

SPACE PHYSIOLOGY AND ENGINEERING: *Can people with disabilities go to Mars?*

Virtual event "Space4People with Disabilities - Pushing Frontiers: Human Spaceflight and Disability"
organized by the United Nations Office for Outer Space Affairs.



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OBJECTIVE

This talk raises awareness about the importance of an evolving safety culture for including people with a disability towards a human mission to Mars.

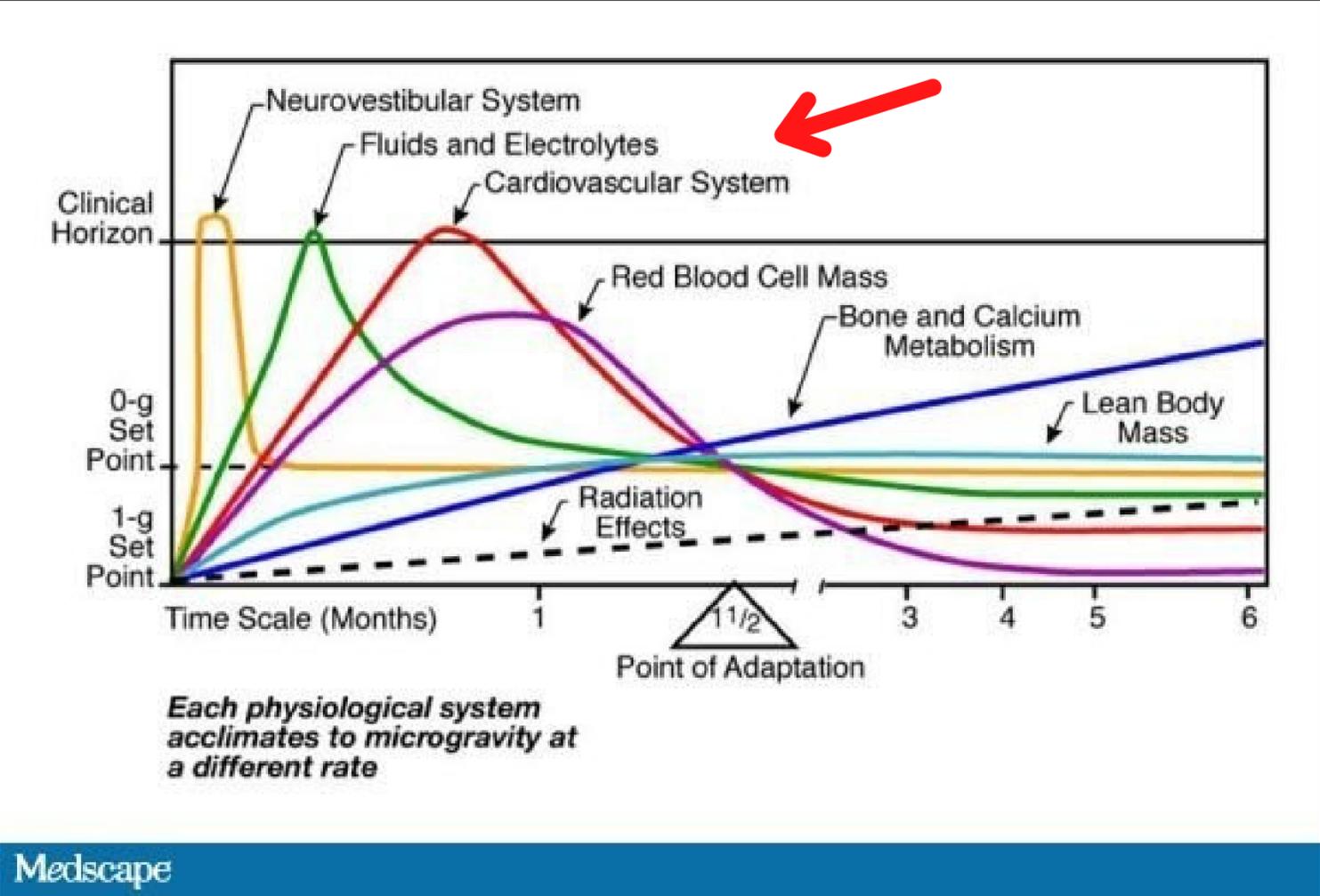


SPACE PHYSIOLOGY

Overview of the human body adaptation



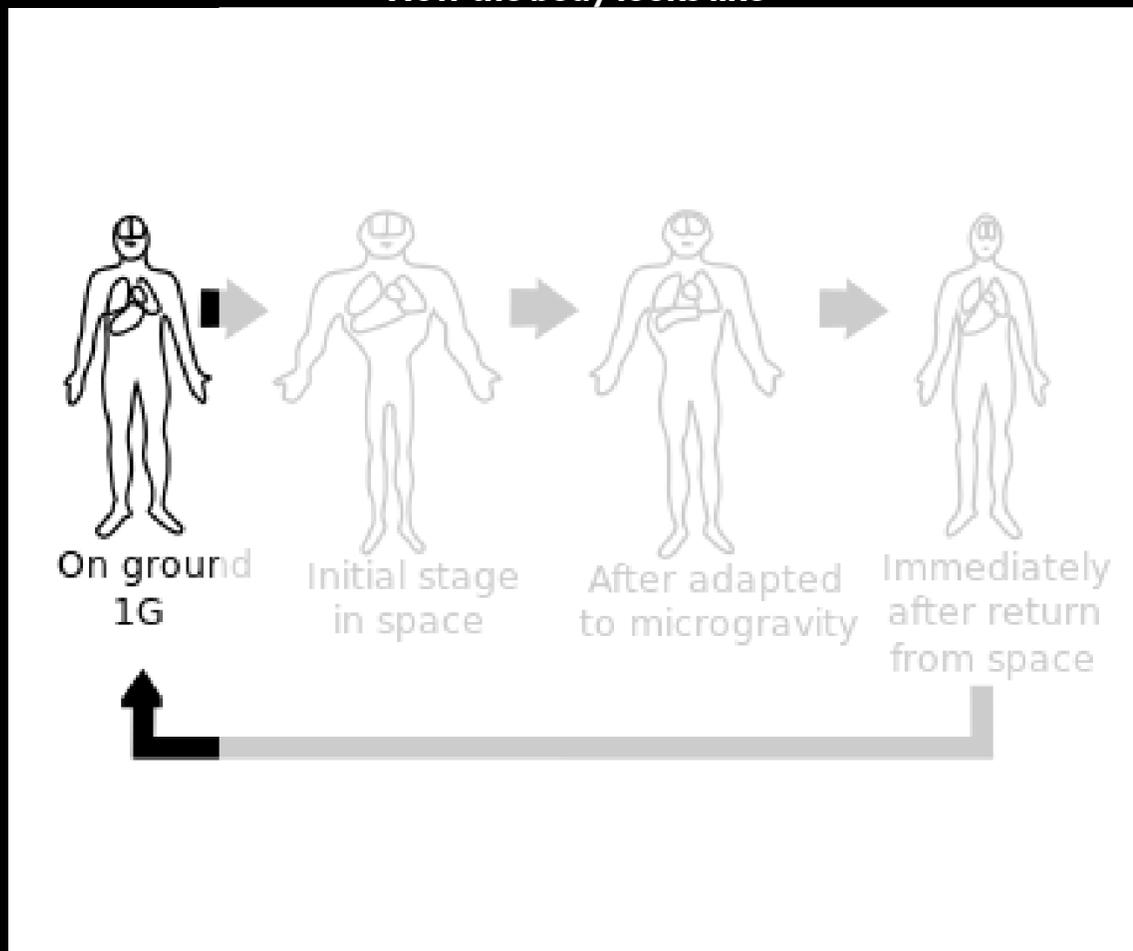
Astronaut Chris Hadfield -
YouTube/CanadianSpaceAgency



