Cortical reorganization in an astronaut's brain after long duration spaceflight

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Our bodies in space

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REVIEW ARTICLE OPEN

Spaceflight-induced neuroplasticity in humans as measured by MRI: what do we know so far?

Angelique Van Ombergen[1,2,3], Steven Laureys[4], Stefan Sunaert[5], Elena Tomilovskaya[6], Paul M. Parizel[7] and Floris L. Wuyts[1,3]

Some organ systems have been studied thoroughly

- cardiovascular
- immune
- musculoskeletal systems

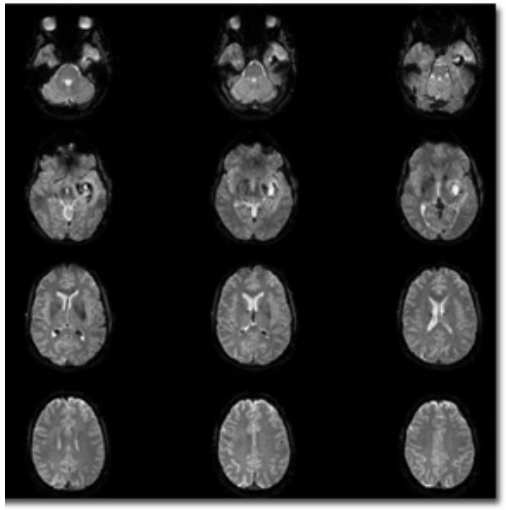
But the brain?

