

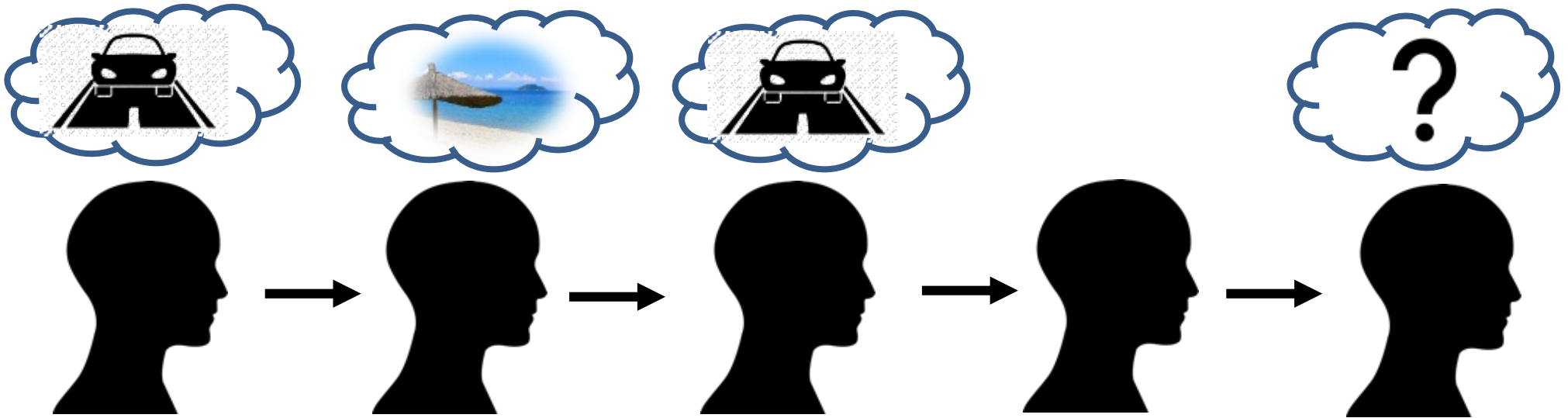


Mind blanking as involuntary manifestation of contentless thinking

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University of Liège
BELGIUM

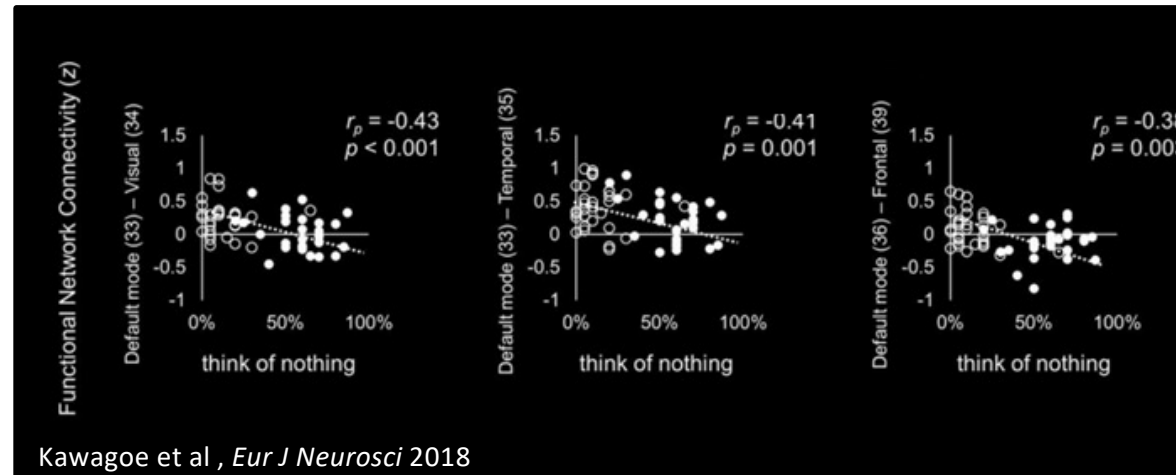
Mental states



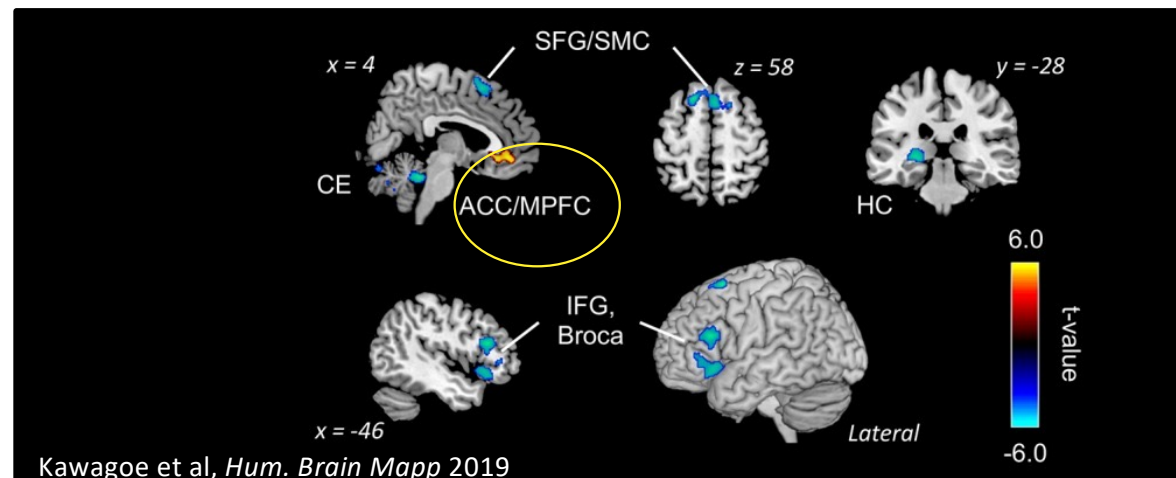
Slide courtesy: Boulakis Paris, Physiology of Cognition Lab

Voluntary Mind Blanking?

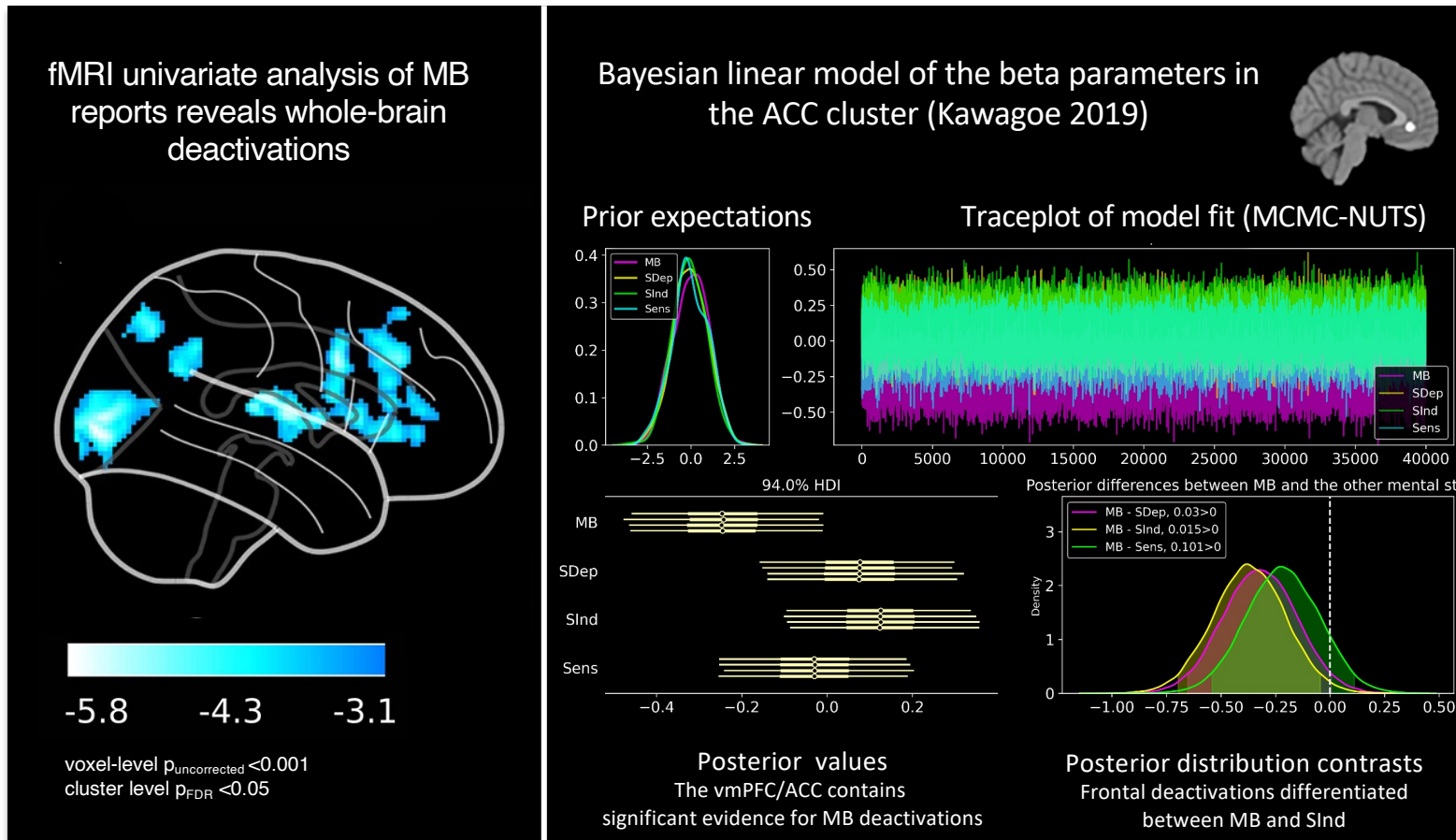
"Keep awake, fixate on the cross, and think of nothing as best you can. When you realise that you are thinking about something, disengage your attention and again try to think of nothing".



