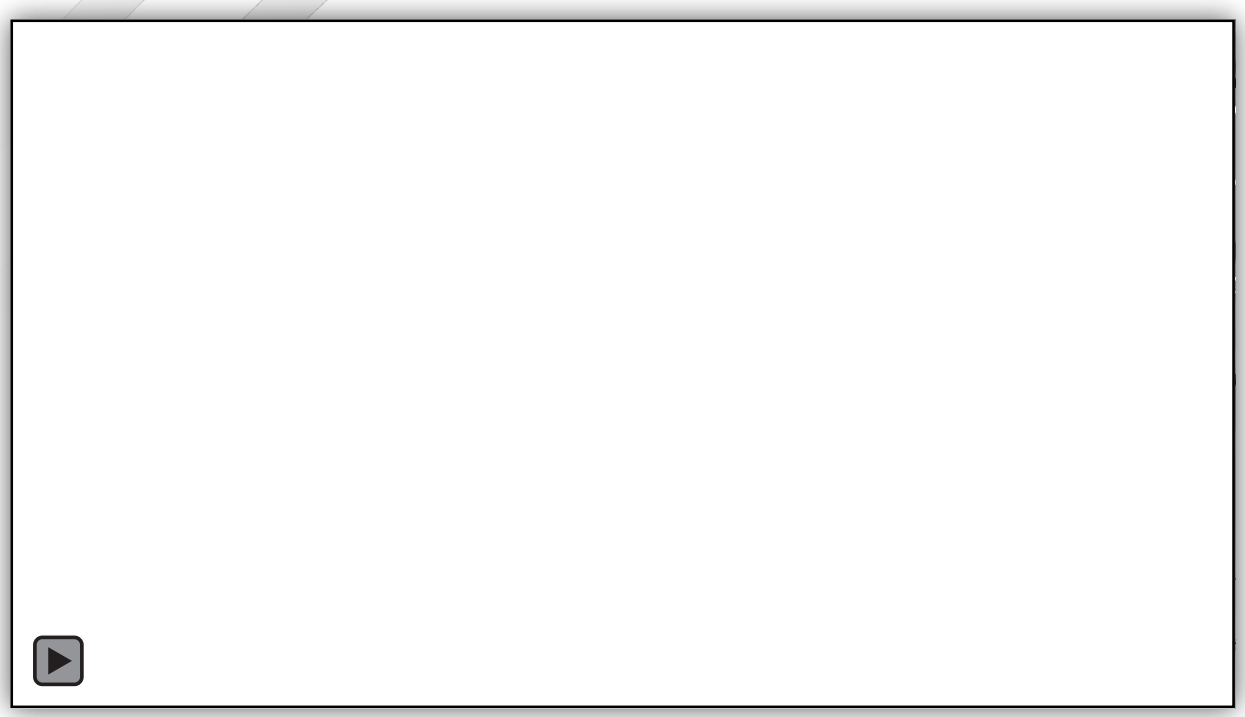

- Slow/fast adaption vs recalibration?
- Contextual?

- Online motor adjustments?




- Earliest changes or late corrections?
- Prior info / initial state estimates?

# A main focus on whole-body goal-directed reaching



- Feedforward and feedback control in 0g vs 1.8g

# Whole-body reaching in 0g

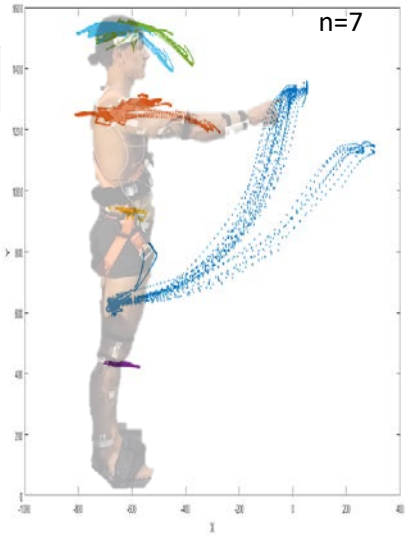
frontiers in Physiology

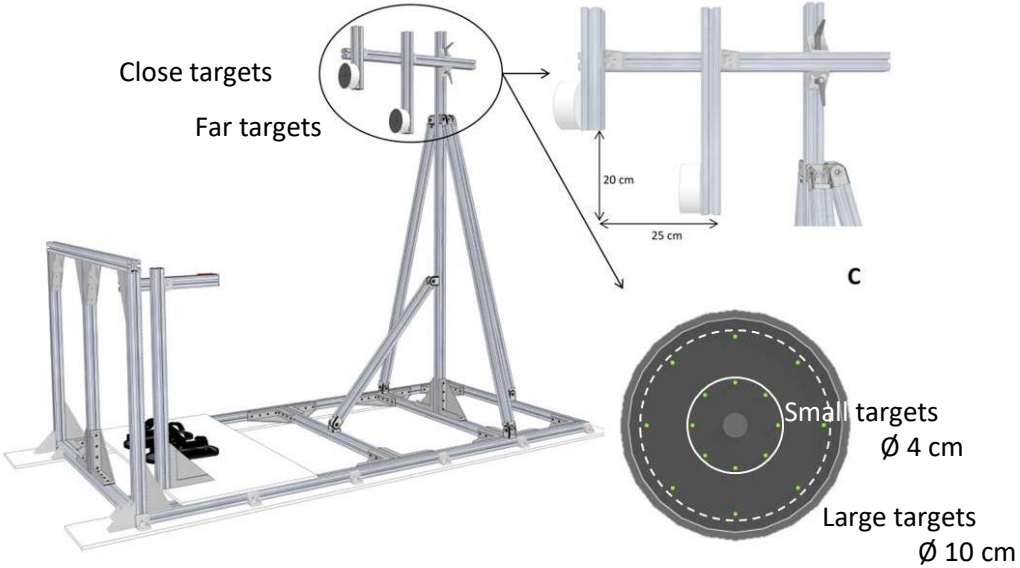
ORIGINAL RESEARCH
published: 20 October 2017
doi: 10.3389/fphys.2017.00821

## Sensorimotor Reorganizations of Arm Kinematics and Postural Strategy for Functional Whole-Body Reaching Movements in Microgravity