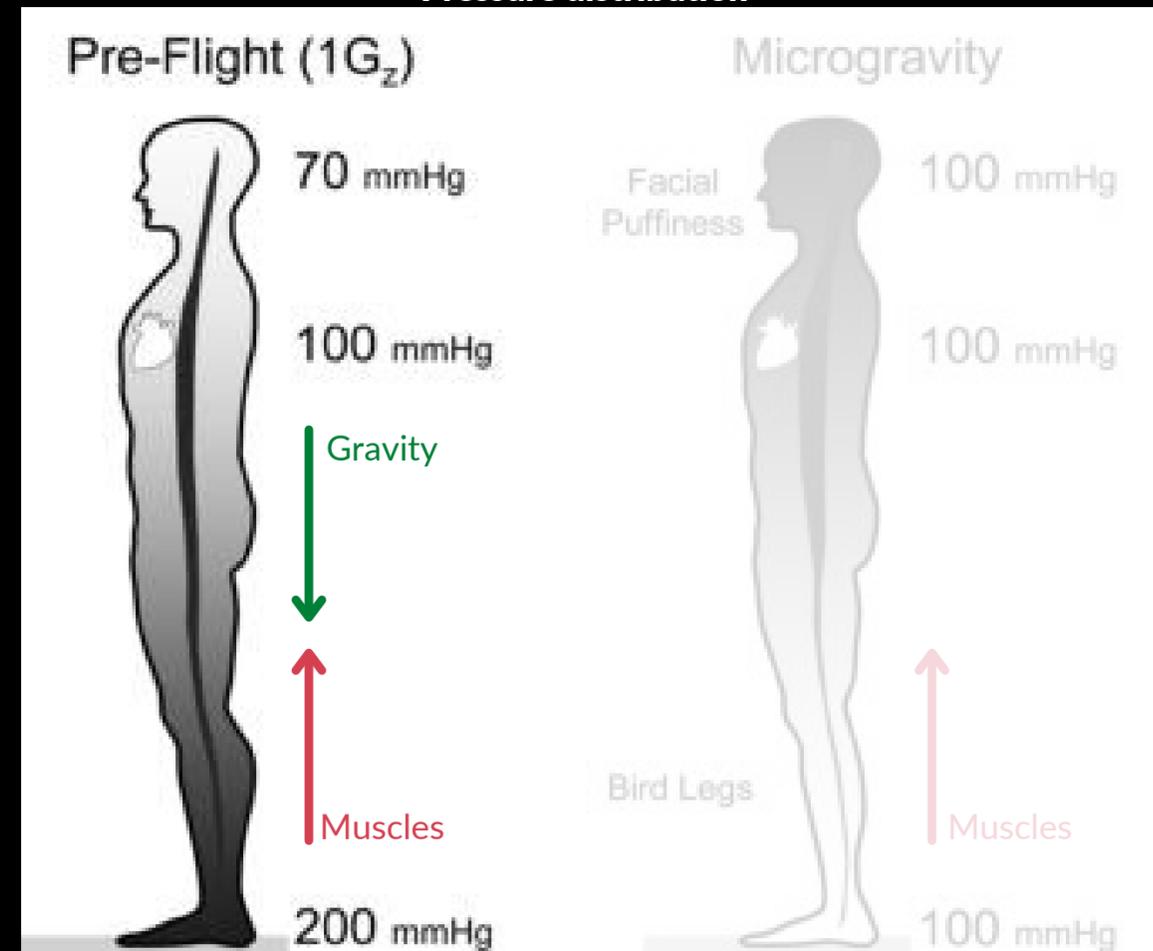
SPACE PHYSIOLOGY

Exposure to Earth's gravity

How the body looks like



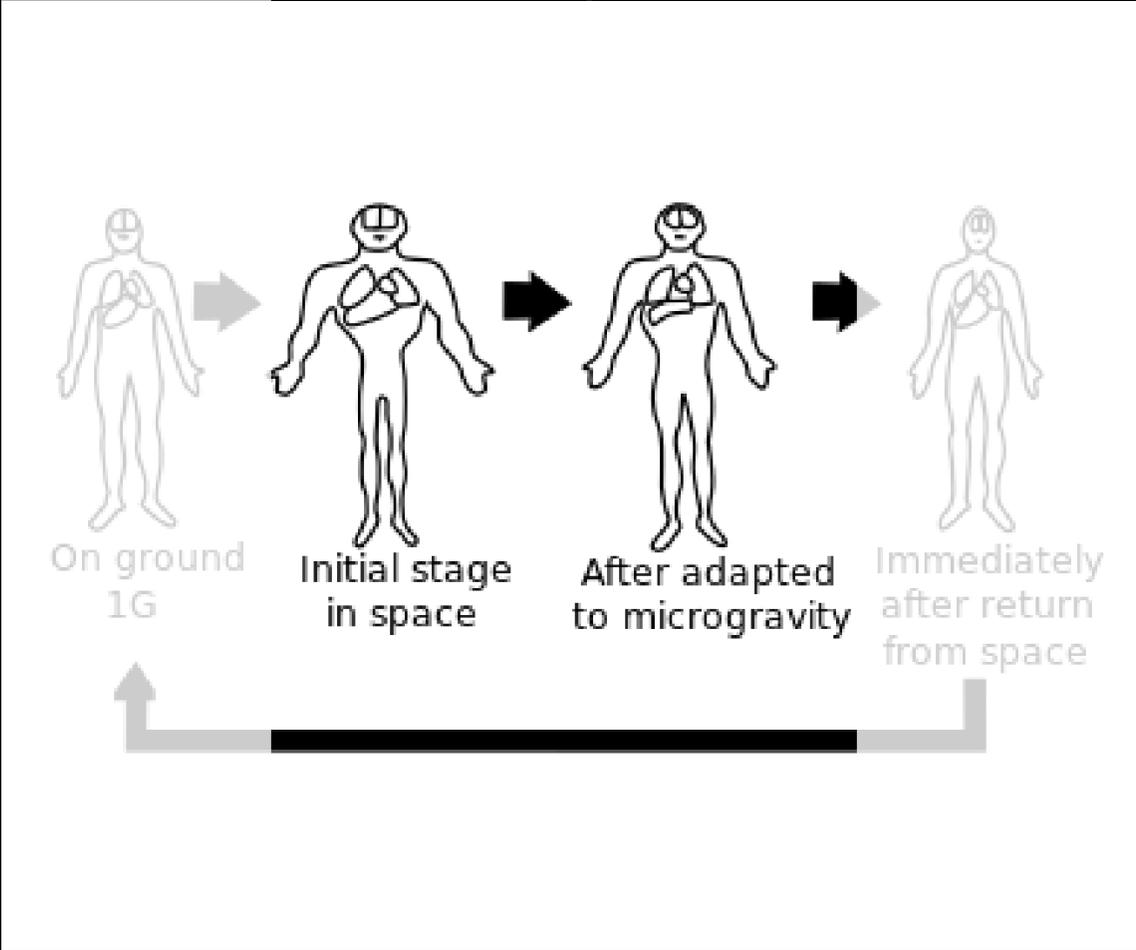
Pressure distribution



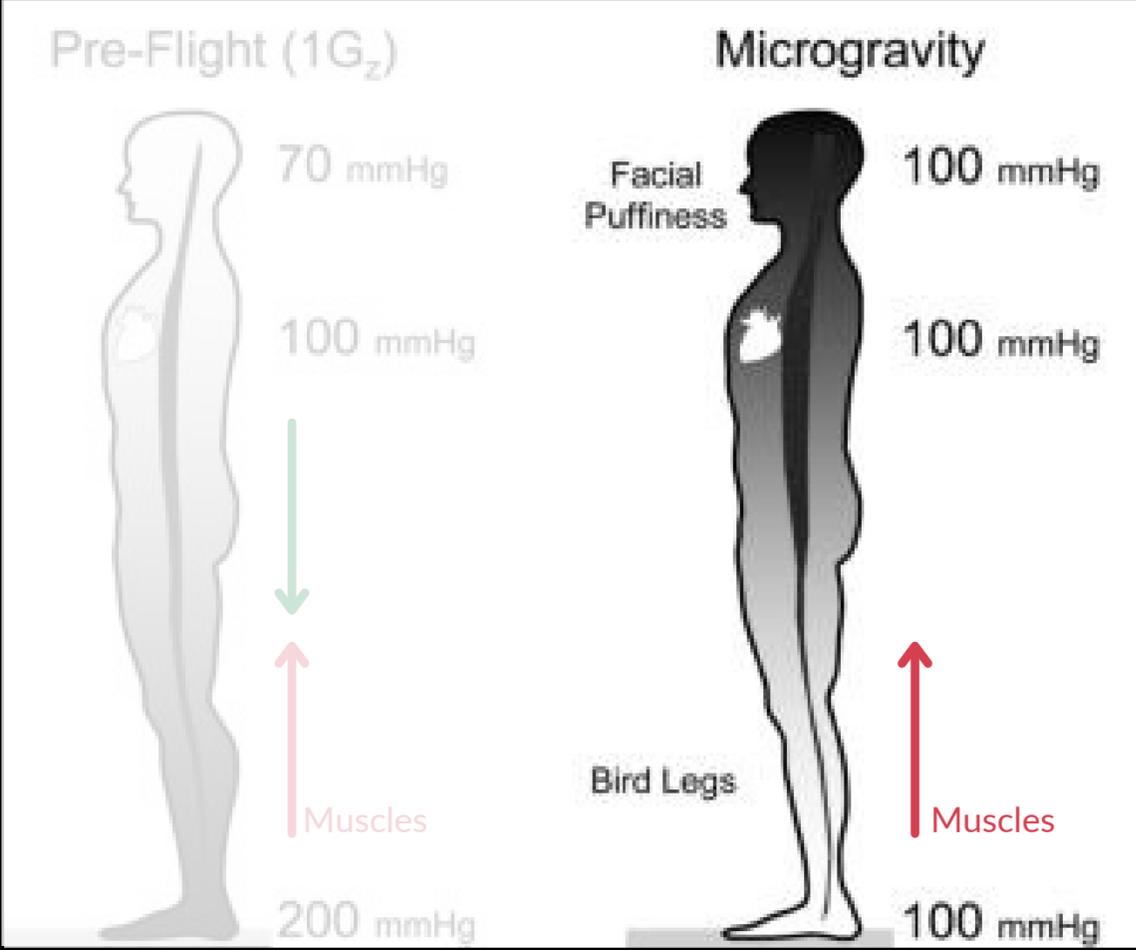
SPACE PHYSIOLOGY

Exposure to microgravity

How the body looks like

