



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



Deterioramento sensorimotorio, neuromuscolare e metabolico associato al volo umano nello spazio e contromisure innovative

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Sensory-motor impairment

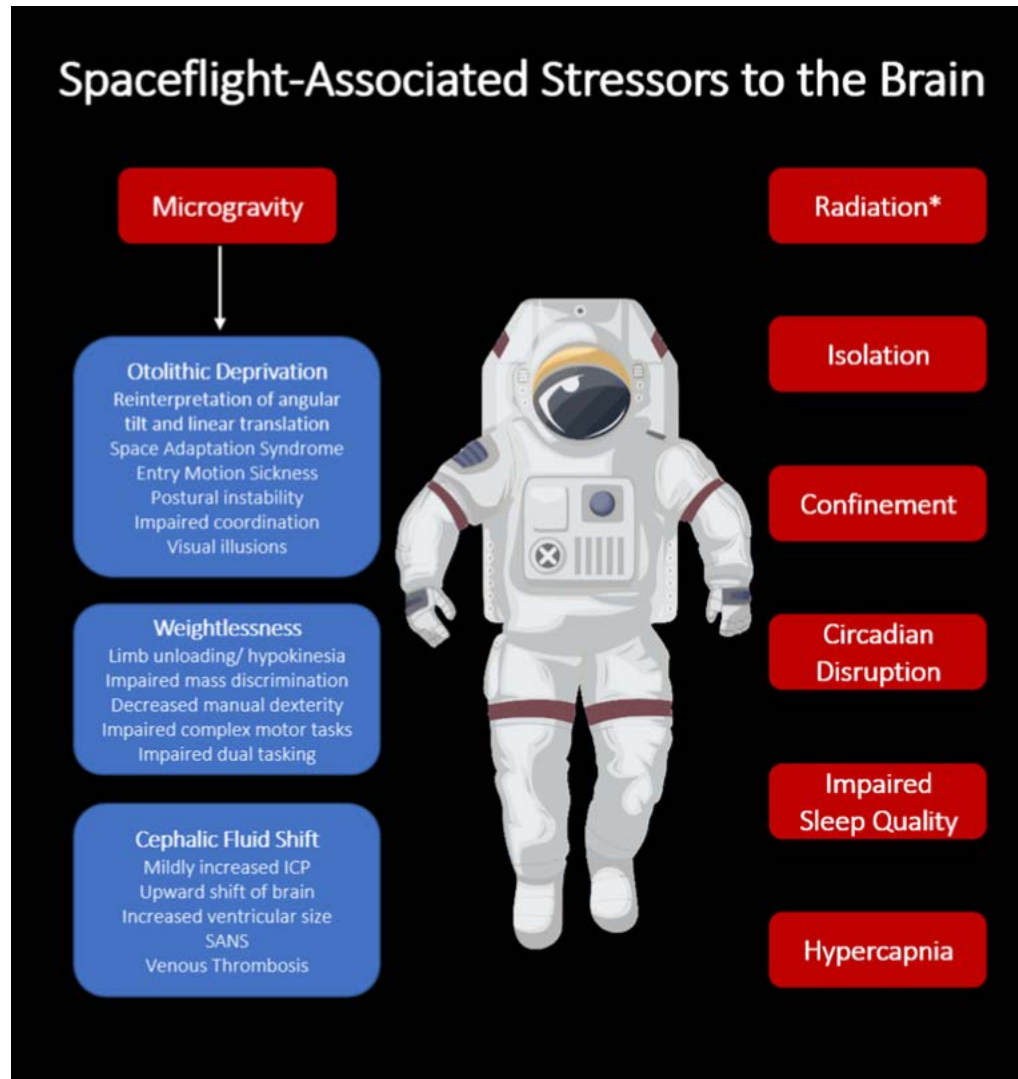


- Documented changes in *sensation*, *movement*, *coordination* and *cognition* after spaceflight
- Sensory-motor dysfunction is recognized as a major potential cause of performance impairment during spaceflight