Measuring brain activity

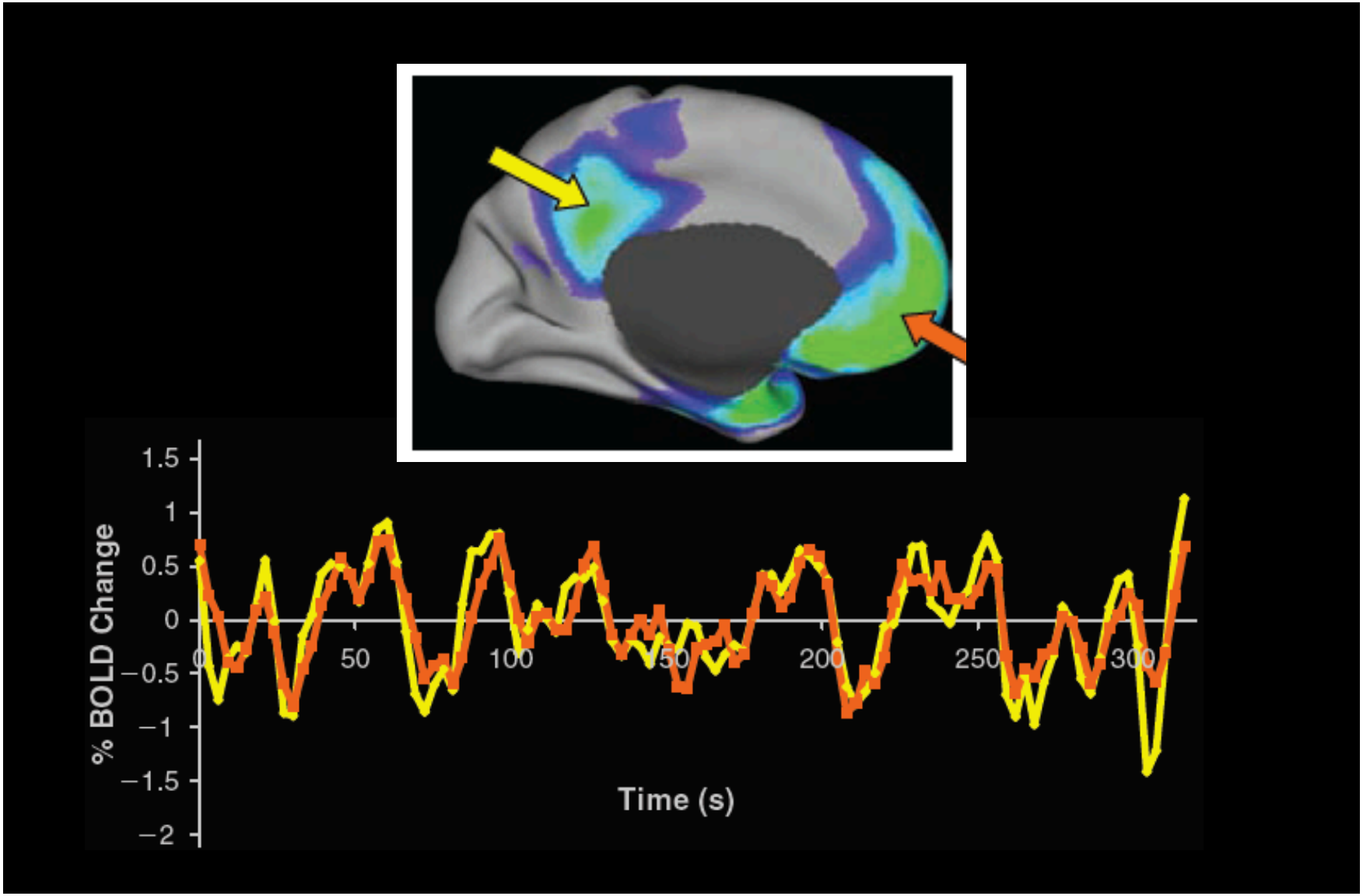
MRI scanner

structure

function



The brain works by default (1)