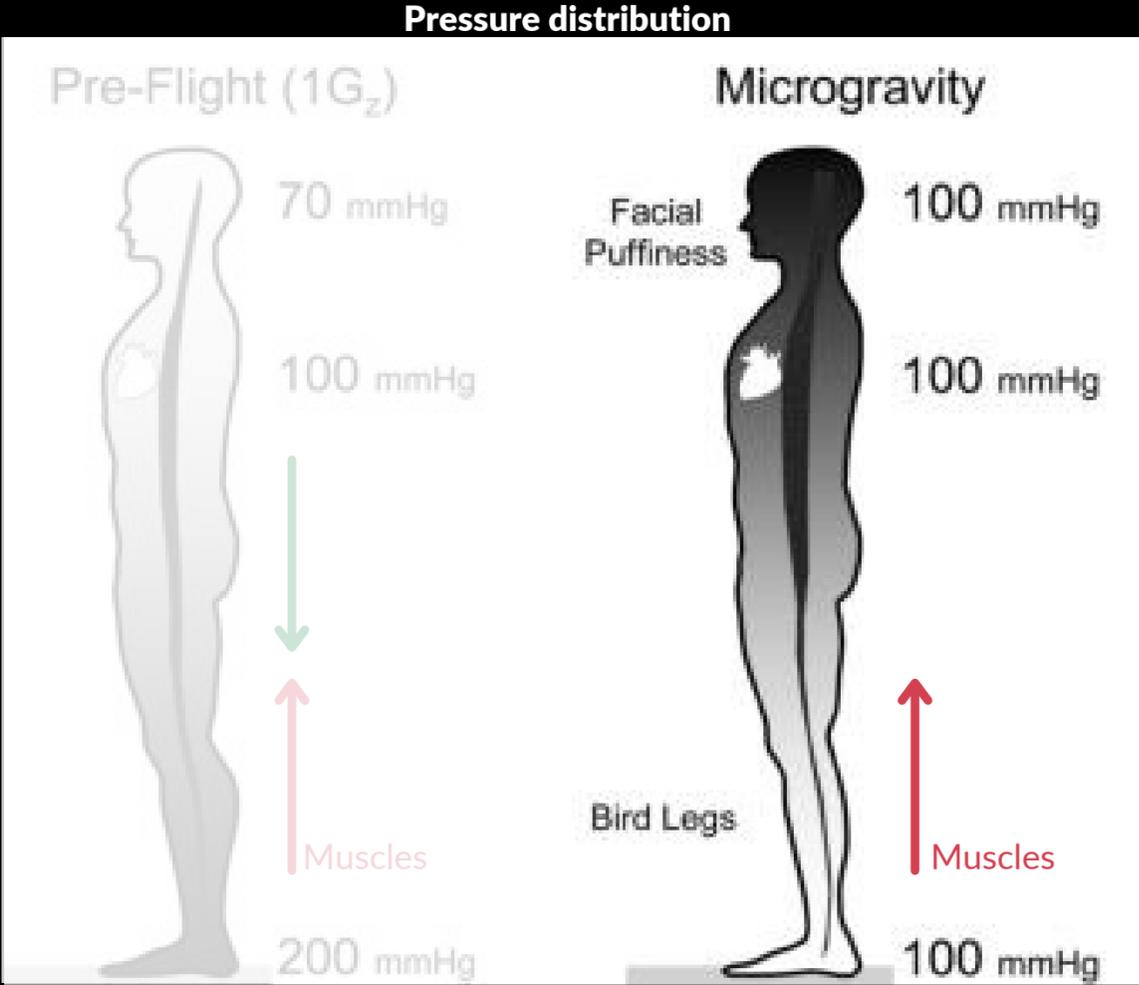


Pressure distribution



SPACE PHYSIOLOGY

Human body adaptation to microgravity



Lee, A. G. et al. (2020). Spaceflight associated neuro-ocular syndrome (SANS) and the neuro-ophthalmologic effects of microgravity: a review and an update. *Npj