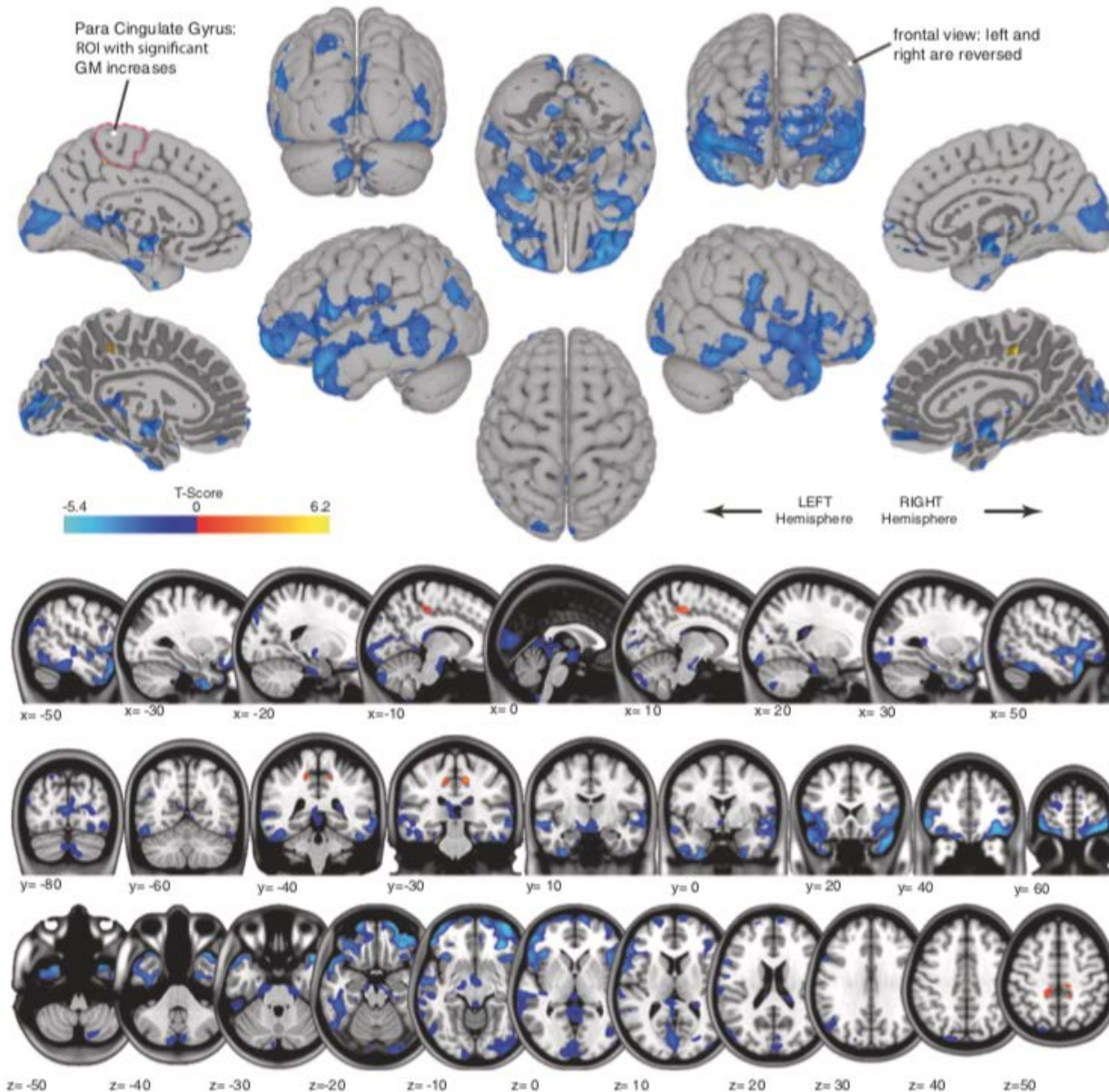
Main sensory motor deficits associated with SF

- Impaired gaze control
- Reduced fine motor control
- Spatial disorientation
- Impaired coordination
- Postural ataxia
- Loss of motor efference

Brain changes with spaceflight



Grey matter changes after 6-month SF



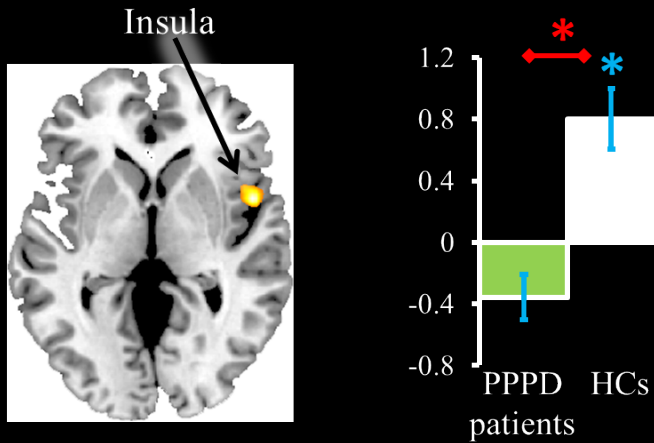
Science

AAAS

Representation of Visual Gravitational Motion in the Human Vestibular Cortex

Indovina, et al. *Science* 308, 416

Patients



Altered Insular and Occipital Responses to Simulated Vertical Self-Motion in Patients with Persistent Postural-Perceptual Dizziness