*Thomas Macaluso[1], Christophe Bourdin[1], Frank Buloup[1], Marie-Laure Mille[1,2,3], Patrick Sainton[1], Fabrice R. Sarlegna[1], Jean-Louis Vercher[1] and Lionel Bringoux[1]**

# Whole-body reaching in 0g

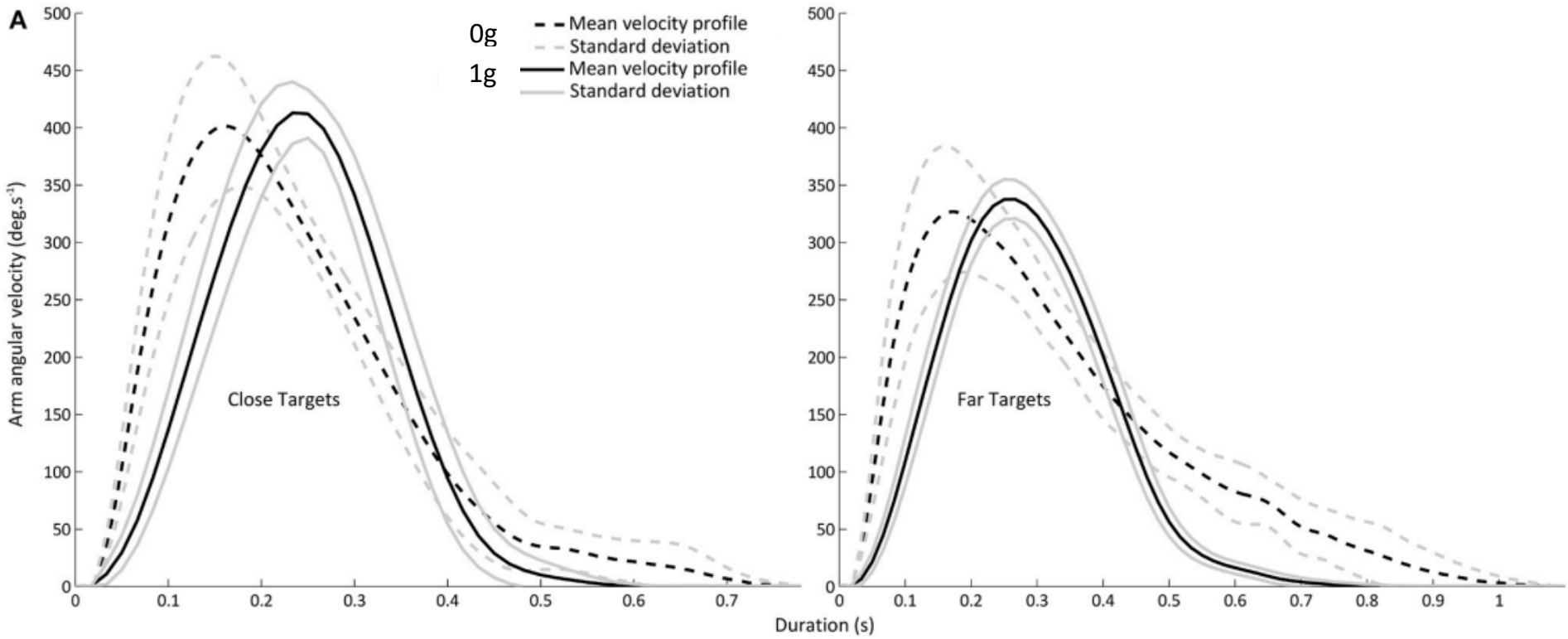




- Reaction time unaffected in 0g
- Success rate preserved (>95%)
- Final deviation to target center: larger in 0g for large targets (1,3 vs 0,7 cm; p <.01)
- No learning effect during the session (40 trials)