"When you realize that you are thinking about something, disengage your attention and again try to think of nothing during the scans"

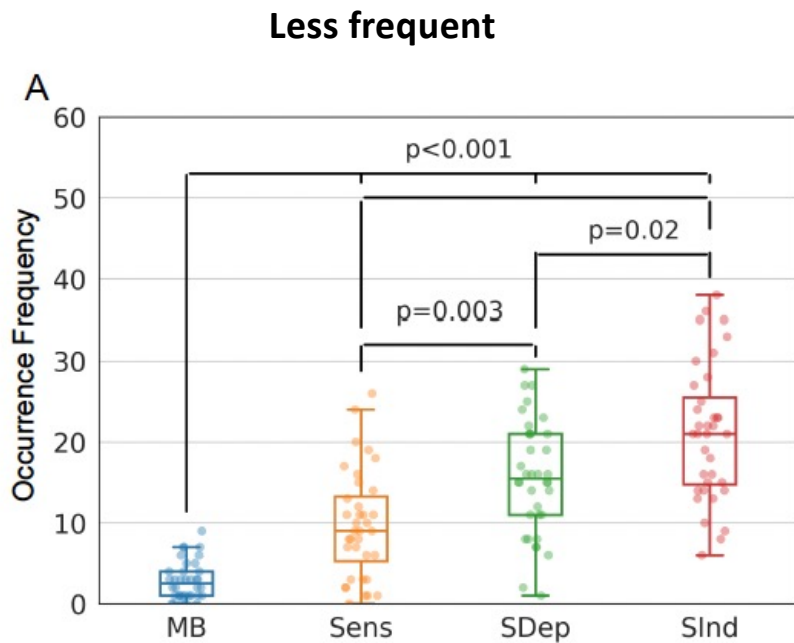


Non-induced Mind Blanking

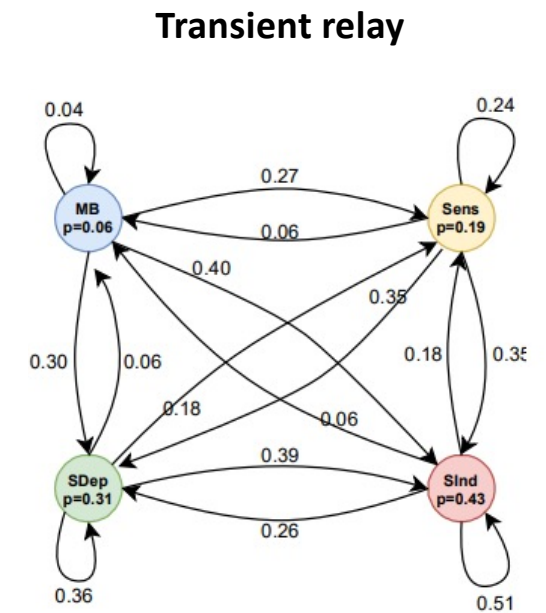
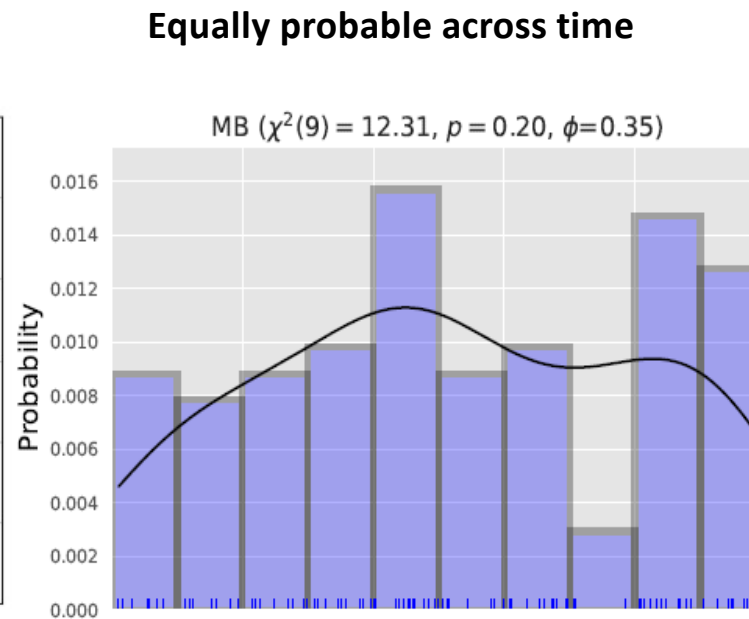


Boulakis, Mortaheb, Van Calster, Majerus, Demertzi. *JNeurosci* 2023

Mind Blanking reports happen spontaneously



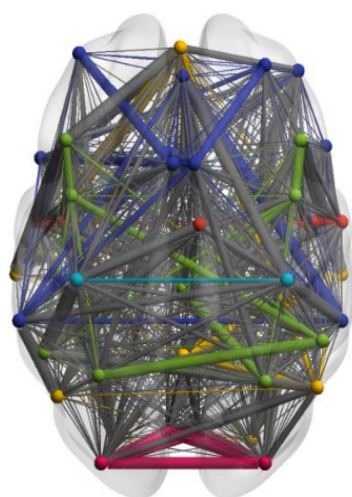
N participants = 36



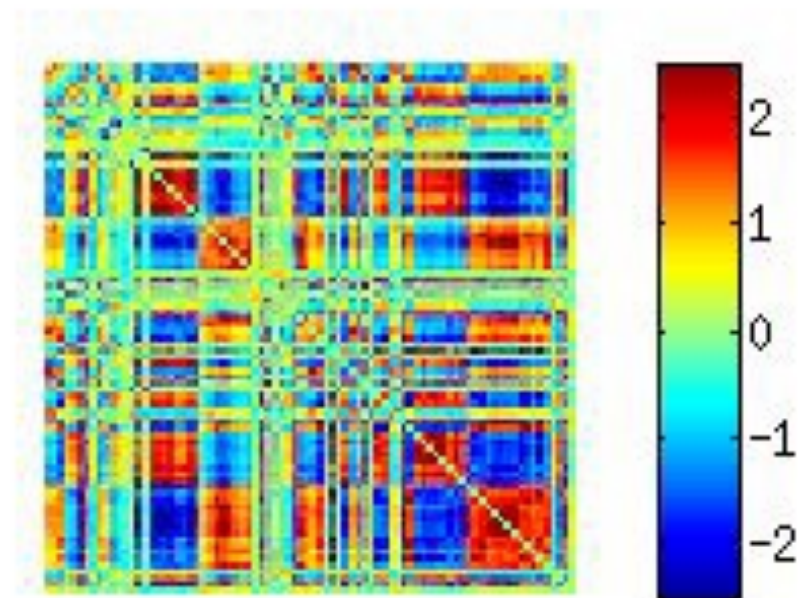
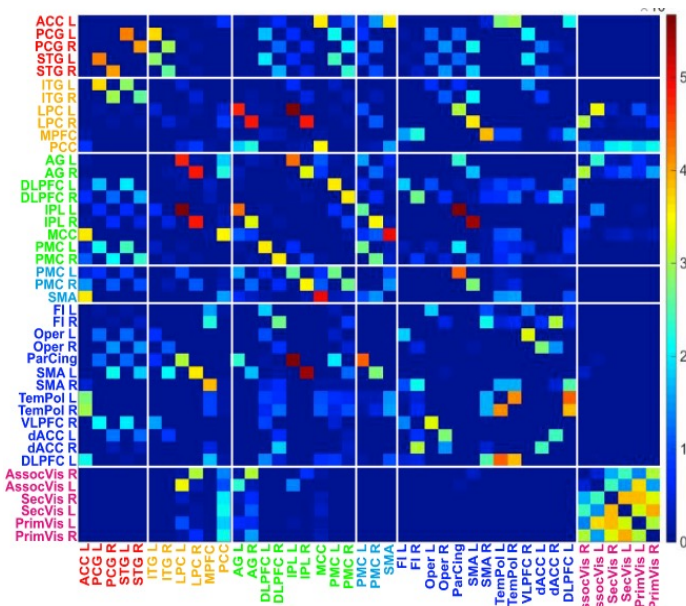
The brain as a network