Riccelli et al *Front Neurol*

F. Lacquaniti

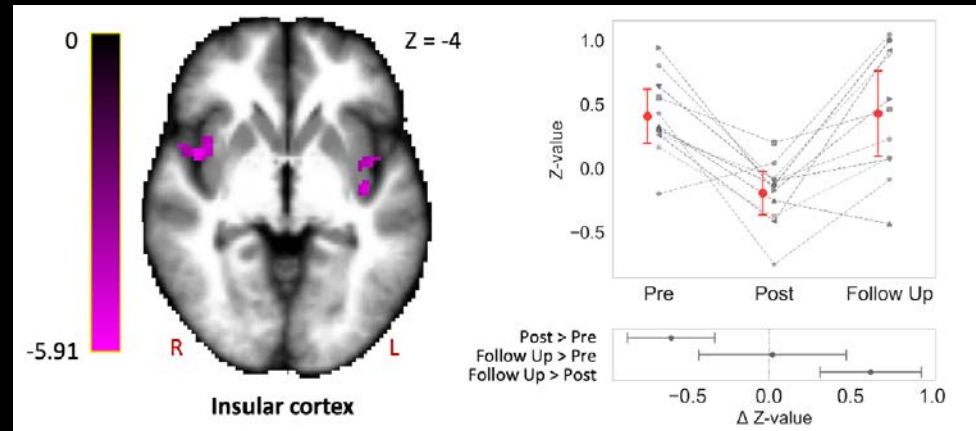
Laboratorio di Fisiologia Neuromotoria, IRCCS