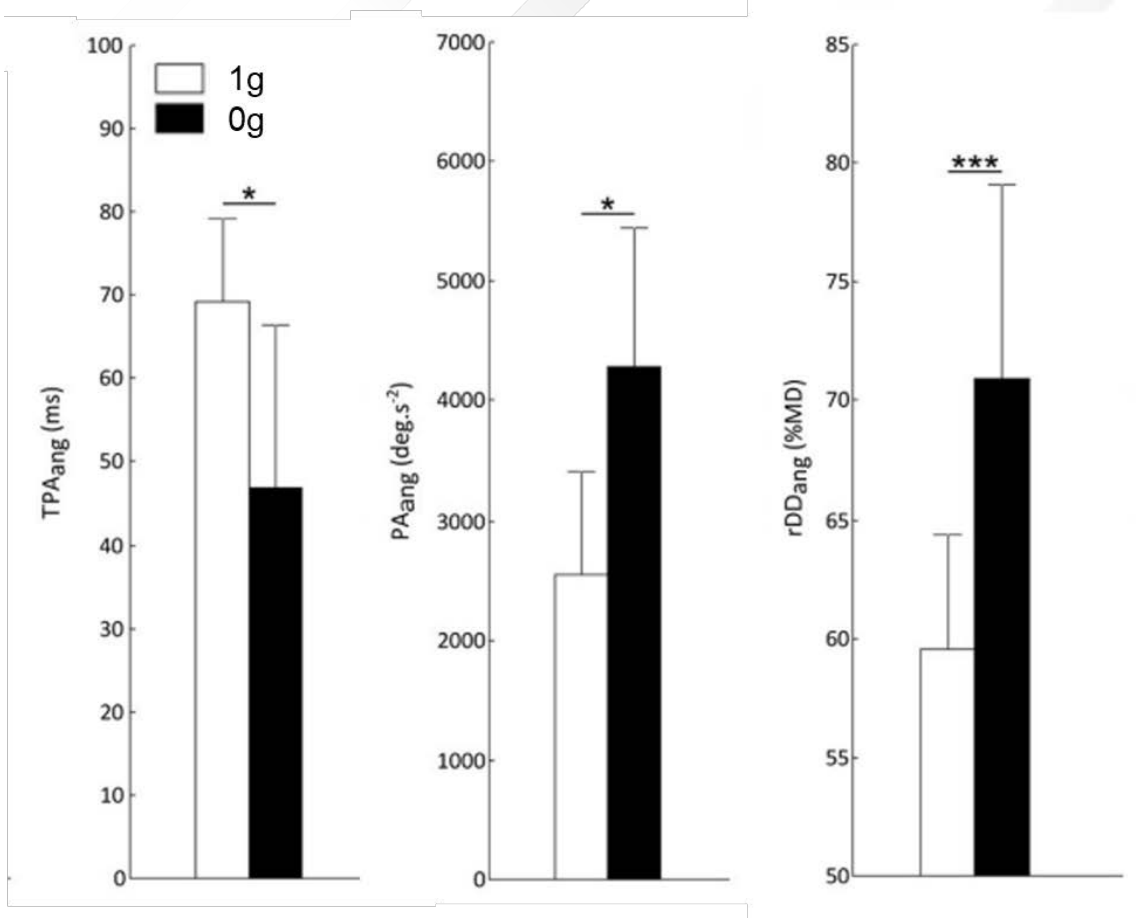
# Whole-body reaching in 0g

- Focal component



# Whole-body reaching in 0g

- Focal component

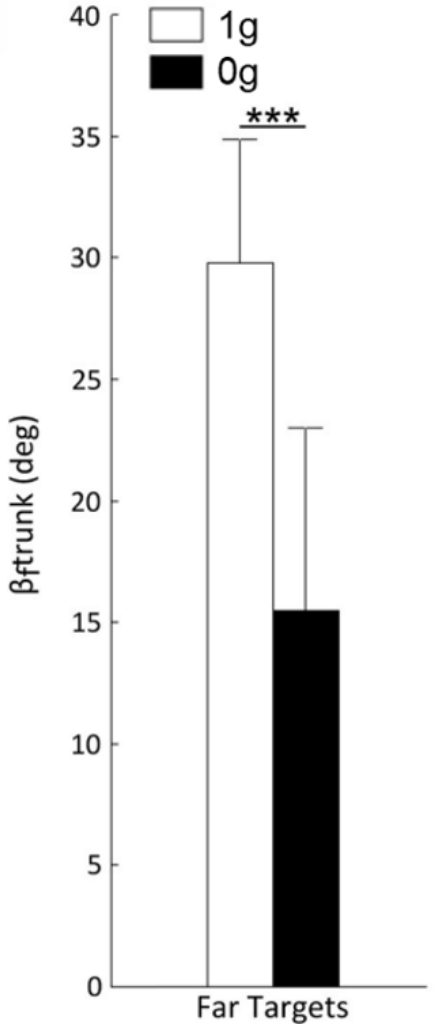



Fast reorganization of focal kinematics for arm angular elevation:

- ↘ Time-to-Peak Acceleration
- ↗ Peak Acceleration
- ↗ Relative Deceleration Duration

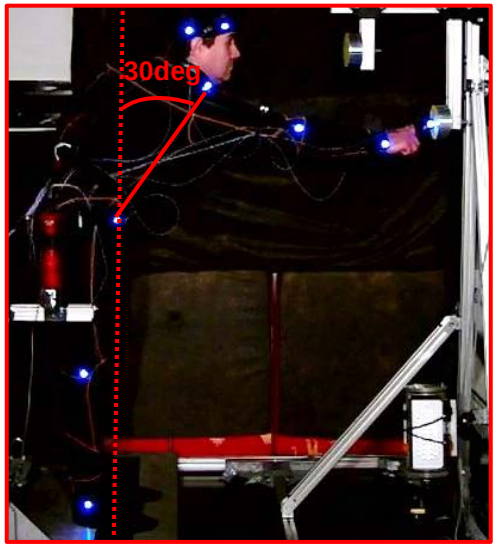
# Whole-body reaching in 0g

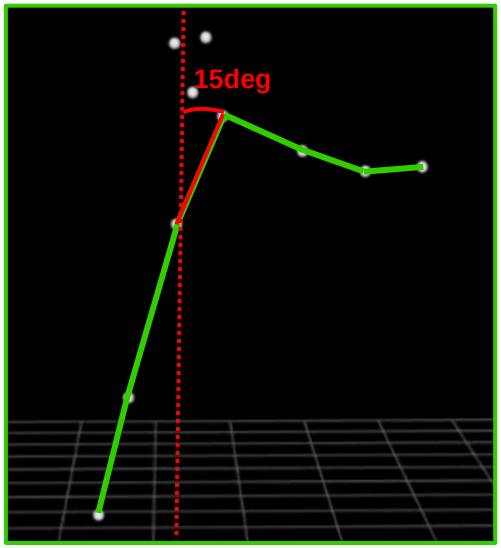
- Postural component




Fast reorganization of posture serving whole-body reaching:

From “hip” to “ankle” strategy



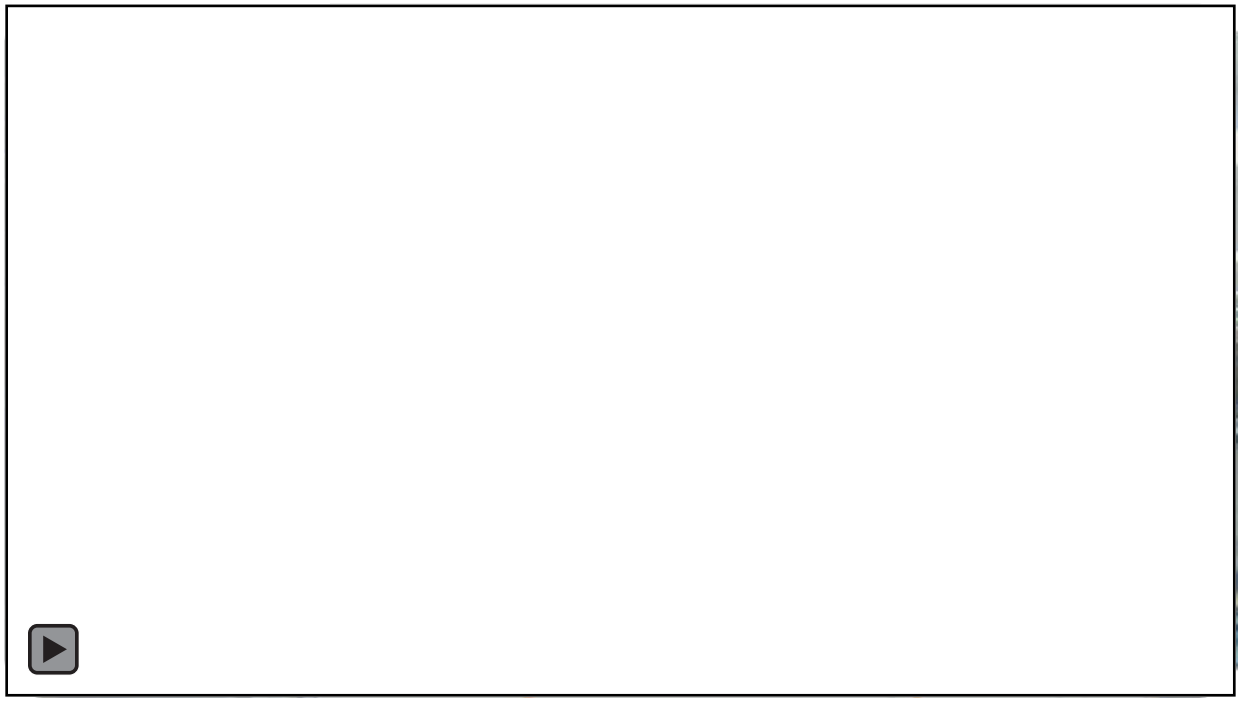
# Corrective responses to target jump in 0g

frontiers in Physiology

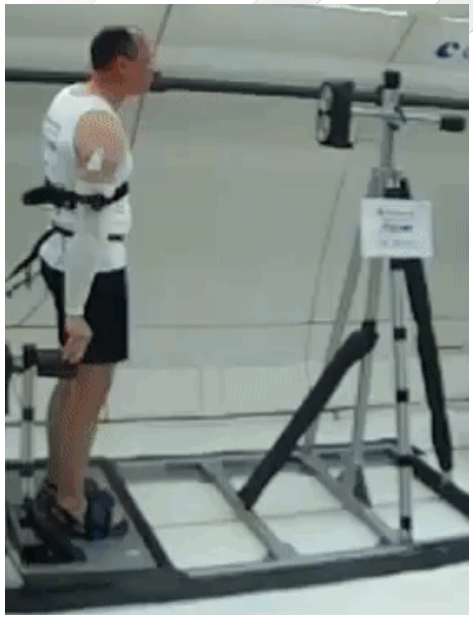
ORIGINAL RESEARCH
published: 24 April 2020
doi: 10.3389/fphys.2020.00377

## Double-Step Paradigm in Microgravity: Preservation of Sensorimotor Flexibility in Altered Gravitational Force Field

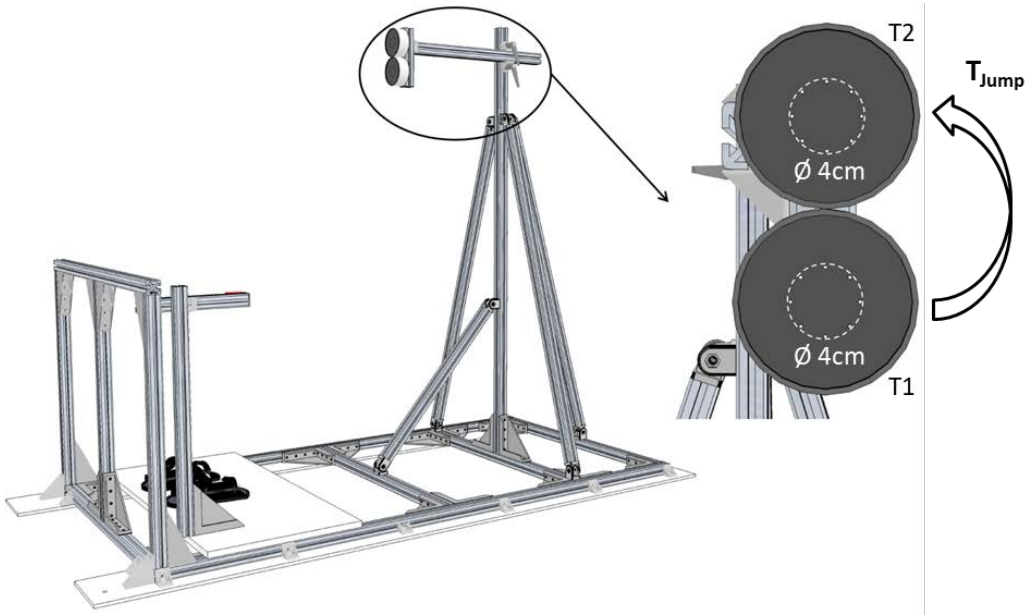
*L. Bringoux[1]*, T. Macaluso[1], P. Sainton[1], L. Chomienne[1], F. Buloup[1], L. Mouchnino[2], M. Simoneau[3,4] and J. Blouin[2]*