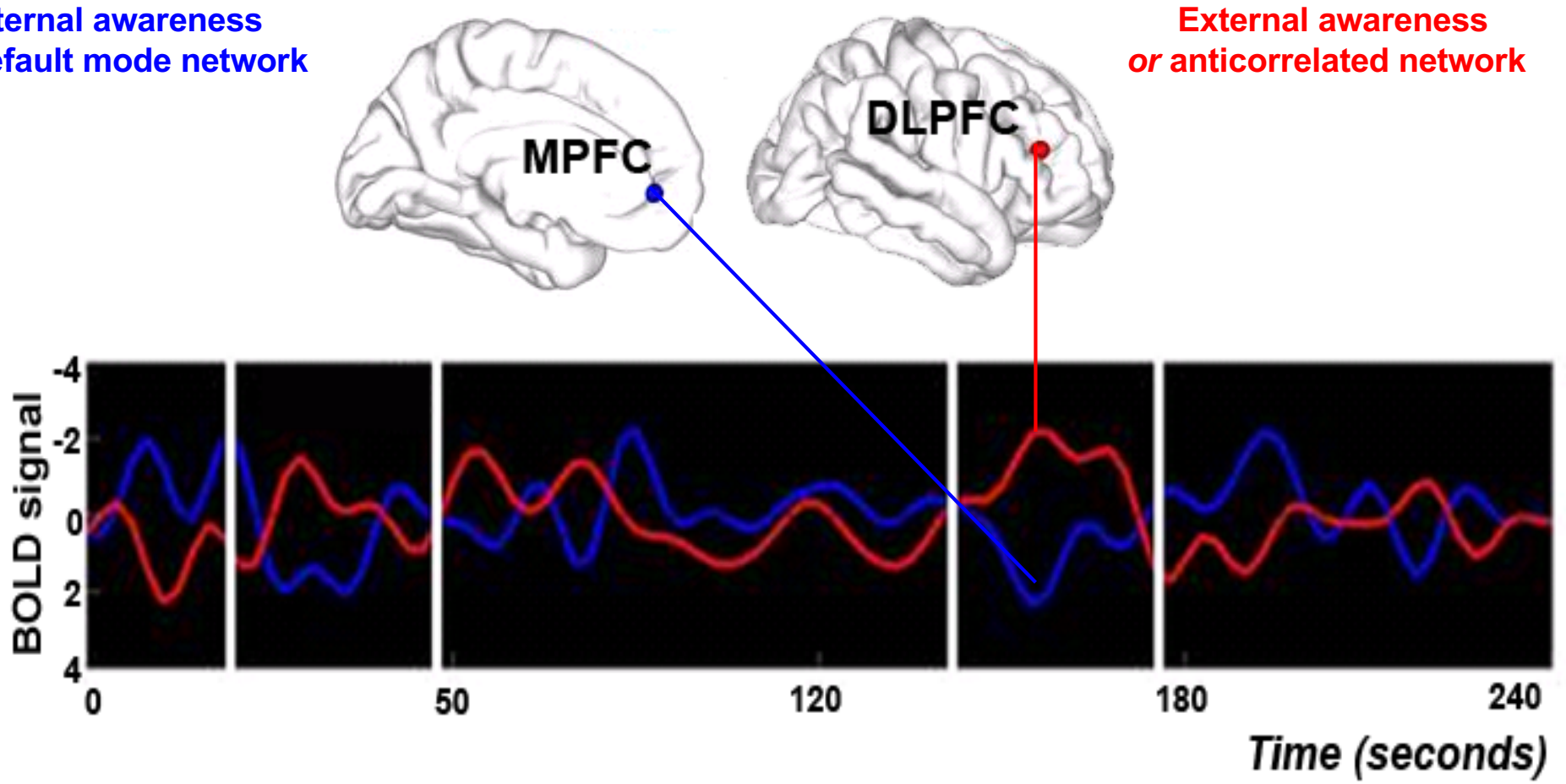


Raichle & Snyder. Intrinsic Brain Activity and Consciousness. In: Laureys S, Tononi G, editors. The Neurology of Consciousness. Oxford: Elsevier Academic Press; 2009. p. 81-48

The brain works by default (2)

Internal awareness
***or* Default mode network**

External awareness
***or* anticorrelated network**



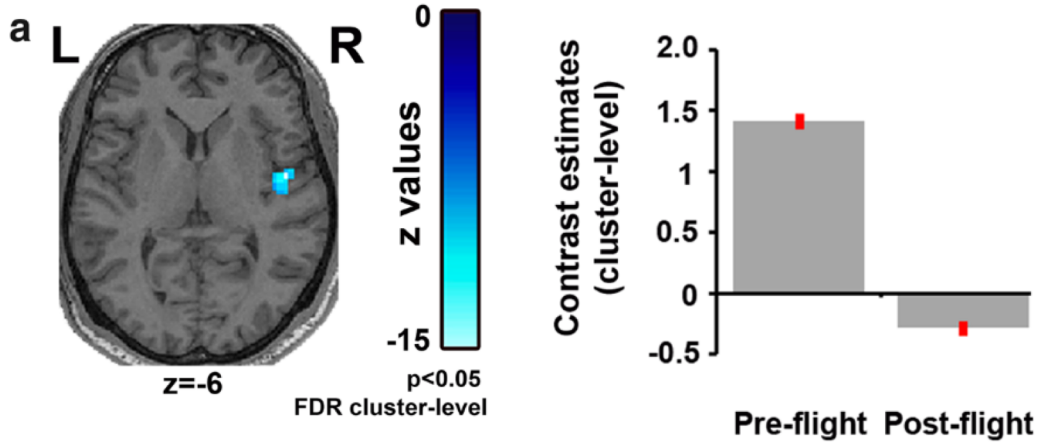
Demertzi & Whitfield-Gabrieli, in: *Neurology of Consciousness* 2nd ed. *2015*
Demertzi, Soddu, Laureys, Curr Opin Neurobiology 2013; Demertzi et al, Front Hum Neurosci 2013