Fondazione Santa Lucia, Roma



SANTA LUCIA
NEUROSCIENZE
E RIABILITAZIONE

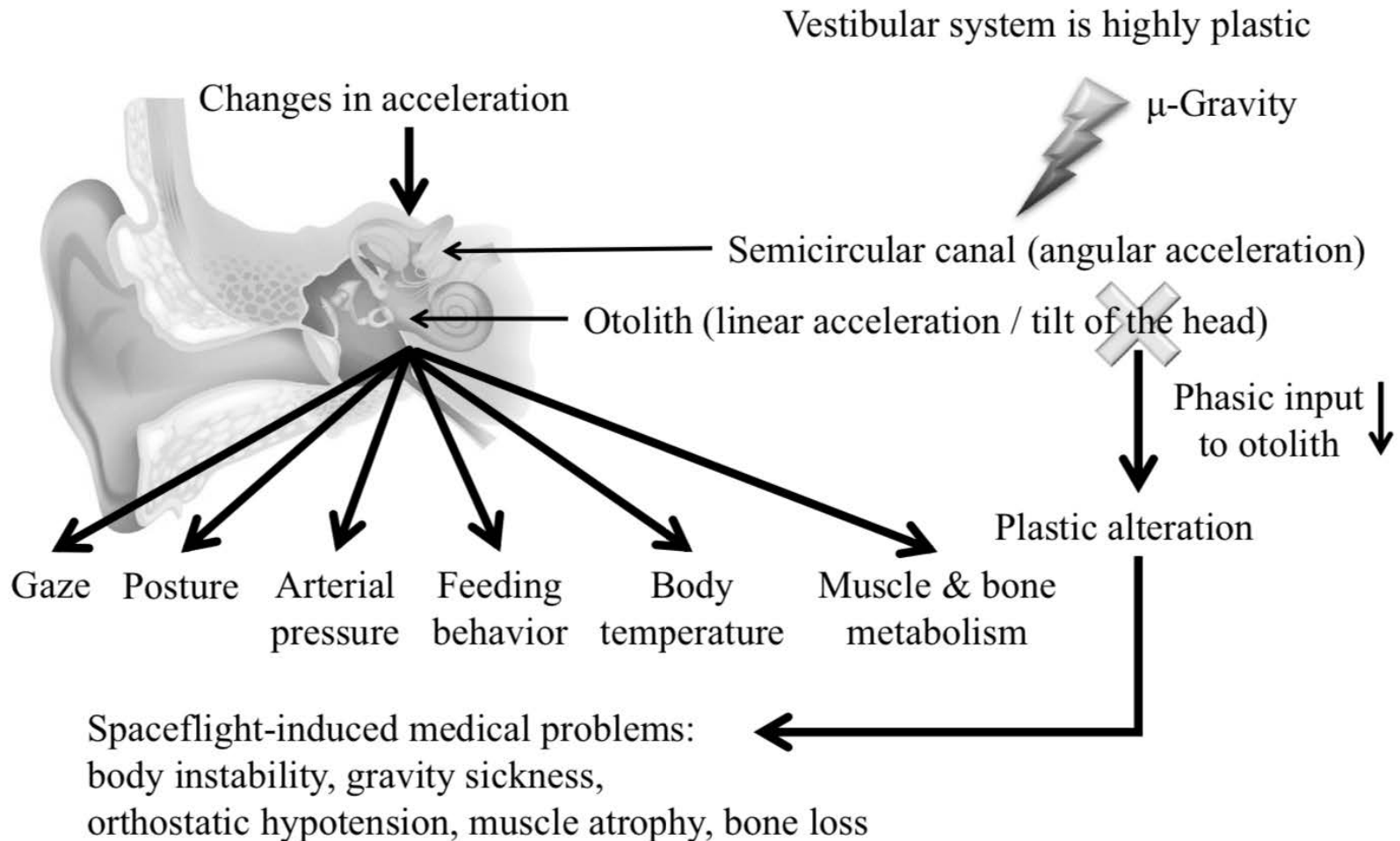
Cosmonauts



Prolonged microgravity induces reversible and persistent changes on human cerebral connectivity

Jillings et al. *Commun Biol*

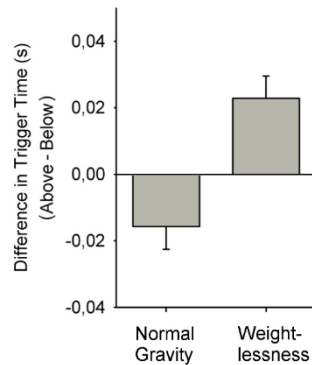
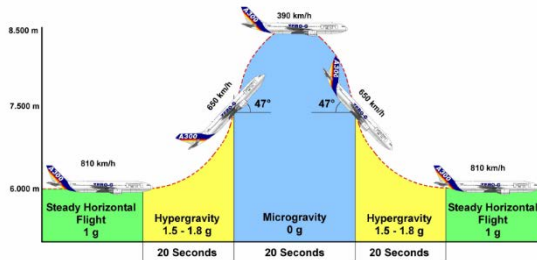
Impact of vestibular changes on main physiological functions



A new method to counteract vestibulopathy and vestibular hypofunction induced by spaceflight

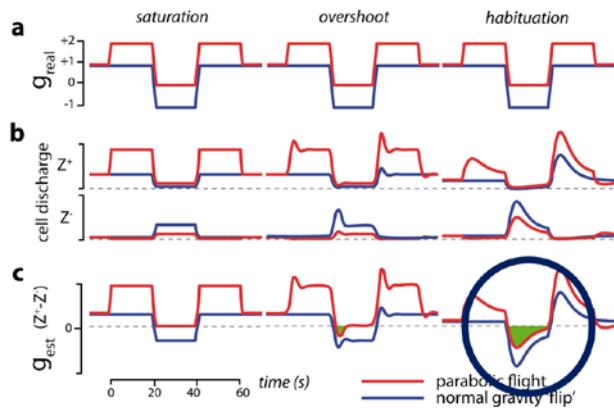
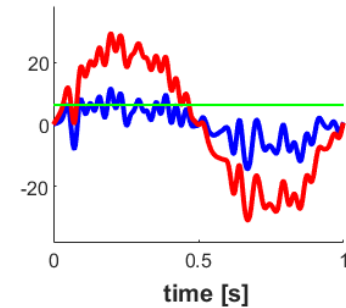
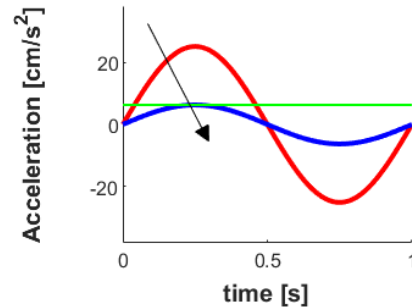
NEUROSCIENCE RESEARCH ARTICLE

B. La Scaleia et al. / *Neuroscience* 510 (2023) 32–48

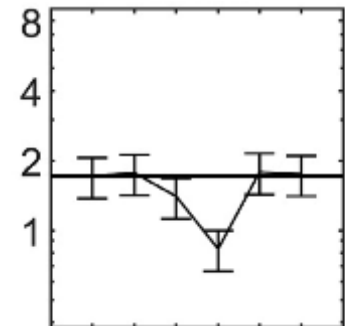


Enhancement of Vestibular Motion Discrimination by Small Stochastic Whole-body Perturbations in Young Healthy Humans