100 billion neurons, ~100 trillion synaptic connections

The Connectome



Aud DMN FP
Mot Sal Vis

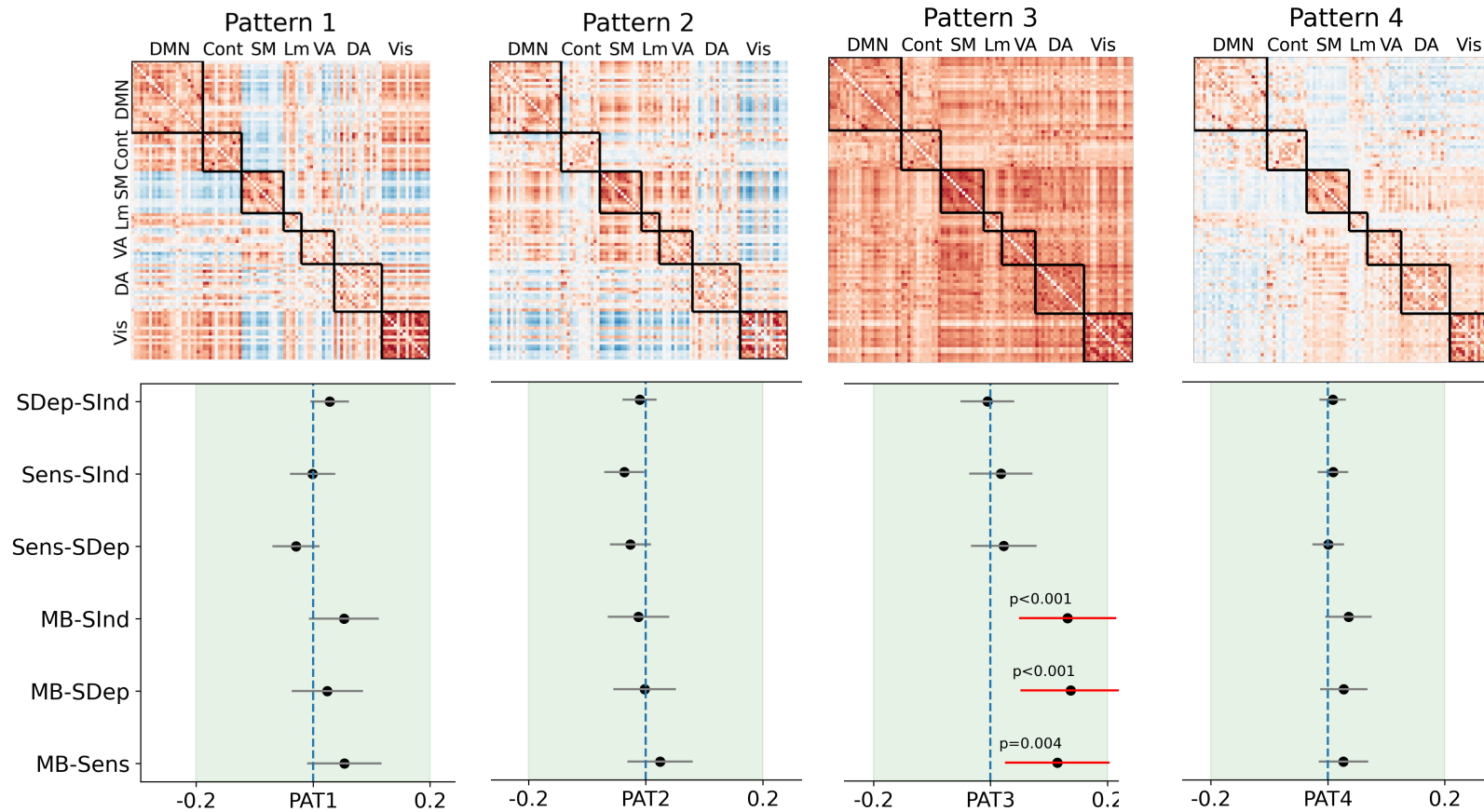


Fornito, Zalesky, Bullmore. Ch 1: An Introduction to Brain Networks. *Fundamentals of Brain Network Analysis*, Academic Press 2016

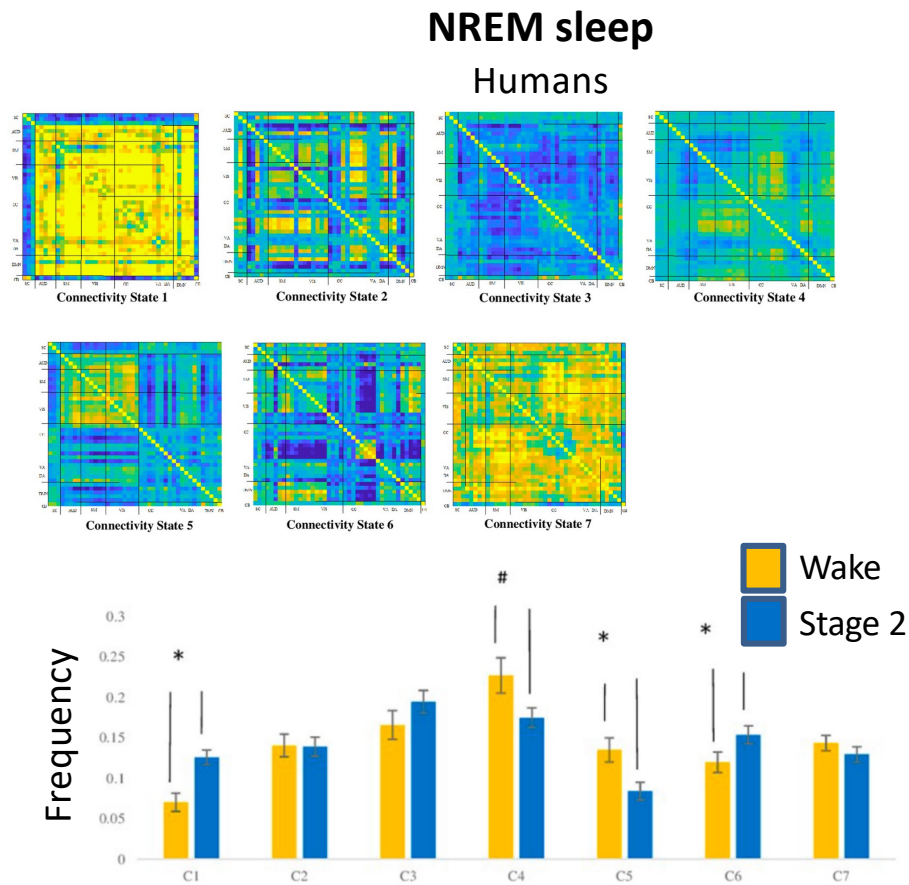
Sporns, Tononi, & Koetter. *PLoS Comput Biol* 2005

Image from: Demertzi & Tagliazucchi, Dehaene, Deco, Bartfeld, Raimondo [...] Sitt. *Science Advances* 2019

MB is linked to a hyper-connected state

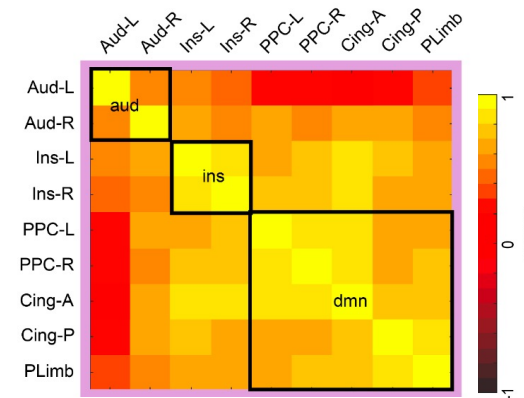
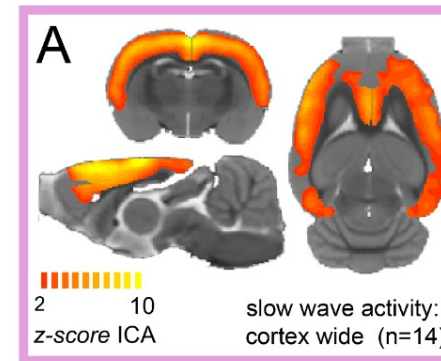


Higher connectivity in unconscious states



El-Baba et al, *PLOS One* 2019

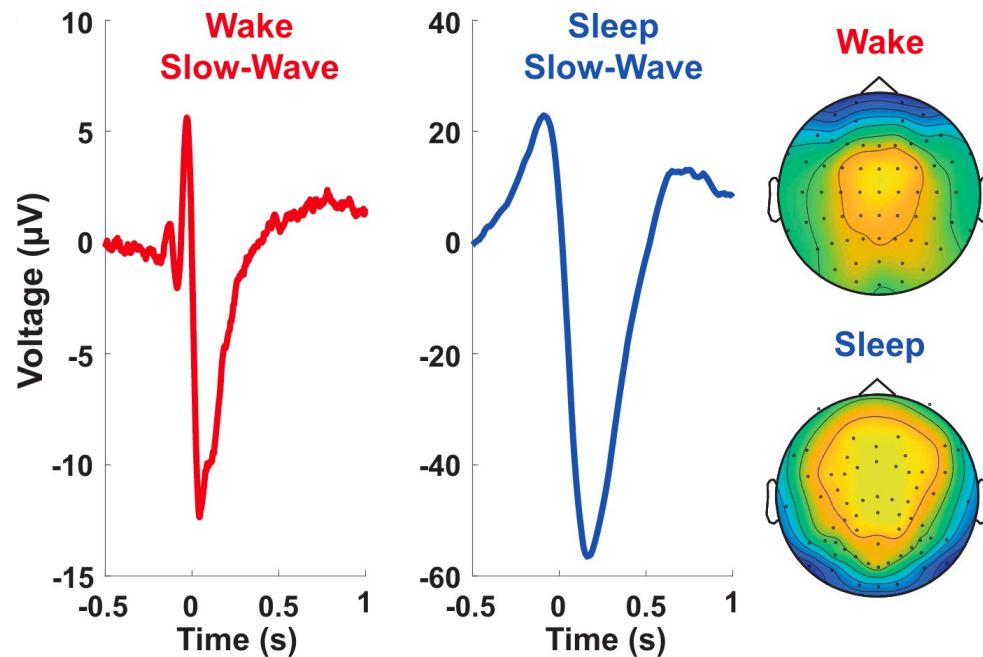
Isoflurane anesthesia Rats



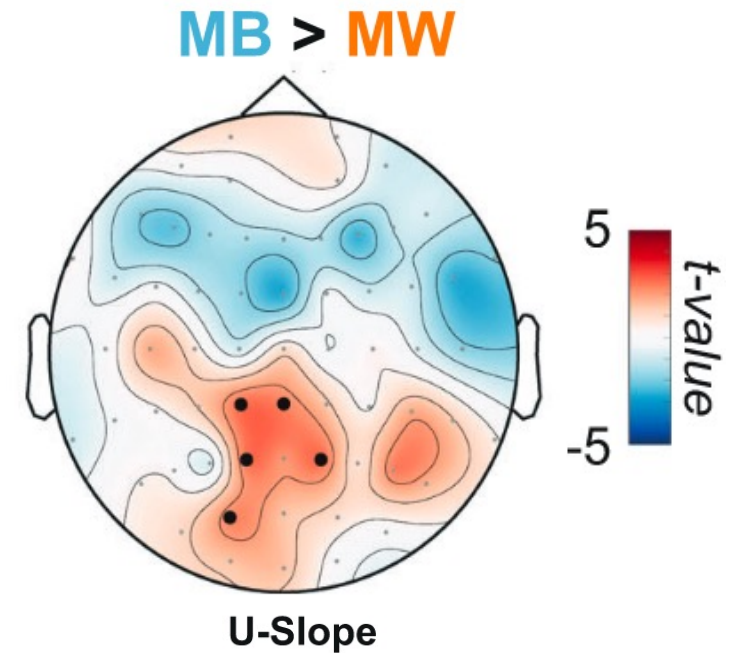
Aedo-Jury et al, *eLife* 2019

Slow wave activity in wakefulness: “local sleeps”