Cortical reorganization in an astronaut's brain after long-duration spaceflight

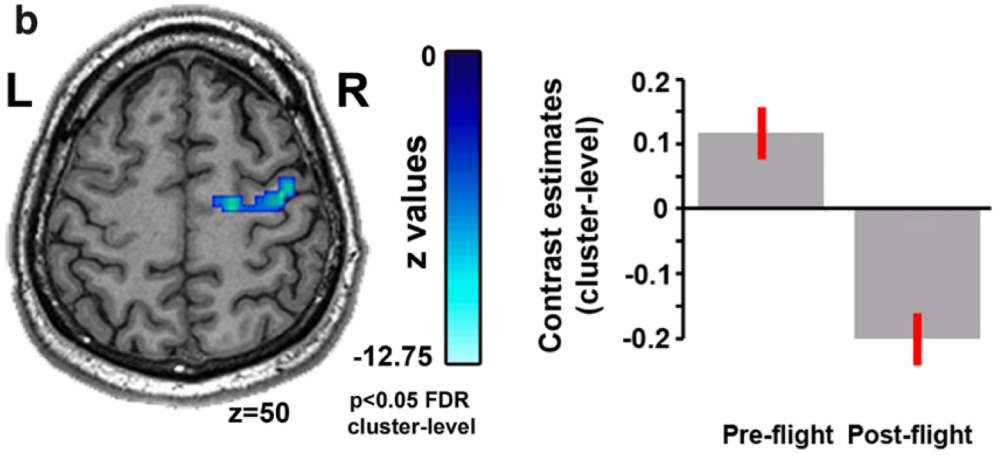
44-year-old male cosmonaut
First long-duration mission (169 days) to the ISS in 2014
fMRI protocol pre-flight: 30 days, post-flight: 9 days after Earth re-entry

European Space Agency

Hypothesis-free



Hypothesis-driven



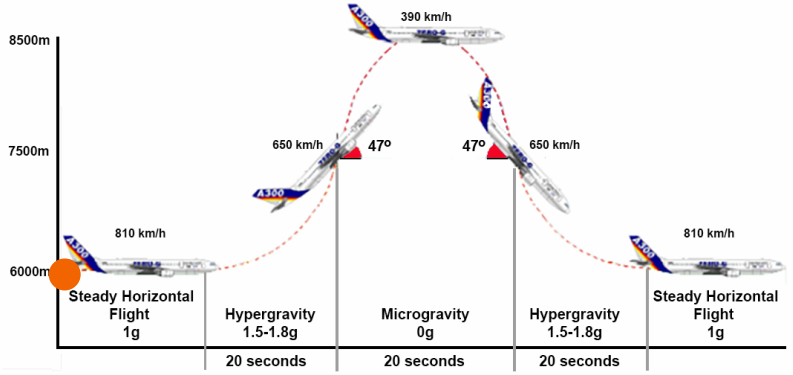
Demertzi & Van Ombergen et al, Brain Structure and Function 2015