Barbara La Scaleia,^a Francesco Lacquaniti^{b,c} and Myrka Zago^{a,d*}



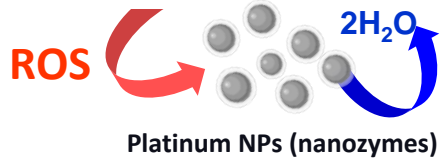
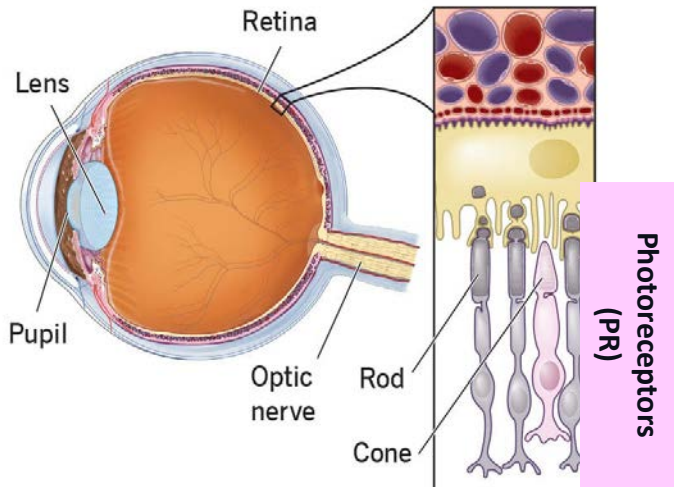
$$A = \varepsilon \frac{\lambda}{q^2} \frac{r(q^2)}{\sqrt{r(q^2)^2 + \omega_0^2/4}}$$



Visual system alteration and oxidative stress prevention

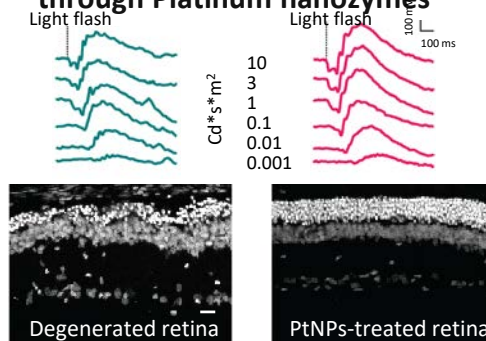
Spaceflight Associated Neuro-ocular Syndrome"

(SANS)

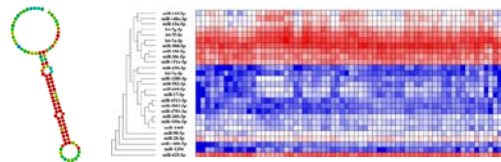


Prevention/recovery of oxidative stress

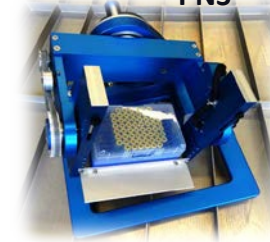
through Platinum nanozymes



MicroRNA dysregulation → PR viability
miRNA therapeutic strategies

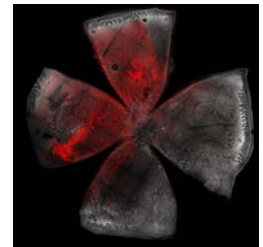


Platform for the study of reduced gravity on CNS and PNS



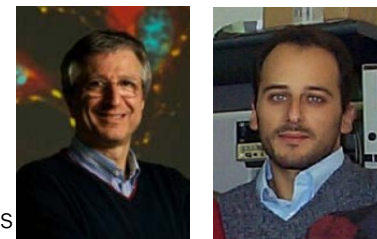
Random Positioning Machine (Airbus™)