Properties of slow waves

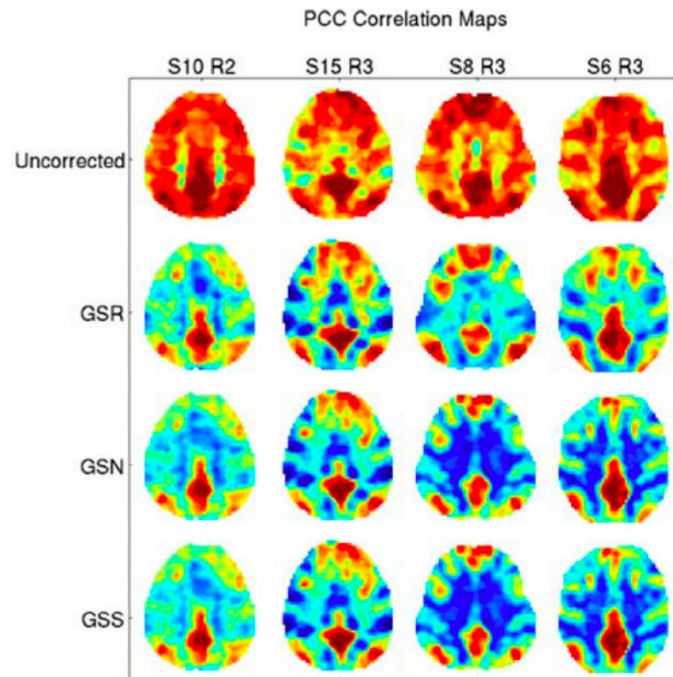


Predictive of mental states



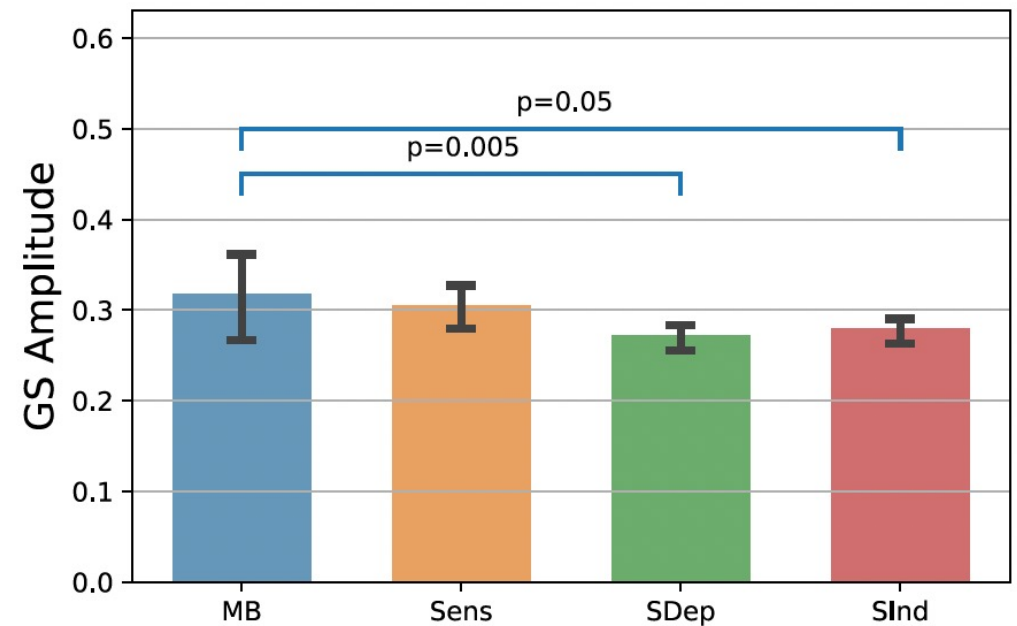
Higher connectivity and BOLD

The Global Signal



Liu et al, *NeuroImage* 2017

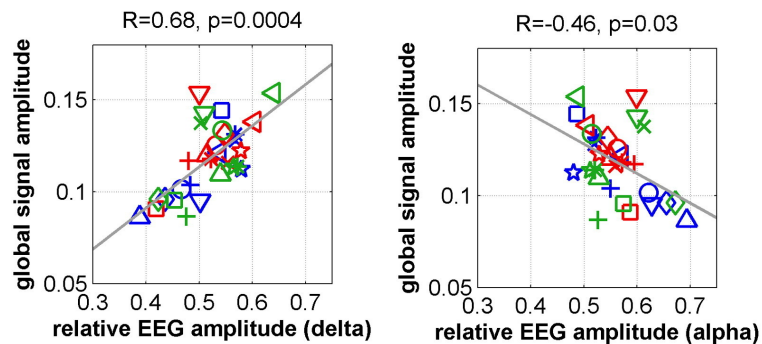
Higher Global Signal Amplitude around MB reports



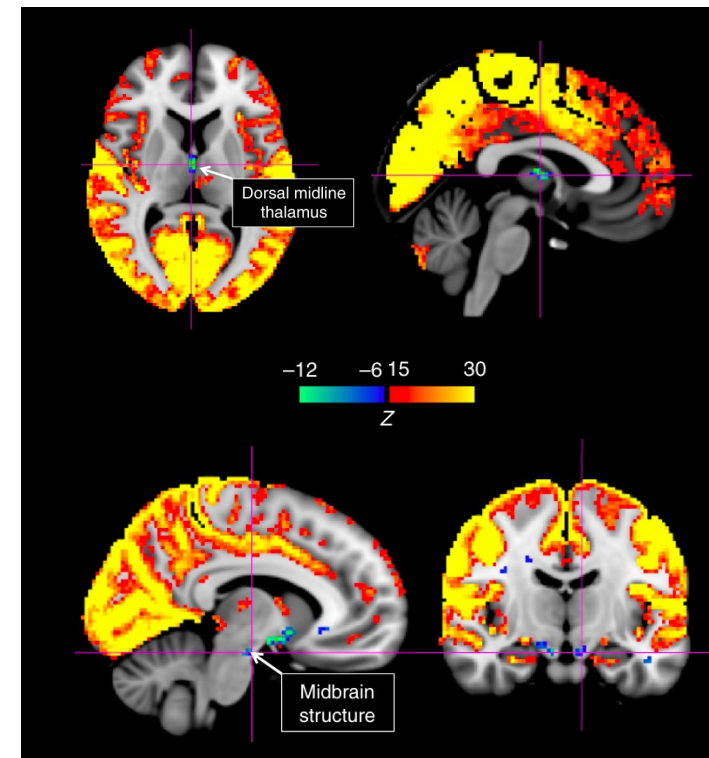
Mortaheb et al, *PNAS* 2022

Global Signal amplitude reflects levels of vigilance

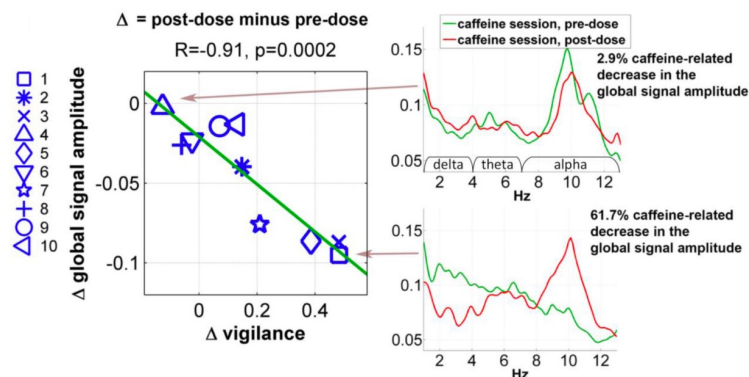
GS amplitude is linked to low arousal



GS amplitude linked to signal decreases in subcortical structures of arousal



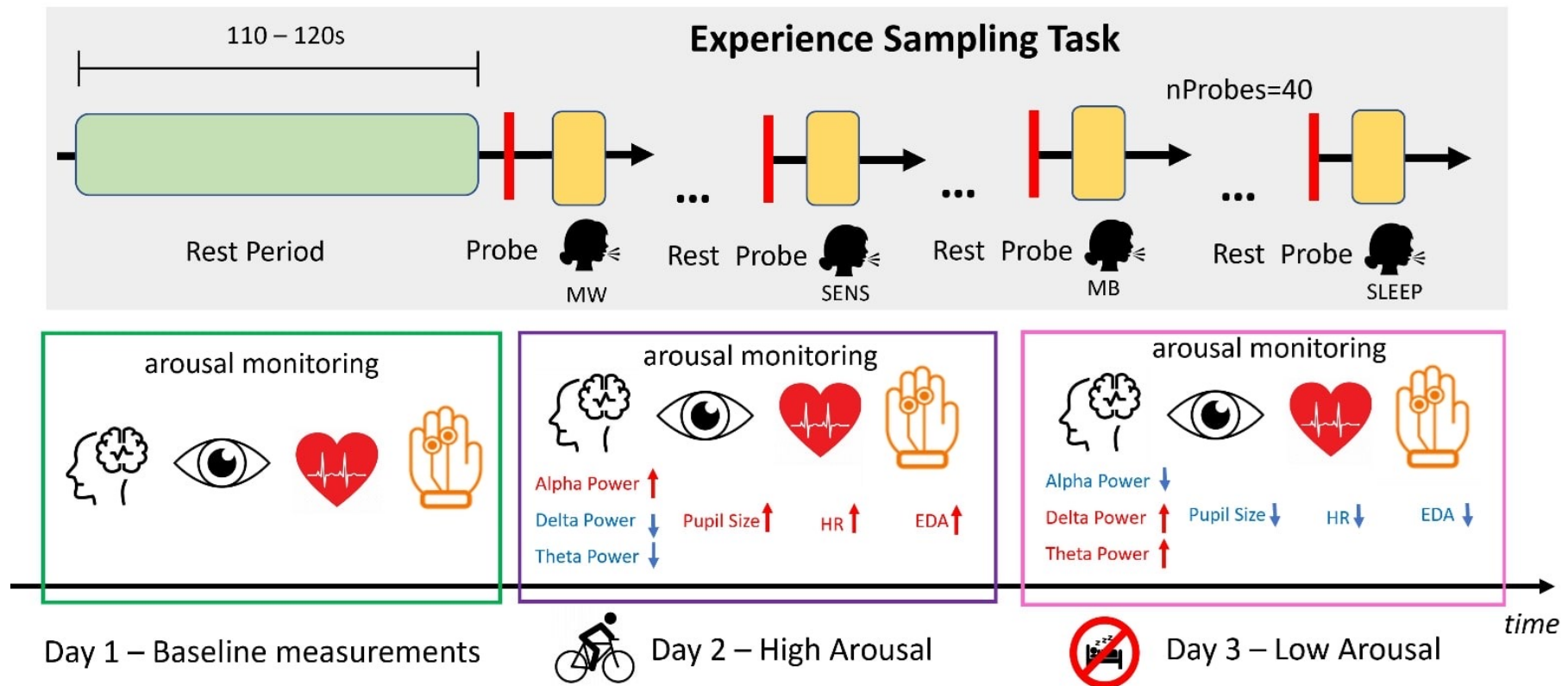
GS amplitude decreases with caffeine intake