Microgravity*, 6(1). <https://doi.org/10.1038/s41526-020-0097-9>

Koppelmans, V. et al. (2016). Brain structural plasticity with spaceflight. *Npj Microgravity*, 2(1). <https://doi.org/10.1038/s41526-016-0001-9>



DISABILITY IN SPACE

Potential facilitations:

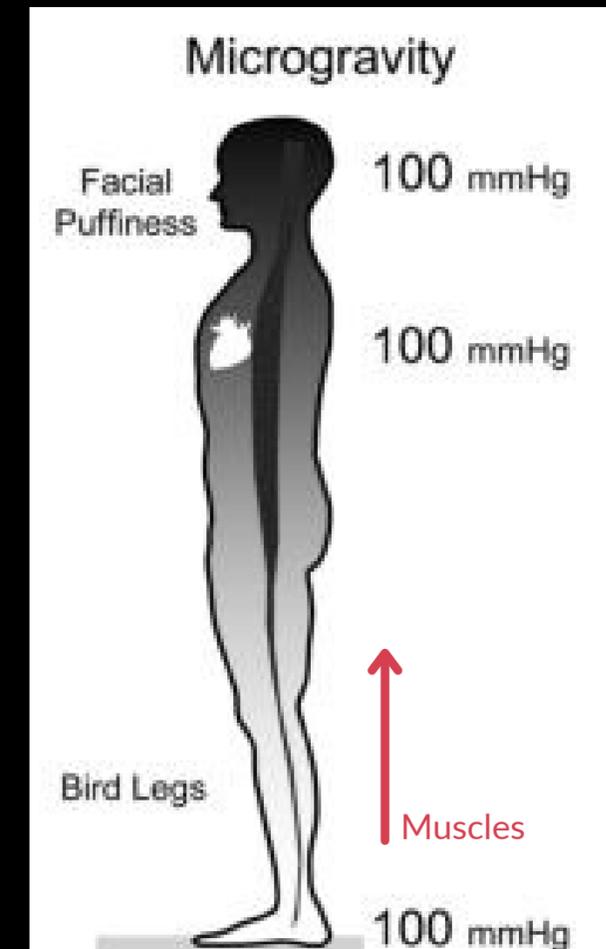
- Endurance, resilience, adaptability;
- Expected higher in-flight mobility;
- Potential less susceptibility to space adaptation syndrome (such as fluid shifts and postflight orthostasis).

Potential limitations:

- Advances of space build on the astronaut population only.



vs.