In vitro/ex vivo retina models



70% of astronauts experience SANS

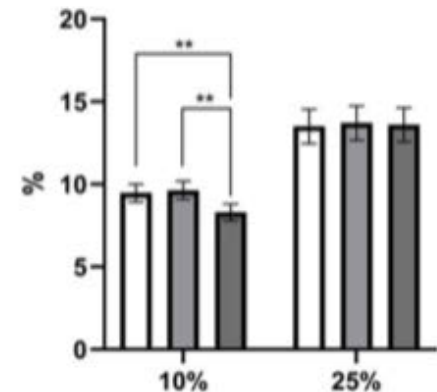
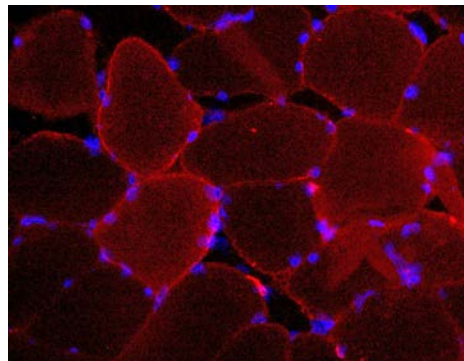
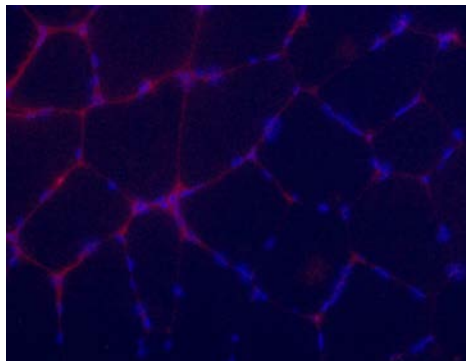
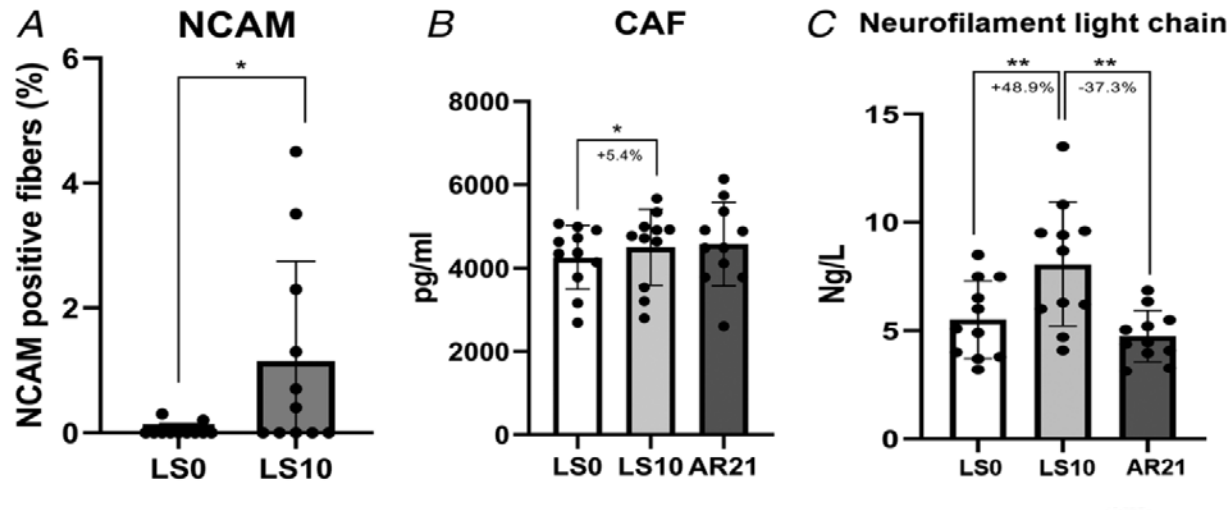
Fabio Benfenati & Pier Paolo Pompa labs










Effects of short-term unloading and active recovery on human motor unit properties, neuromuscular junction transmission and transcriptomic profile