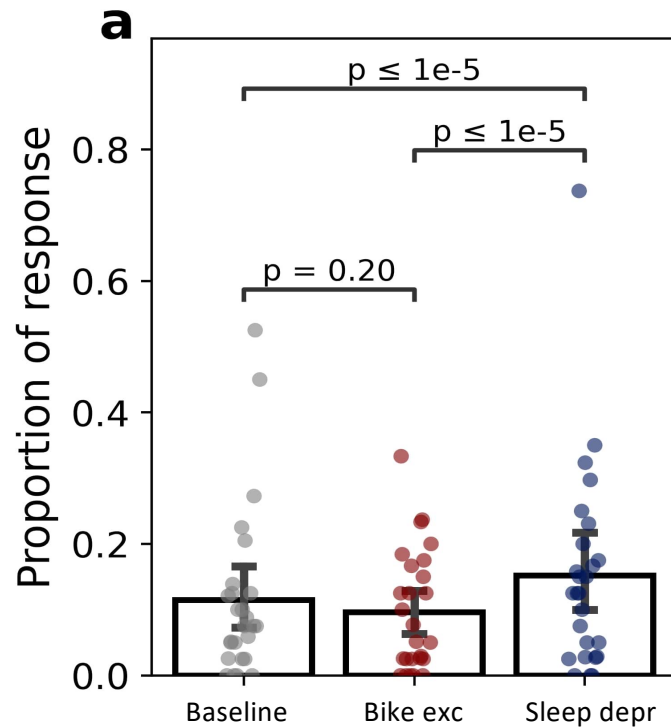
Wong et al, *Neuroimage* 2013

Liu et al, *Nat Communications* 2018

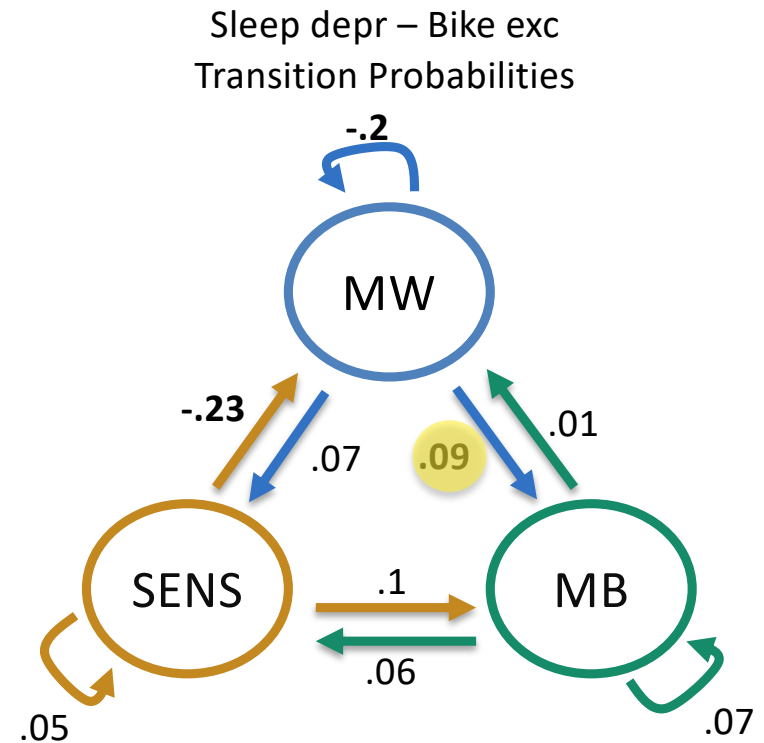
Do arousal variations mediate MB?



Altered arousal increases MB reports

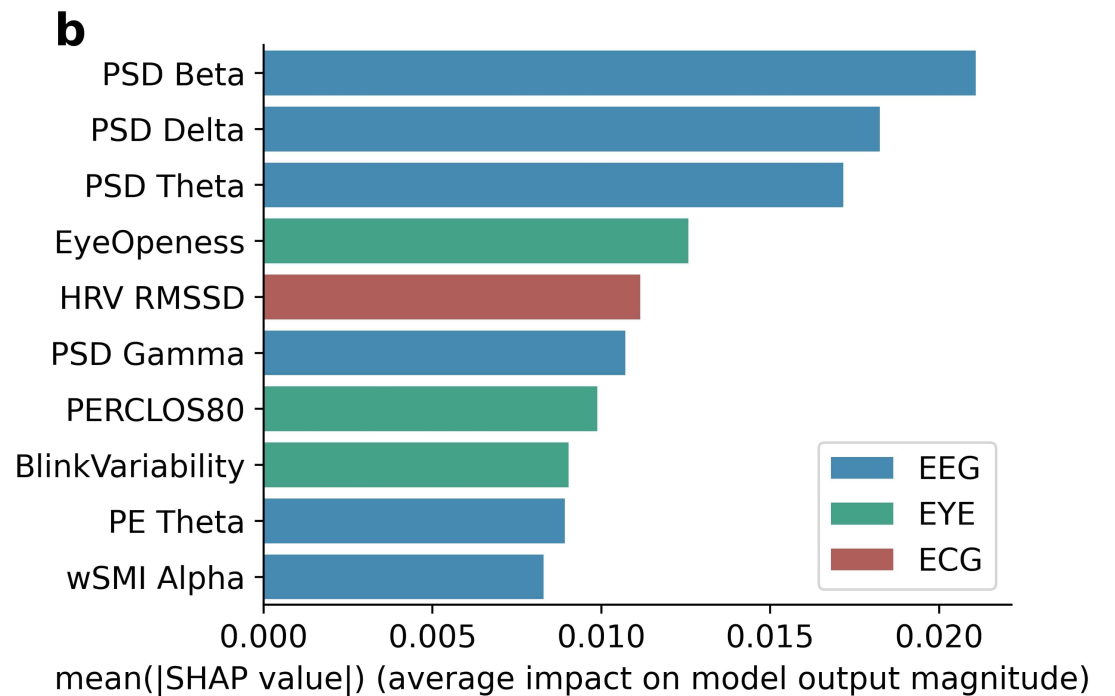
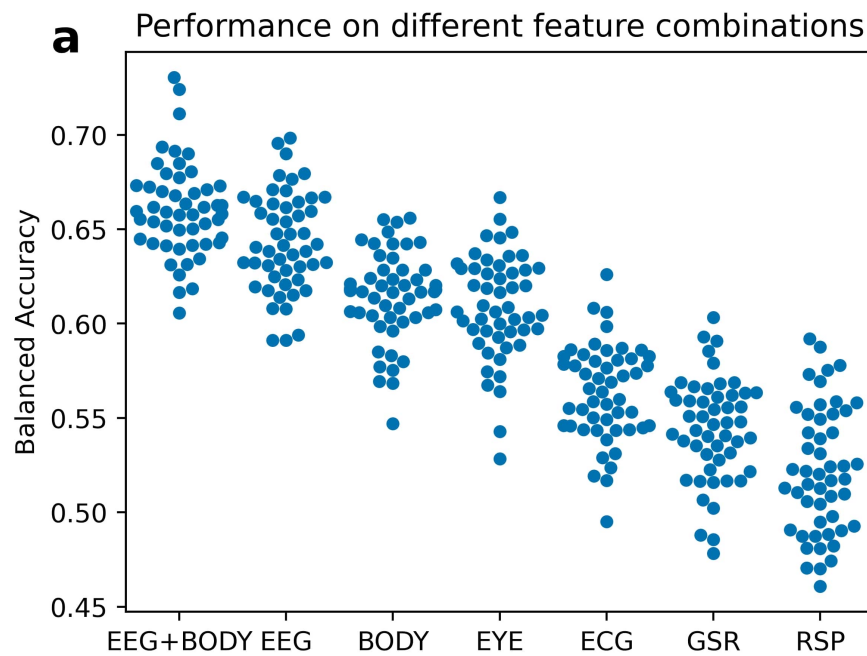


BUT MB was more frequent in first half of post-exercise vs. second half (divergence = 4.08, $p = 3.2e-02$)



MB has a unique brain-body profile

MB vs. other states



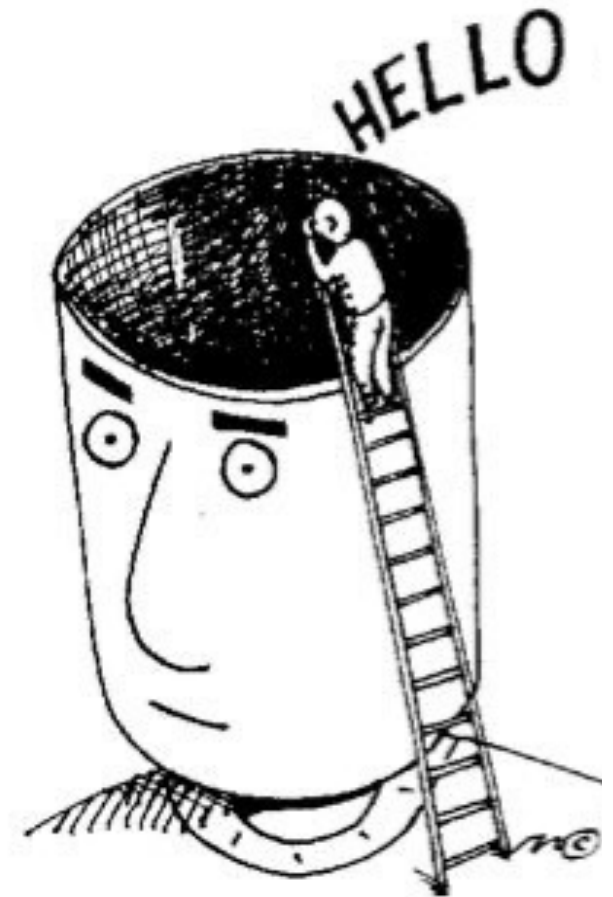
Summary

Mind Blanking reports:

- are uniform time in typical waking
- are more frequent after sleep deprivation
- are more frequent after immediate physical exercise
- are "spontaneous" (but also can be induced, forgotten, undetected) *Andrillon, Lutz, Windt, Demertzi (in prep).*



MB is a default mental state during ongoing thinking





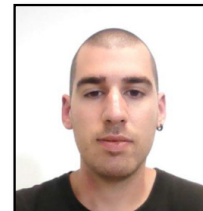
PHYSIOLOGY OF COGNITION Lab



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Mortaheb, PhD



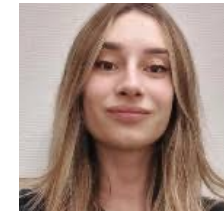
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Boulakis



Larry D
Fort



Nikos J
Simos



Stefania
Zoi

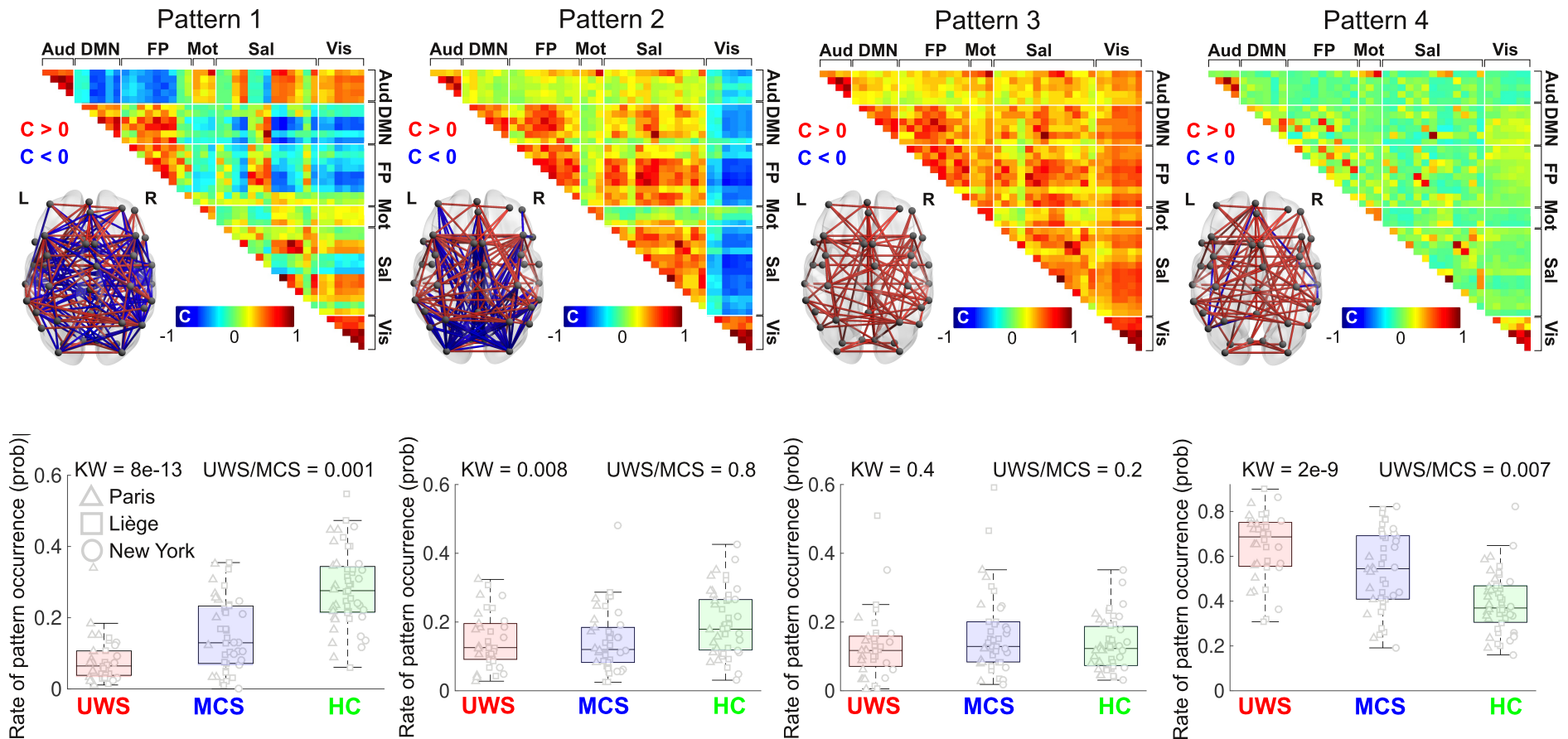
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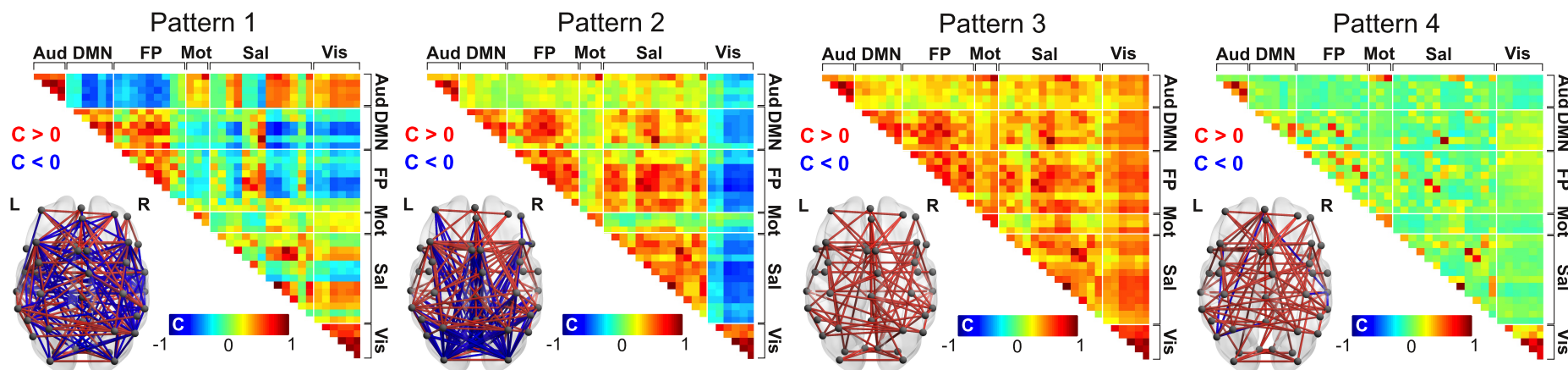
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“Rich” connectivity in communicating states

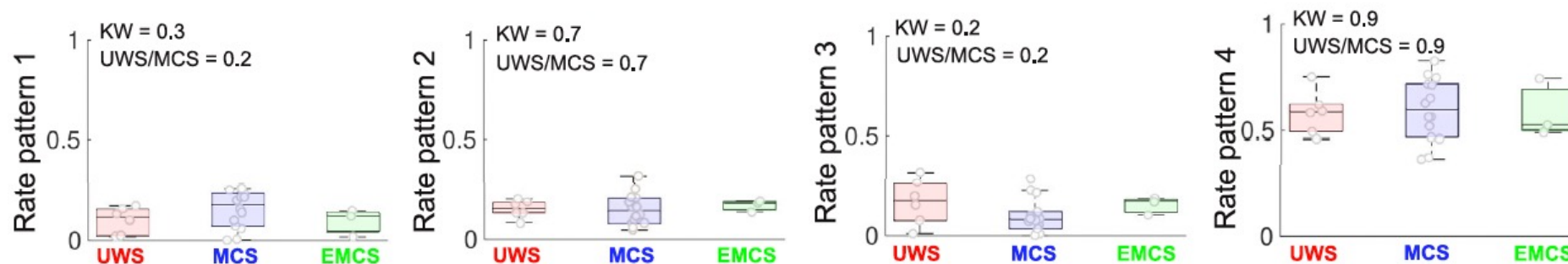


Demertzi & Tagliazucchi, Dehaene, Deco, Barttfeld, Raimondo, Martial, Fernández-Espejo, Rohaut, Voss, Schiff, Owen, Laureys, Naccache, Sitt. *Science Advances* 2019

Simple connectivity in “unconsciousness”