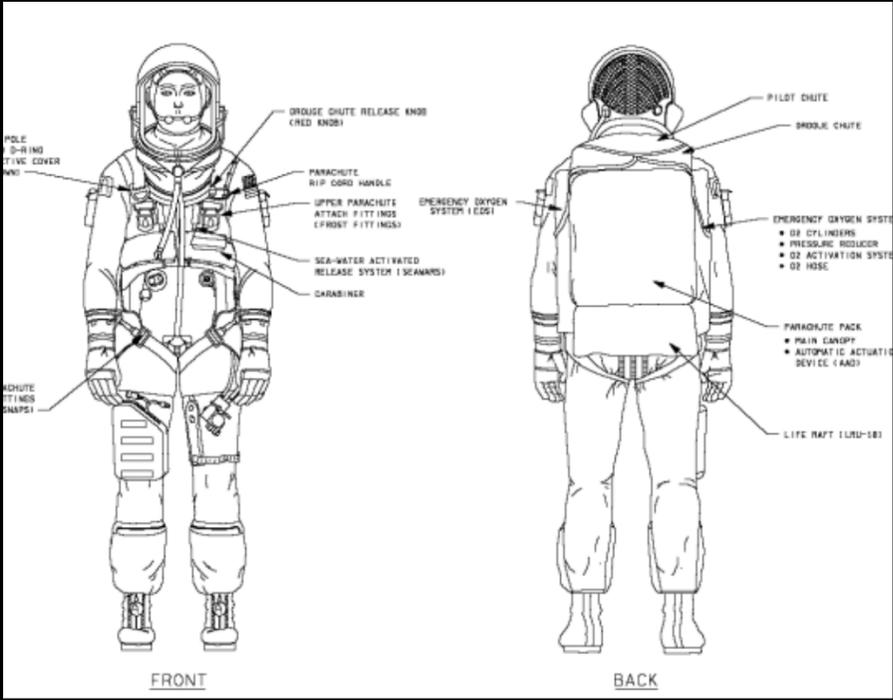


DISABILITY IN SPACE

Safety, protocols, mitigation strategies, countermeasures...



Astronauts practice emergency evacuation from the Orbiter - NASA



Personal parachute assembly - Crew Escape Systems 2005 - Workbook -NASA



NASA astronaut Jessica Meir - NASA

FLYING WITH A DISABILITY!



NASA astronaut Leland Melvin (STS 122 and STS-129) - NASA



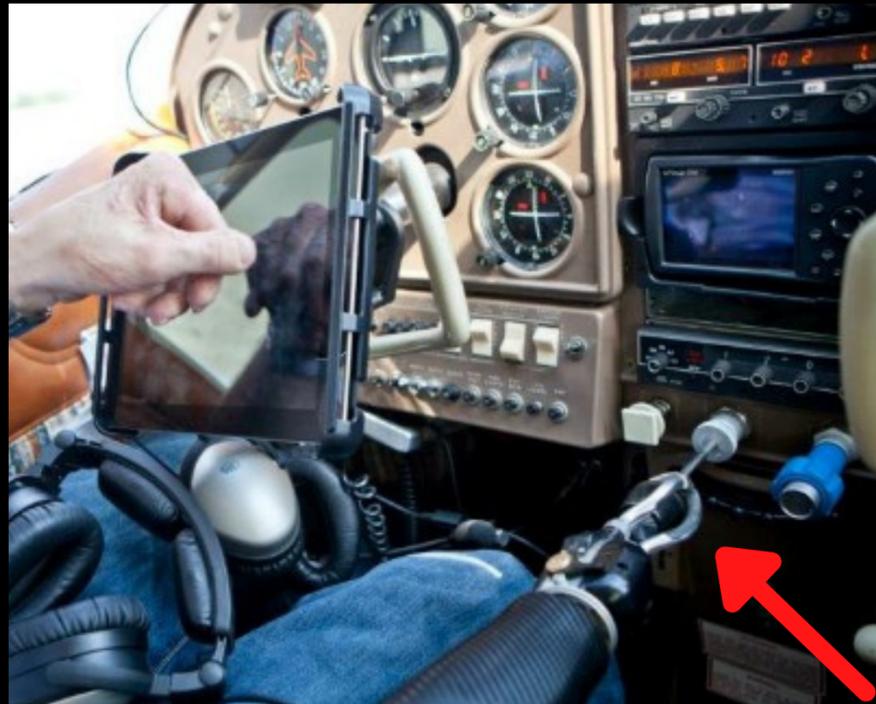
Stephen William Hawking - goZeroG



Children with disabilities experience weightlessness and lunar gravity on aircraft flights - ESA