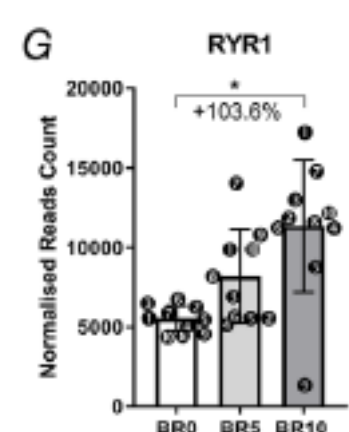
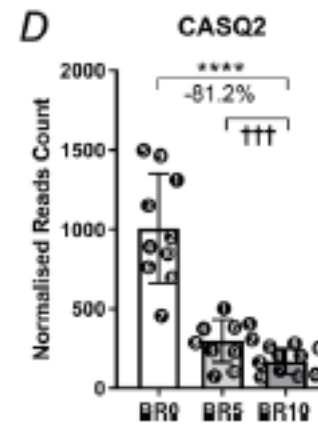
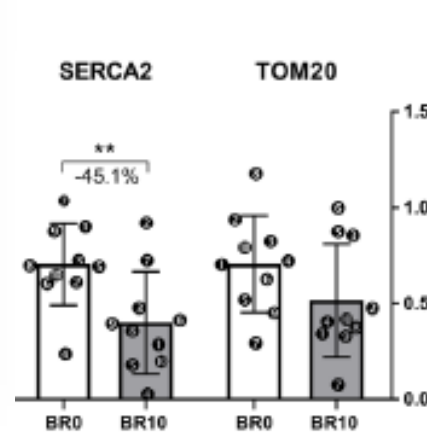
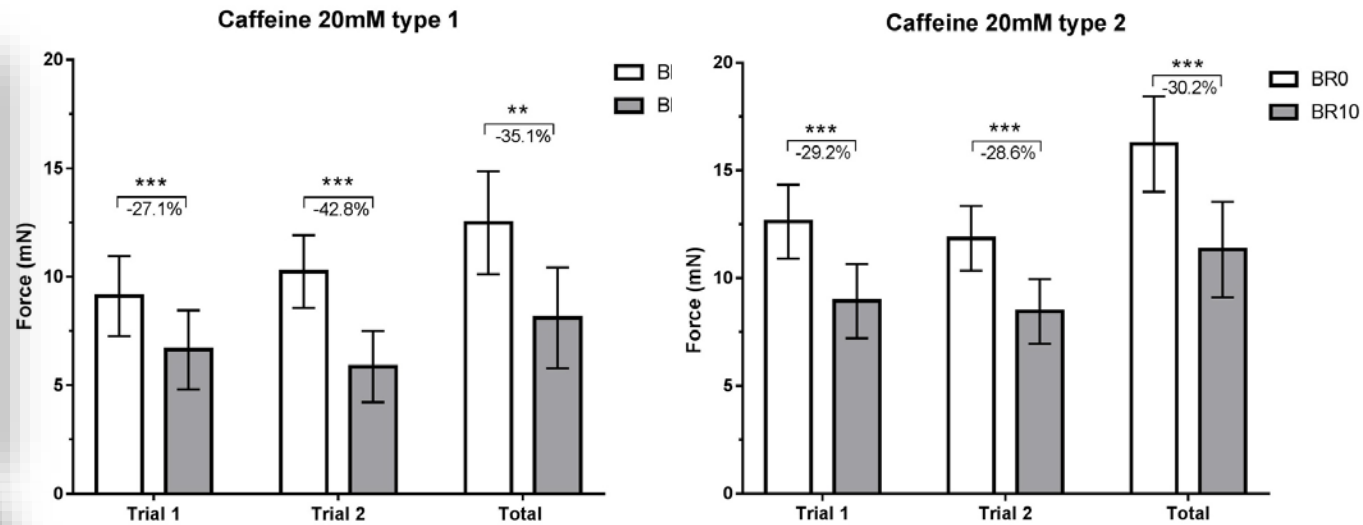
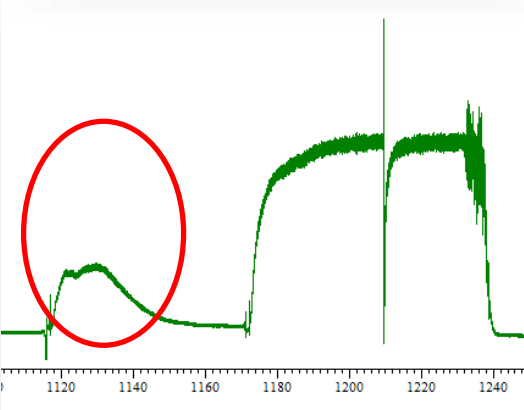
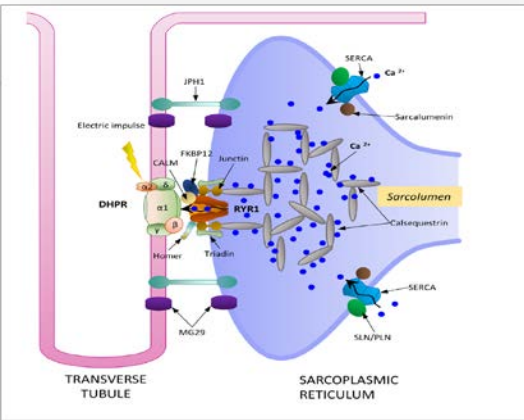


Fabio Sarto¹, Daniel W. Stashuk², Martino V. Franchi^{1,3}, Elena Monti¹, Sandra Zampieri^{1,3,4}, Giacomo Valli¹, Giuseppe Sirago¹, Julián Candia⁵, Lisa M. Hartnell⁵, Matteo Paganini¹, Jamie S. McPhee⁶, Giuseppe De Vito^{1,3}, Luigi Ferrucci⁵, Carlo Reggiani^{1,7} and Marco V. Narici^{1,3,7}