# Whole-body reaching in 0g



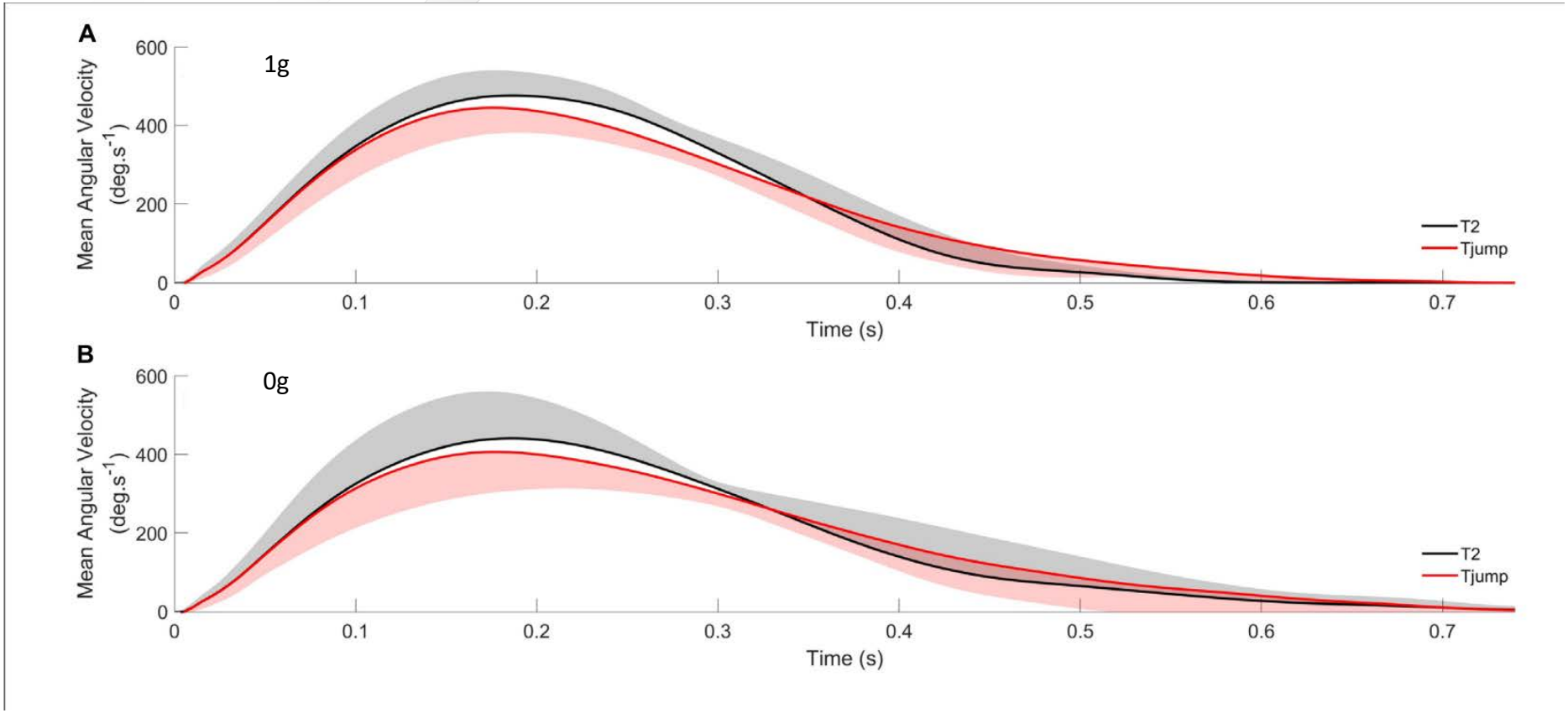
n=7



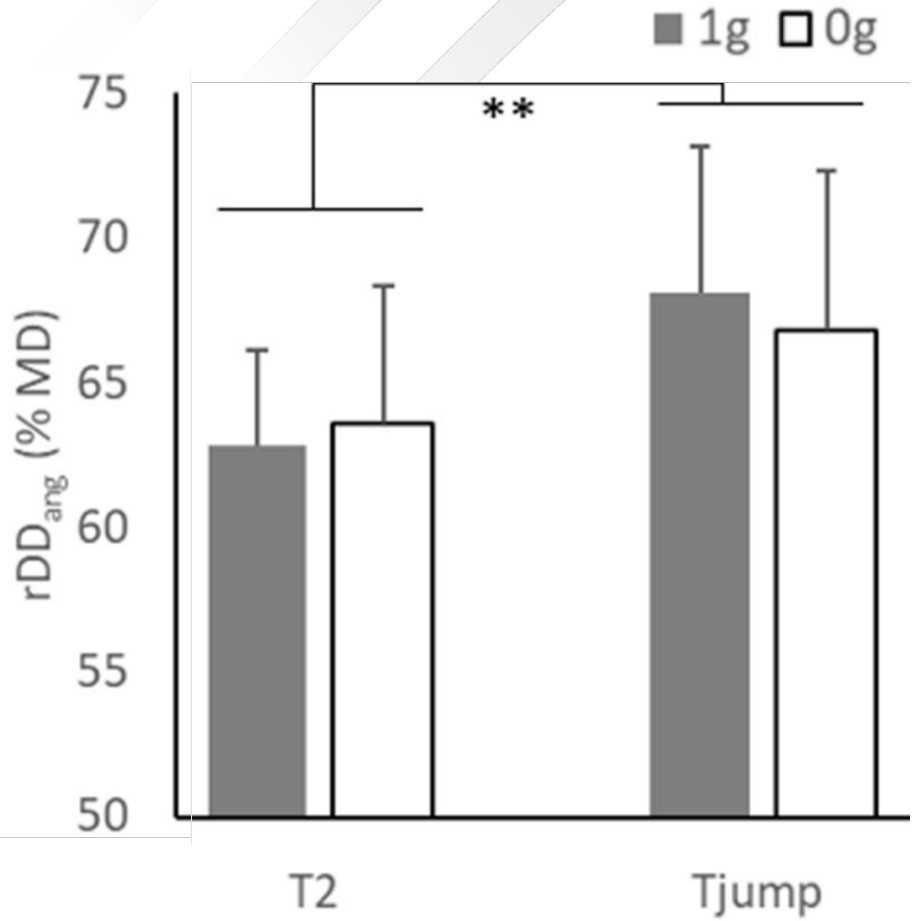

- Reaction time unaffected by $T_{jump}$ in 0g
- Success rate preserved (>90%)
- Final deviation comparable with and without $T_{jump}$
- No learning effect during the session (10 $T_{jump}$ trials over the 50 trials presented in a session)

# Corrective responses to target jump in 0g

- Focal component



# Corrective responses to target jump in 0g




Fast reorganization of focal kinematics keeping $T_{jump}$ responses accurate in 0g:

- ↗ Relative Deceleration Duration comparable in both environments

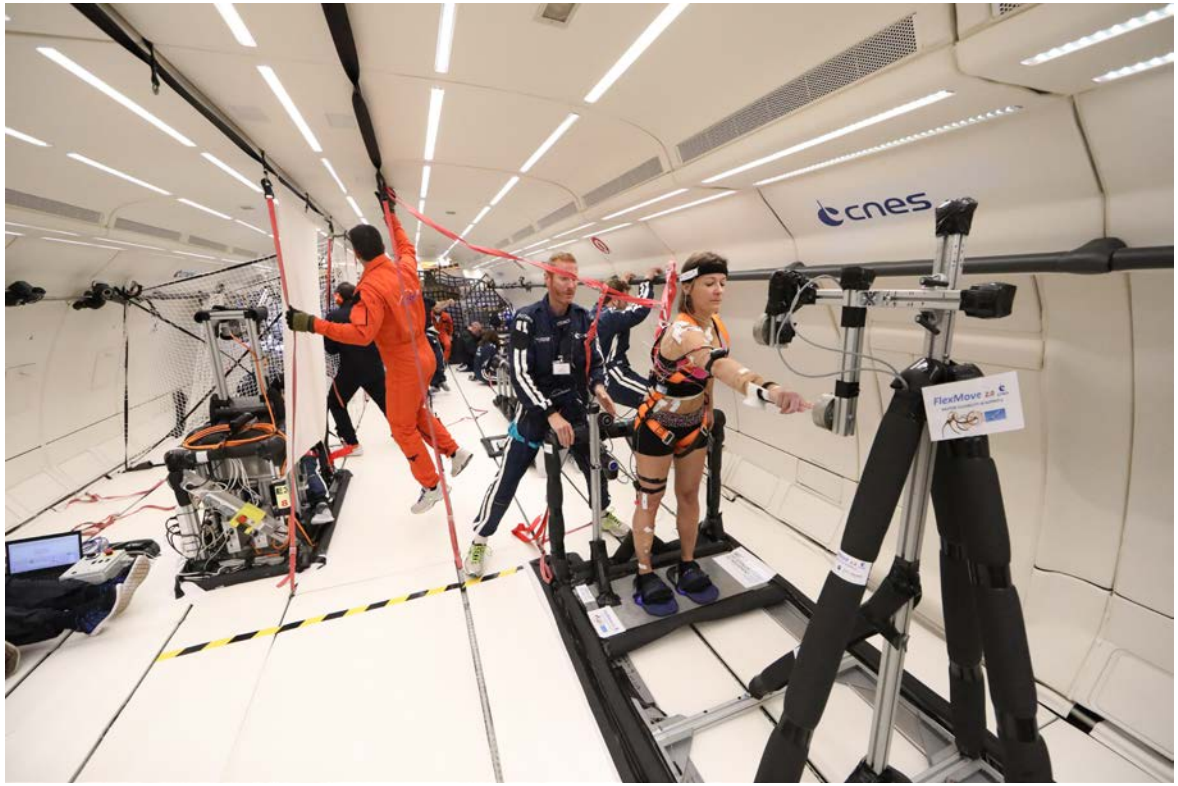
# Whole-body reaching in 0g vs 1.8g

bioRχiv
THE PREPRINT SERVER FOR BIOLOGY

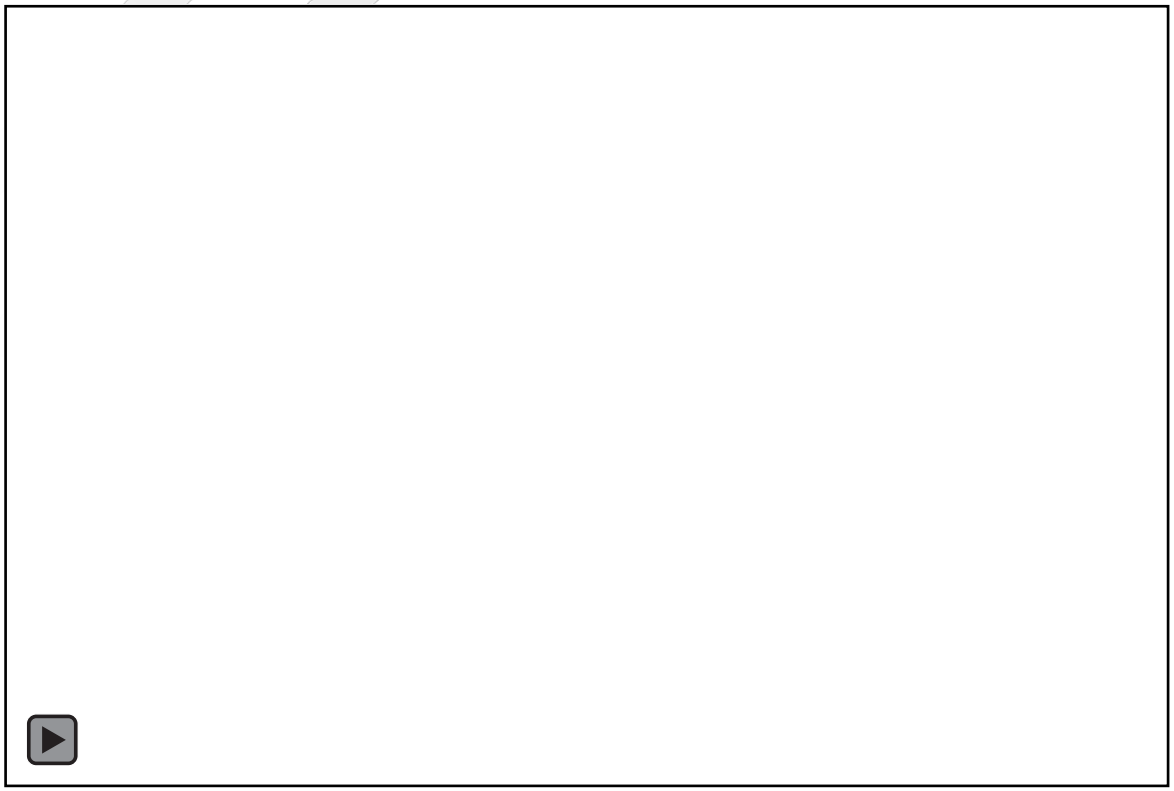
**Performance During Whole Body Reaching Movements Is Impaired In Hypergravity While Preserved In Microgravity**