Less anticorrelated activity after exposure to microgravity

SCIENTIFIC REPORTS

www.nature.com/scientificreports/

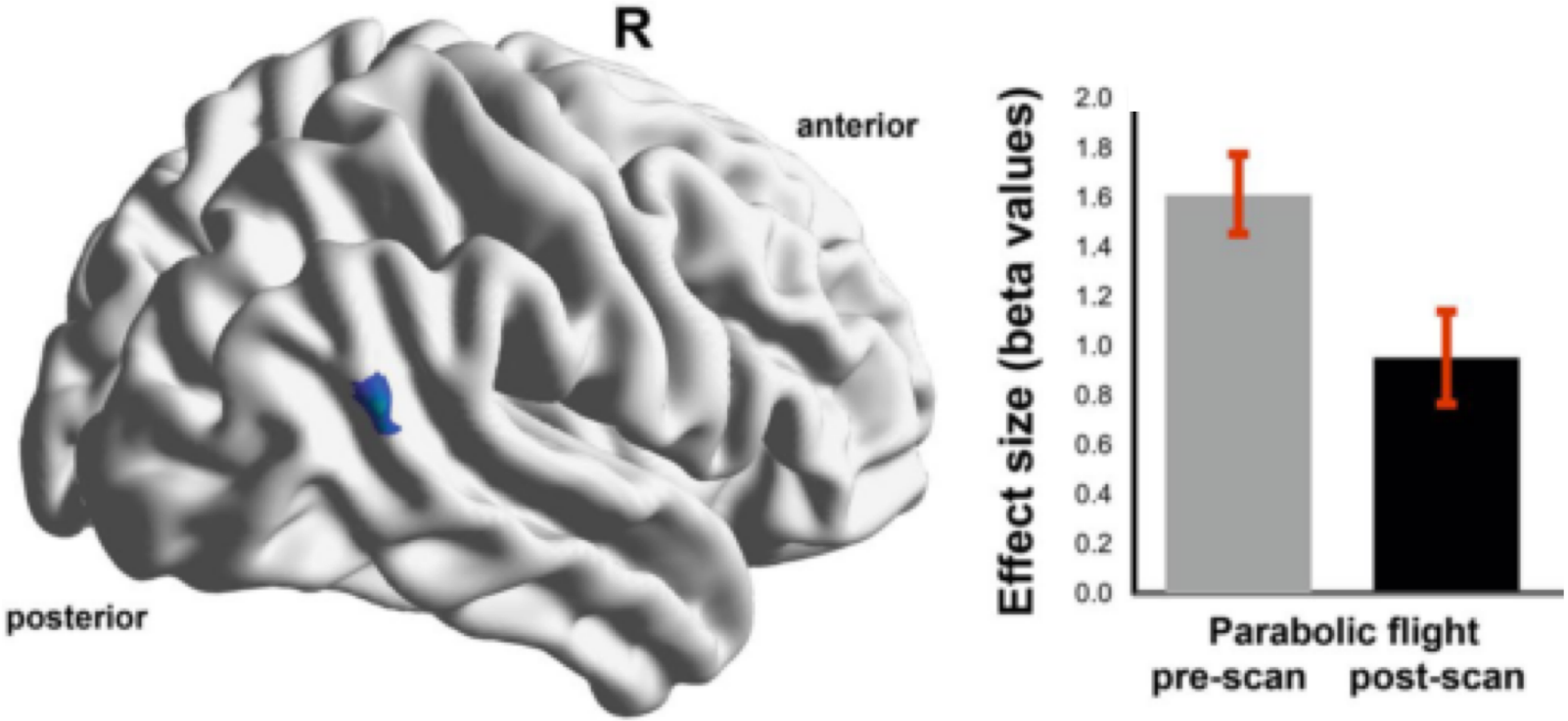
Parabolic flight



Parabolic flight trajectory

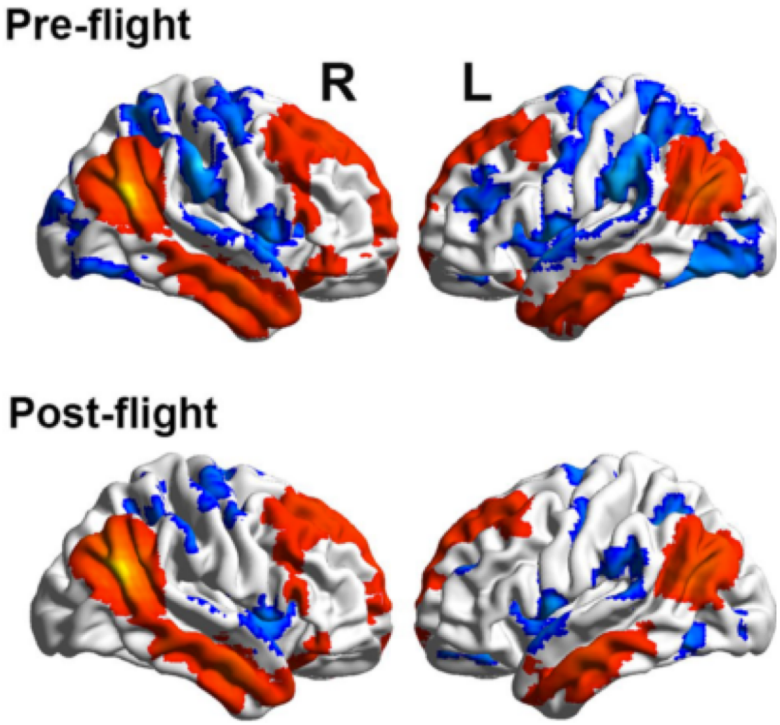
Angelique Van Ombergen[1], Floris L. Wuyts[1], Ben Jeurissen[2], Jan Sijbers[2], Floris Vanhevel[3], Steven Jillings[1], Paul M. Parizel[3], Stefan Sunaert[4], Paul H. Van de Heyning[1], Vincent Dousset[5], Steven Laureys[6] & Athena Demertzi[6,7]