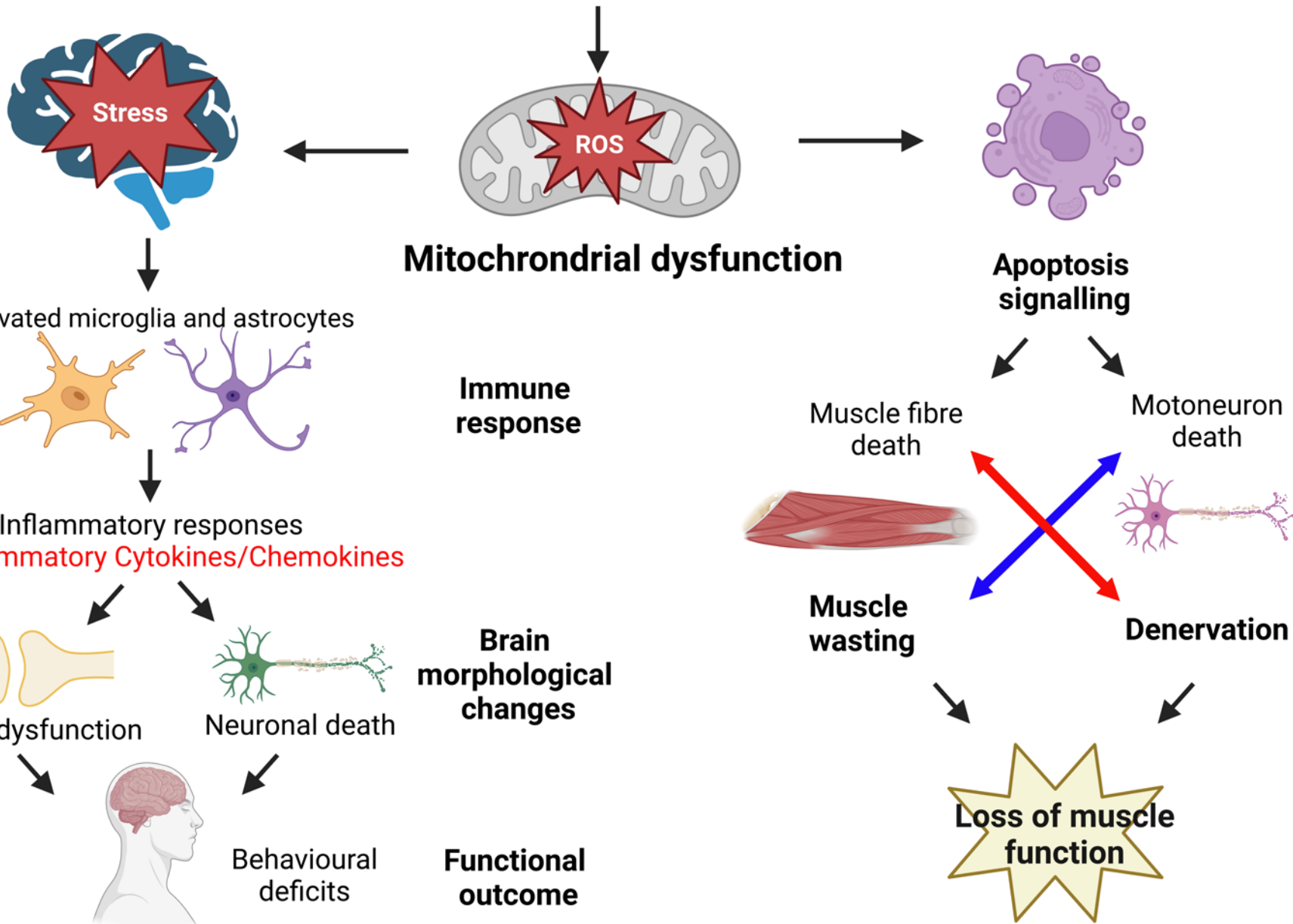


Neuromuscular junction instability and altered intracellular calcium handling as early determinants of force loss during unloading in humans

Elena Monti¹ , Carlo Reggiani^{1,2} , Martino V. Franchi¹ , Luana Toniolo¹, Marco Sandri^{1,3}, Andrea Armani^{1,3}, Sandra Zampieri^{1,4} , Emiliana Giacomello⁵, Fabio Sarto¹, Giuseppe Sirago¹ , Marta Murgia^{1,6}, Leonardo Nogara¹, Lorenzo Marcucci¹, Stefano Ciciliot^{1,3} , Boštjan Šimunic², Rado Pišot² and Marco V. Narici^{1,2,7} 



Spaceflight Hazards



Need for an integrated neuro-muscular countermeasures approach

- **C/M against sensory-motor impairment:** combined RT exercises with added proprioceptive stimuli. Aerobic exercise in 'enriched environment'. Vestibular system training using small stochastic whole-body perturbations. Frequent learning of new exercise sequences. Use of augmented reality.
- **C/M against oxidative stress and inflammation:** use of nanotechnology (e.g. platinum nanozymes), vitamins (A, C, D, E) glutathione, SOD, hormones, probiotics (microbiota protection), nutritional supplements, exogenous NAD+ supplementation to mitigate mitochondrial dysfunction, brain, nervous, muscle tissue damage and accelerated cellular aging.
- **Sleep quality and social inclusion:** improved sleep environment, improved work-rest schedules, pharmaceuticals, light treatment, psychological support.