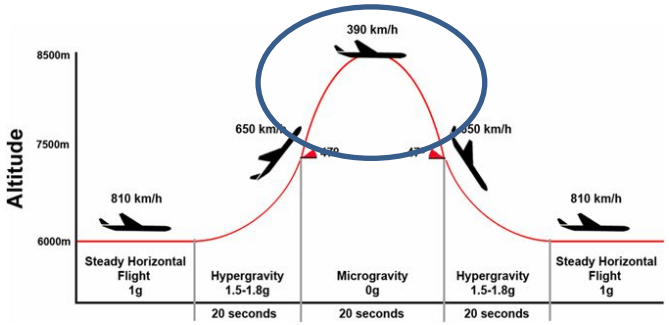
L. Chomienne, P. Sainton, F. Sarlegna, L. Bringoux

**doi:** https://doi.org/10.1101/2021.12.08.471552

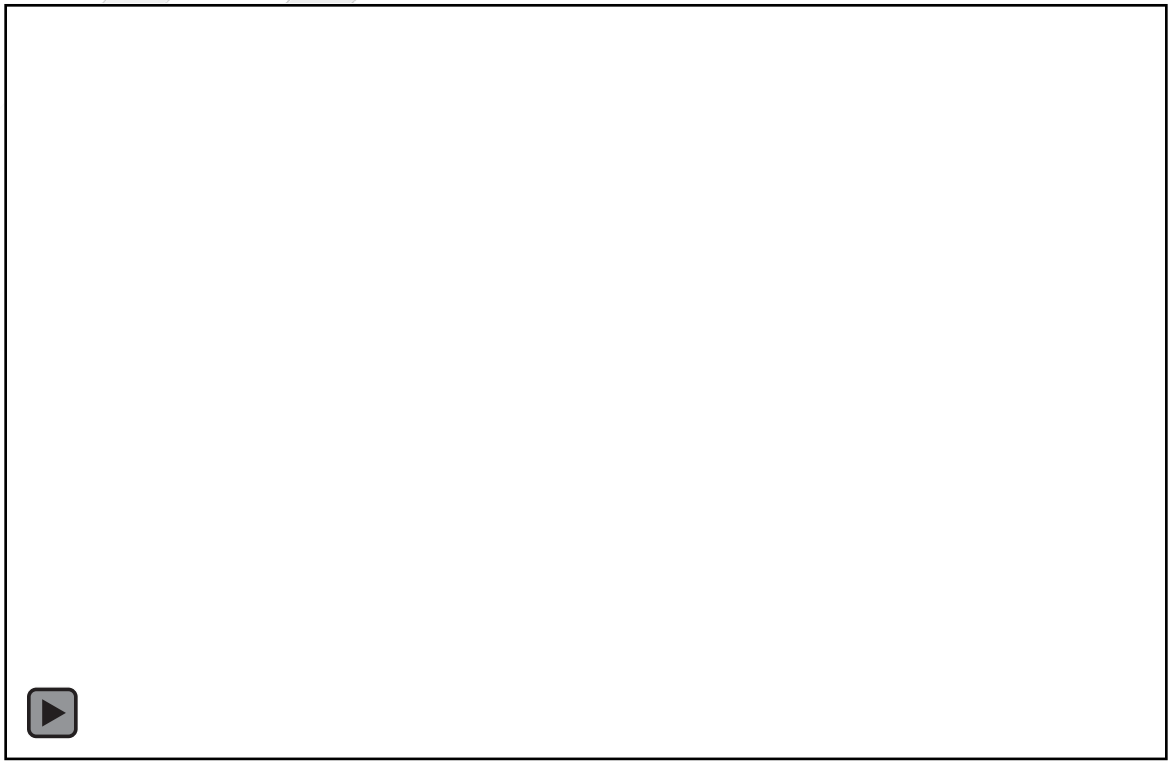


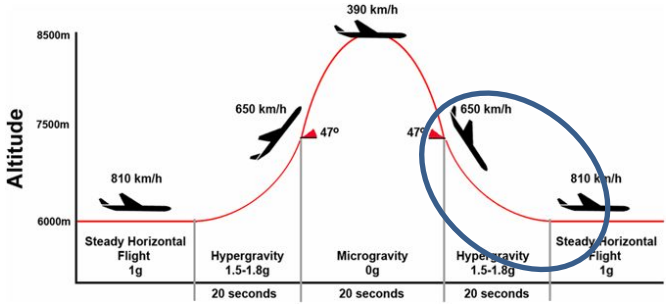
# Whole-body reaching in 0g vs 1.8g





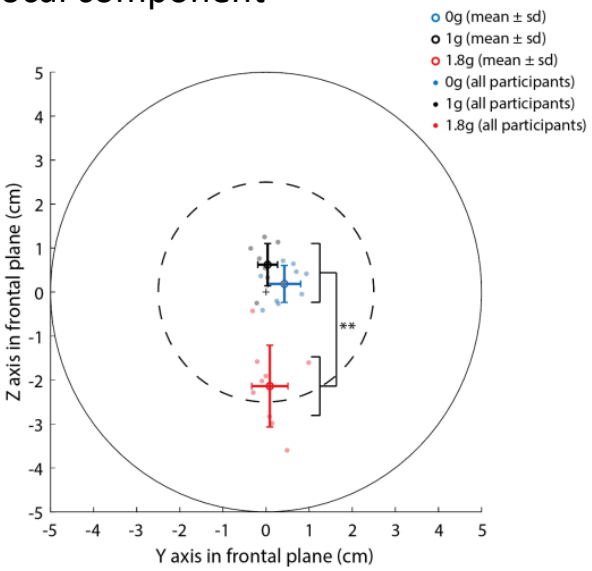
# Whole-body reaching in 0g vs 1.8g

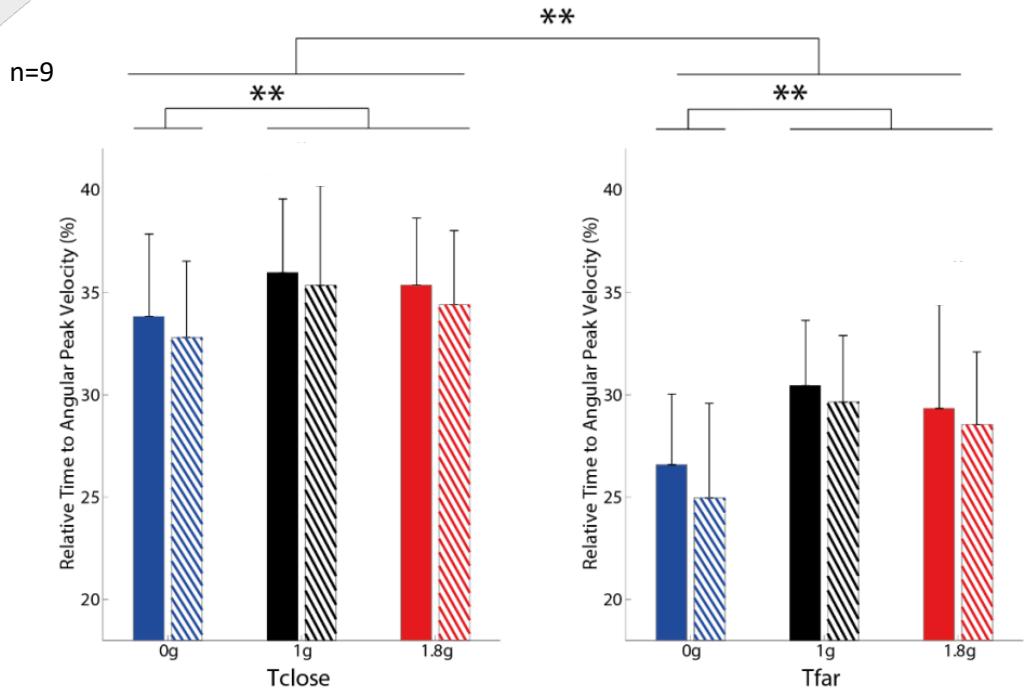




# Whole-body reaching in 0g vs 1.8g

- Focal component

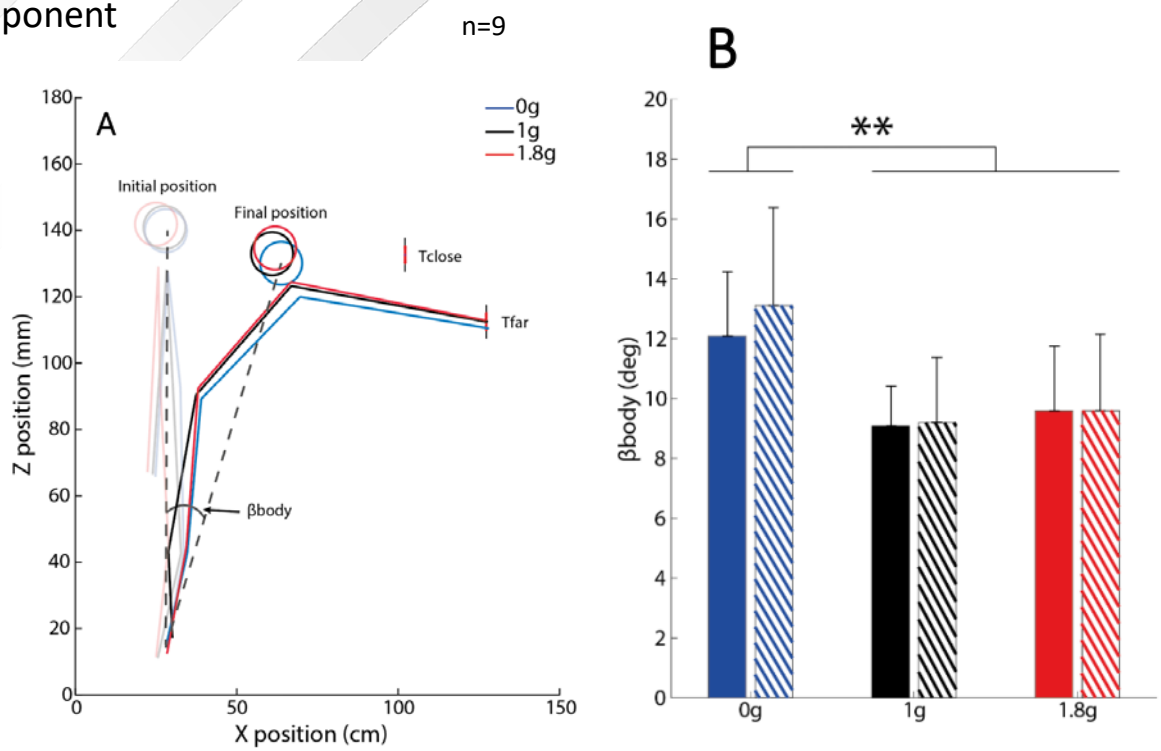



- Endpoint accuracy degraded in 1.8g (1.8g:-2.21 cm vs 0g: 0.14 cm)
- Unchanged Movement time in 1.8g / 1g (vs ↗ in 0g)
- Unchanged Relative Deceleration Duration in 1.8g / 1g (vs ↗ in 0g)
- No learning effect during the session (50 trials per g-level)

# Whole-body reaching in 0g vs 1.8g

- Postural component




- Unchanged body tilt in 1.8g / 1g (vs ↗ in 0g)
- No learning effect during the session

# Whole-body reaching in 0g vs 1.8g


Sustained impairment of whole-body reaching performance in 1.8g

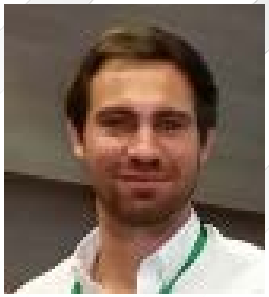
Residual non-adapted Earth-based organization

# Whole-body reaching in g-Force field

- Initial state estimates allow for fast adaptation of arm motor planning and underlying postural sets in microgravity (White et al. 2020)…
  but not in hypergravity.

- Fast adapted internal models allow for early efficient online adjustments in response to unpredictable goal-directed perturbations (Crevecoeur & Scott. 2014).

# THANKS!



T. Macaluso

L. Chomienne