Intrinsic connectivity in PF (1)

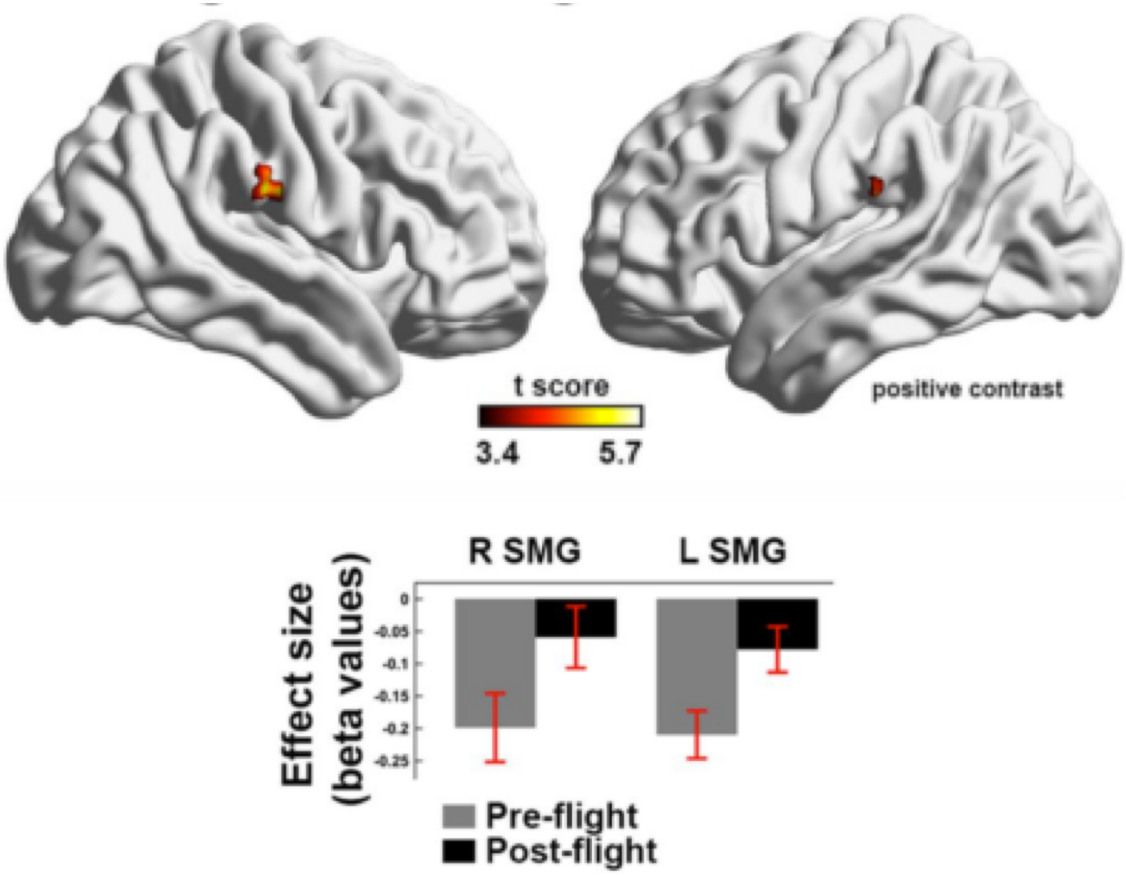


Van Ombergen … and Demertzi, Sci Reports 2017

Anticorrelations decrease after PF



Post - Pre



Van Ombergen … and Demertzi, Sci Reports 2017

Conclusions

- fMRI resting state connectivity can be utilized to assess the ongoing mind by proxy
- After exposure to gravity alterations the brain's default function changes
- Results relevant for future planetary missions, vestibular disorders and the neuroscientific study of bodily consciousness

Thank you!

MIND SCIENCE FOUNDATION

Human Brain Project

James S. McDonnell Foundation

Université de Liège

GIGA



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