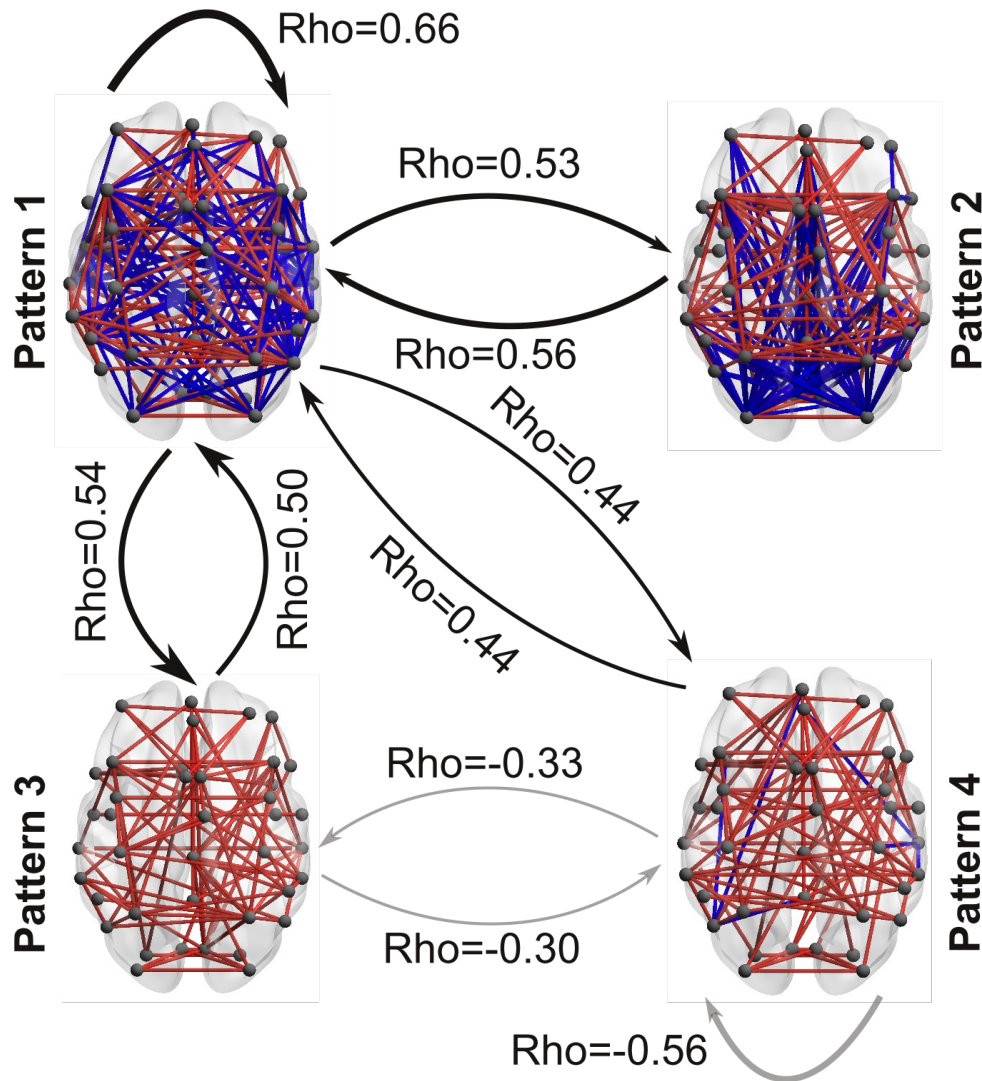


Propofol anesthesia



Demertzi & Tagliazucchi, Dehaene, Deco, Barttfeld, Raimondo, Martial, Fernández-Espejo, Rohaut, Voss, Schiff, Owen, Laureys, Naccache, Sitt. *Science Advances* 2019

Higher dynamism in conscious states

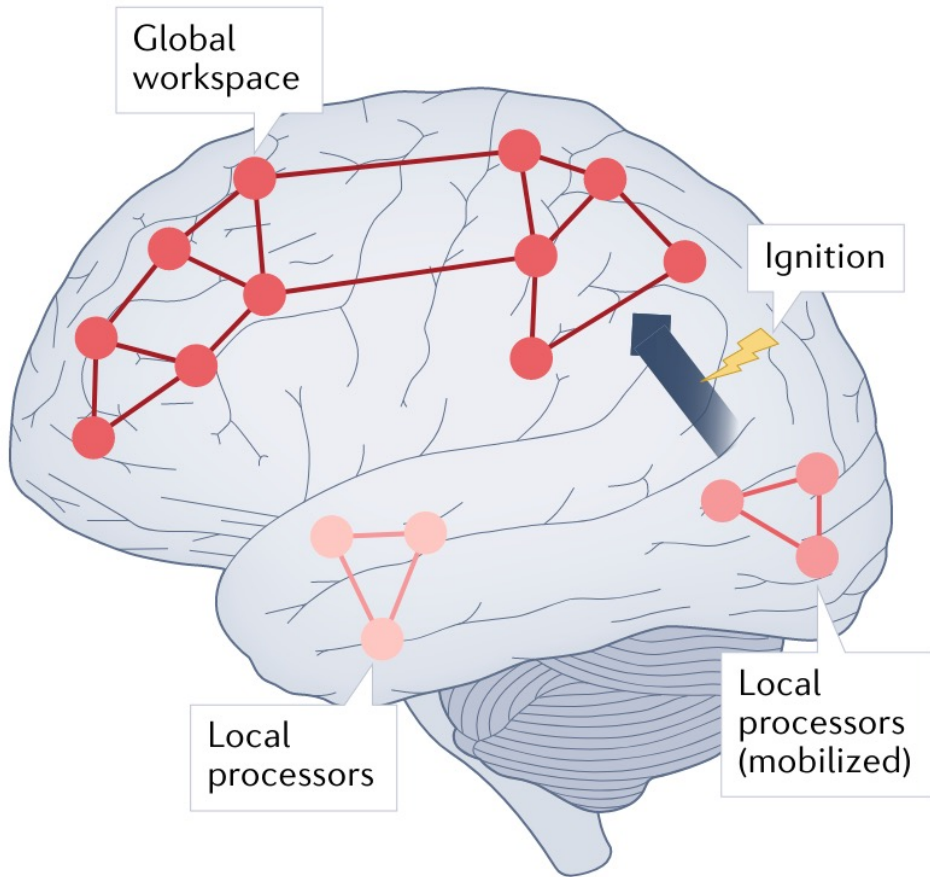


— Healthy > MCS > UWS
— UWS > MCS > Healthy

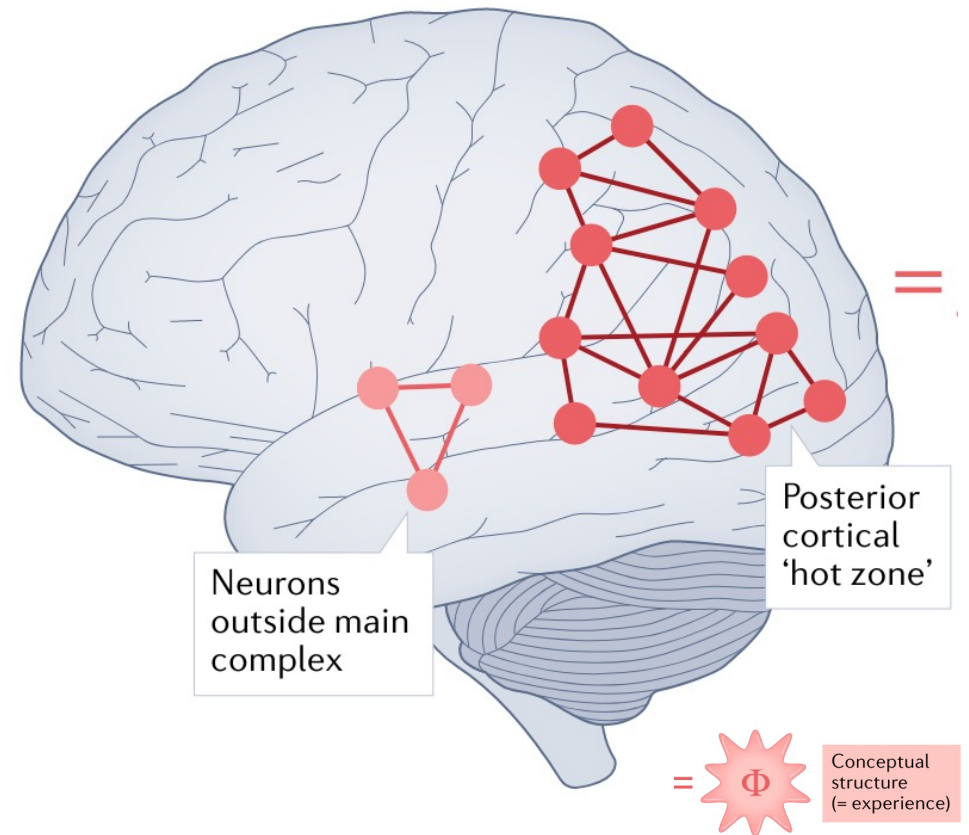
Demertzi & Tagliazucchi, Dehaene, Deco, Barttfeld, Raimondo, Martial, Fernández-Espejo, Rohaut, Voss, Schiff, Owen, Laureys, Naccache, Sitt. *Science Advances* 2019

Non-reportable Awareness?

