Outer Space

The Last Frontier Changes Our Neuronal Constellation

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INTRODUCTION

Mankind dreams of space since as long as the first stars blinked in the first men's eyes. Recently, plans for humans to travel to Mars have been publicly announced and publicized extensively. To reach Mars, humans will have to travel for about 250 days, needing around the same time to come back to Earth.

Though for long difficulties were based on technology to leave Earth and move through space, now the questions are of another kind: are humans able to survive such a trip?

CHALLENGES

There are various phenomena that our travelers will have to look out for, even if they don't jump into an alien ship:

- Radiation (solar cosmic rays, radiation belts of Earth, and galactic cosmic rays with at least 1% Heavy Charged Particles)
- Microgravity
- Macrogravity
- Hypomagnetic field
- Temperature

Also, the spaceship, even though it will certainly be the latest model, it still won't be the most pleasant place to live in for so long:

- It's cramped
- Has constant noise
- 6 to 7 people crew
- 2-way communication with Earth goes up to 44 min

Our biology catches up to us:

- Circadian rhythm
- Cardiovascular changes
- Resurfacing of latent viruses with immunity changes

And we can't escape travelling with ourselves:

- Solitude
- Leadership problems
- Division into groups
- Culture and language differences
- Interrelationships
- Earth out of sight phenomenon
- Bur out
- Keeping track of urine and blood analysis – another needle?
- How's the food taste today?
- I hope this pain isn't vesicular lithiasis...
- Are the children alright?

HURDLES

There are no perfect models to simulate space. The International Space Station (ISS) is too close to Earth to mimic space conditions, parabolic flights only keep 0-gravity for 25 sec, extreme environments such as confinement can't reproduce the psychological challenges of outer space, laboratories immerse subjects in water, lay them in beds with a 6° tilt downwards or irradiate animals with 1 or 2 types of radiation for a small amount of time, which differs from space. The subject sample is very small to draw and generalize conclusions. To overcome this, studies use small animals who differ from humans. Also, it's technically difficult and costly to use assessment tools like an MRI in space. Cognitive tests don't show impairments as the astronaut/cosmonaut community is highly differentiated. In ISS many research studies run in short periods of time, with low availability for studies on brain changes. Each phenomenon is studied separately. What's the combined effect of them all? To complicate things further, 75% of space travellers uses hypnotics during their stay in space.

CHANGES

Besides tumours, space radiation impairs cognitive abilities, reduces dopamine, noradrenaline and serotonin in the cortex prefrontalis affecting emotion, attention, spatial learning and contextual memory. Inflammation will reduce neurogenesis. In space core body temperature rises up to 1°C. Space travellers sleep a mean of 6h/day, which is lower than the average adult, also, day/night cycles in the ISS are about 90 minutes. They usually complain of being tired, lacking concentration and motivation – Russian cosmonauts consider it a single disease. There are sensorium changes from small lights in the visual camp to changes in smell. Posture and balance are altered. Cardiovascular changes in distribution alter cerebral vasculature and cerebrospinal fluid space. Pharmacokinetics and pharmacodynamics differ from Earth.

And that's all focusing in the brain, just trying to reach Mars.

CONCLUSION

Mankind has always been up for a good challenge; we are nomads by nature, adaptative, lucky and defious. We'll conquer space and beyond!

Currently on the ISS

Commander Alexey Ovchinin
Nick Hague
Luca Parmitano
Alexander Skvortsov
Andrew Morgan
Christina Koch