DISABILITY IN AVIATION

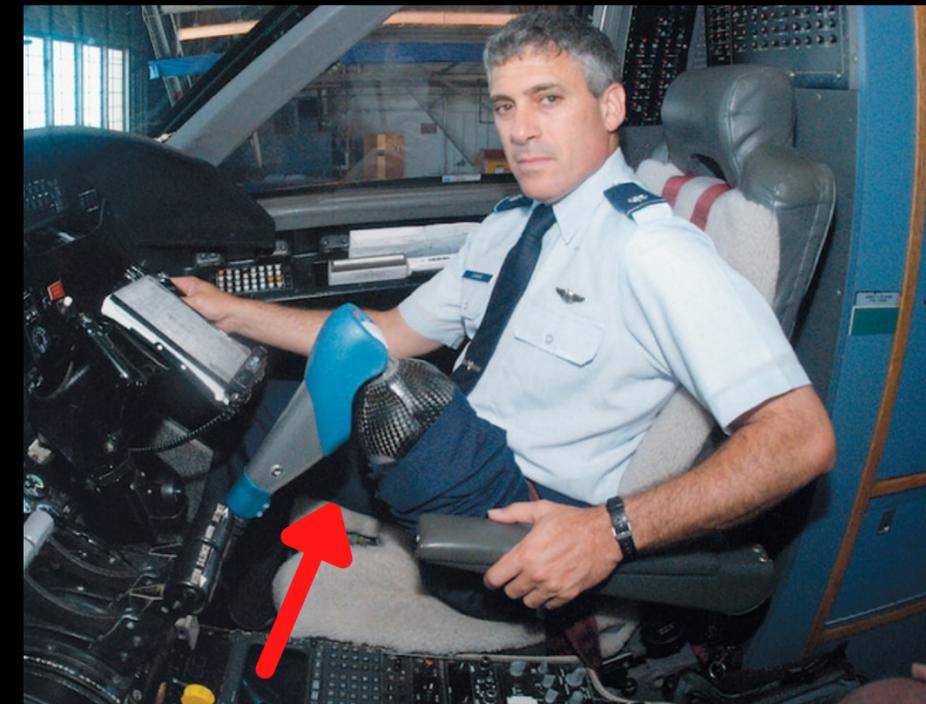
The "Functional Health" approach



Brian Thomas - CNN



Jessica Cox - AbleFlight.org



Lt. Col. Andrew Lourake - U.S. Air force

Jendle, J., et al. (2017). Pilots and Diabetes Technology: Functional Health. *Journal of Diabetes Science and Technology*, 11(2), 191-194. <https://doi.org/10.1177/1932296816680510>

Ricaurte, E., et al. (2018). Medical Certification Strategies in Response to Technologically Advanced Prosthetic Devices. June. https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2010s/media/201807.pdf



DISABILITY ON (SIMULATED) MARS

Analogue Missions



Mars Desert Research Station - Crew 172

...aim at simulating part of the complexity of a crewed mission on the ground and represent a possible *future* scenario of human life on the surface of a planet*.

*Cinelli, I. (2020). Short- and Long-Duration Mission Human Factors Requirements. In Seedhouse (Ed.), Handbook of Life Support Systems for Spacecraft and Extraterrestrial Habitats. Springer. https://doi.org/https://doi.org/10.1007/978-3-319-09575-2_34-1



ANALOGUE MISSIONS

Fidelity



Health

Stresses and stressors*



Location

Environmental aspects



Mission Design

Operational aspects

*Cinelli, I. (2020). Short- and Long-Duration Mission Human Factors Requirements. In Seedhouse (Ed.), Handbook of Life Support Systems for Spacecraft and Extra-terrestrial Habitats. Springer. https://doi.org/https://doi.org/10.1007/978-3-319-09575-2_34-1



DISABILITY ON (SIMULATED) MARS

Safety



Mars Desert Research Station



Mars Desert Research Station - Crew 200



Mars Desert Research Station - Crew 172



Can people *acquire a disability on* ~~with disabilities go to~~ Mars?

Medical standards vs. safety - Incapacitation, impairment, limitation and disability cannot be excluded from future flights and can be addressed by improving safety.

Possible future scenarios of incoming planetary surface missions or missions requiring a higher level of autonomy (level of care > III*):

- A person with a disability is heading to space or on a Planet;
- A person acquires a disability in space or on a Planet;
- A person acquires a disability during re-entry, taking off or landing.



*NASA. (2015). NASA Space Flight Human-System Standard - REVISION A: CREW HEALTH (Vol. 1). <https://standards.nasa.gov/human-factors-and-health>



In space, there are humans... but humanity?

Thank you!