Challenges for Theories of Consciousness

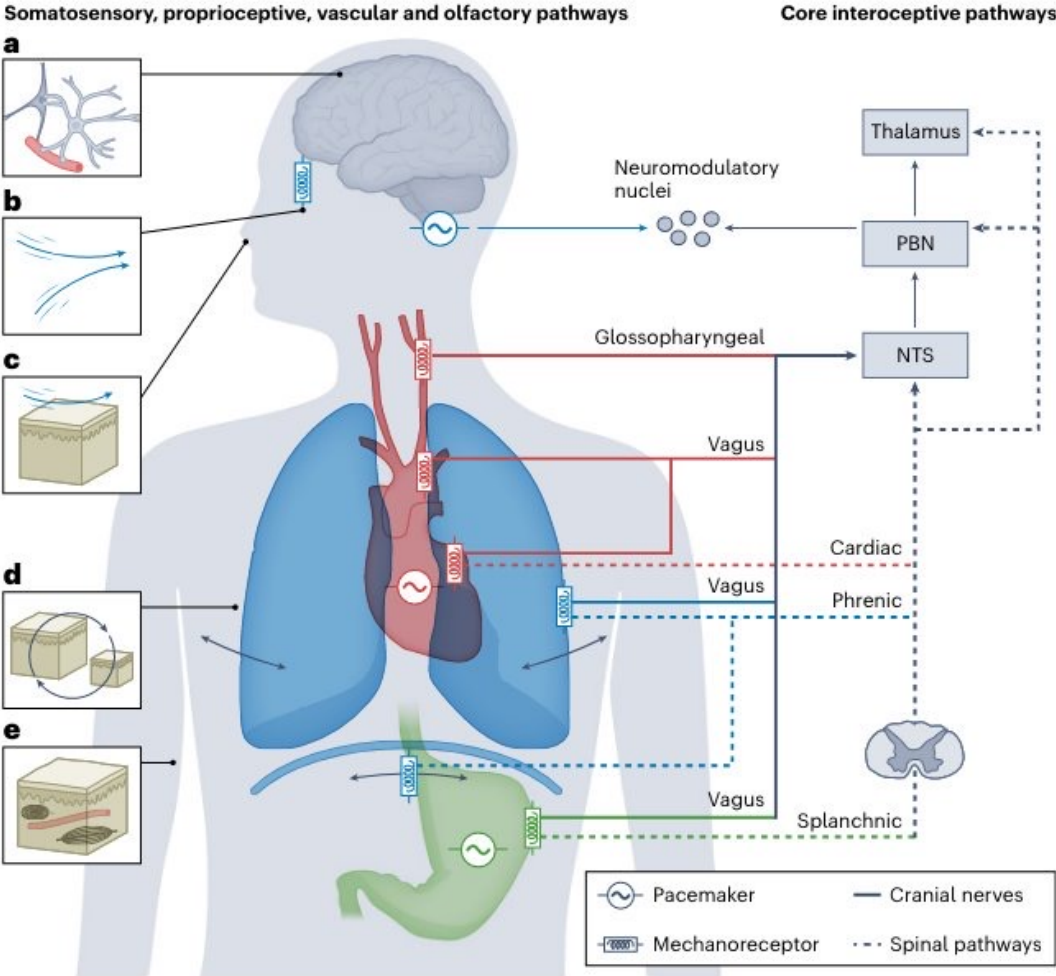


Global Neuronal Workspace Theory



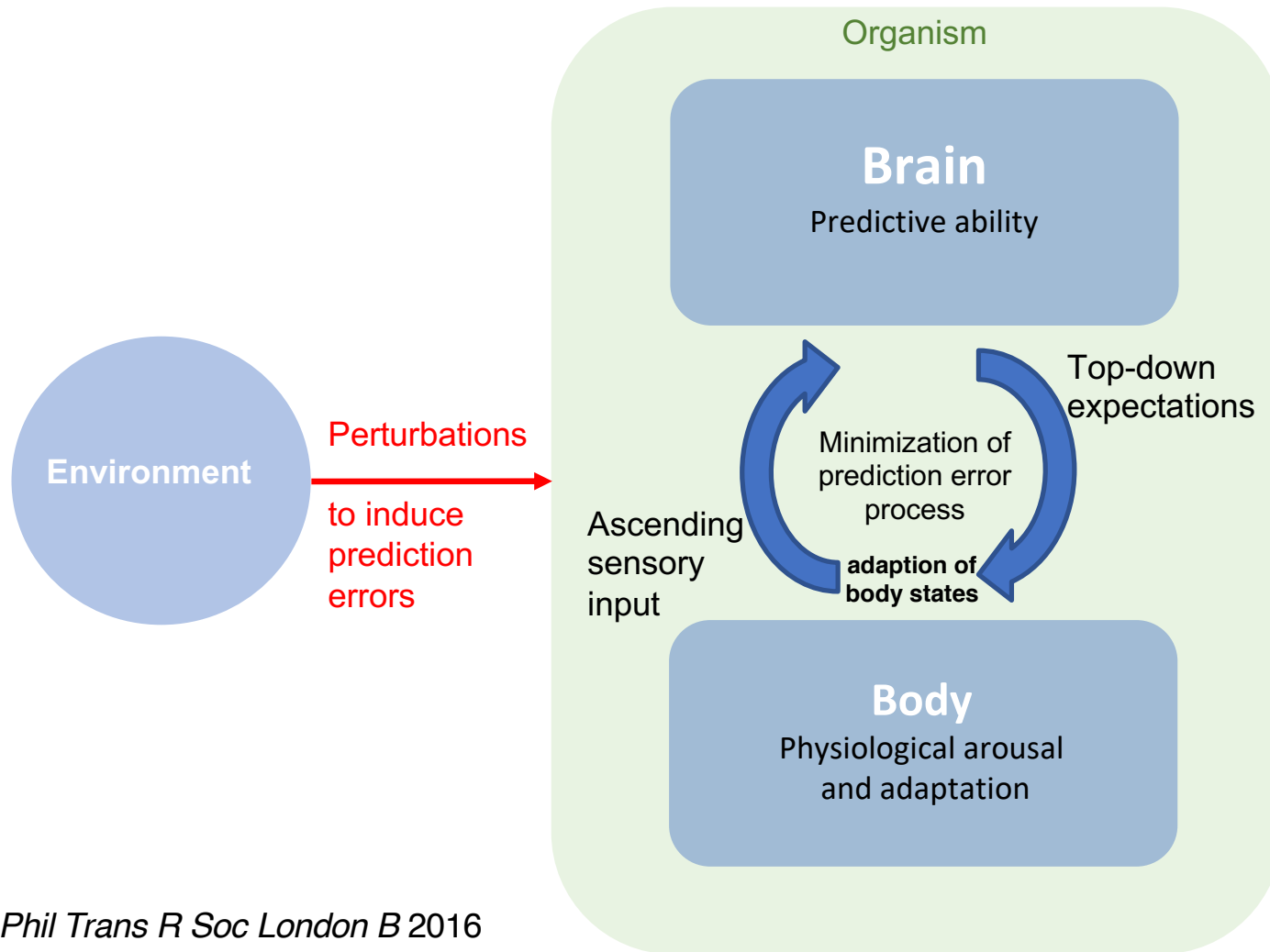
Integrated information theory

The embodied perspective



Engelen, Solcà, Tallon-Baudry. *Nature Neurosci* 2023
Varela F. *Nat Rev Neurosci*. 2001

The mind is embodied and embedded

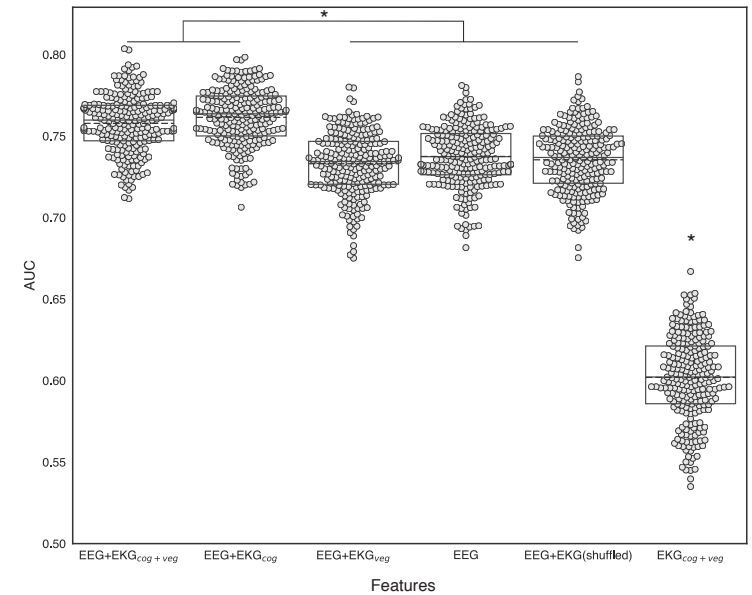
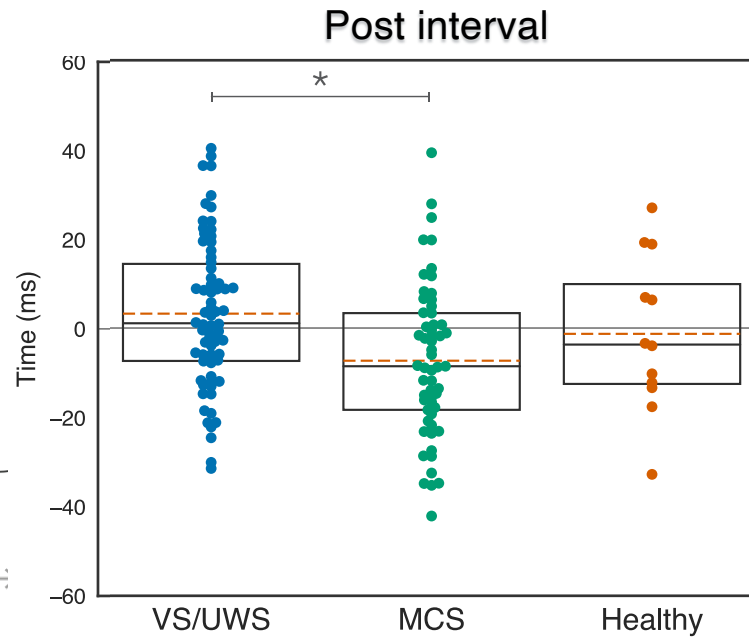
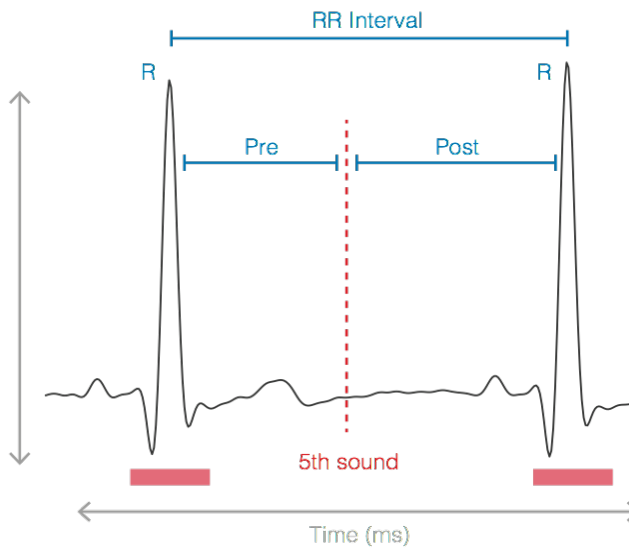


Cardiac reactions to oddballs in MCS

Auditory oddball paradigm
Bekinschtein et al., PNAS, 2009

**Cardiac cycle-phase acceleration
only in MCS**

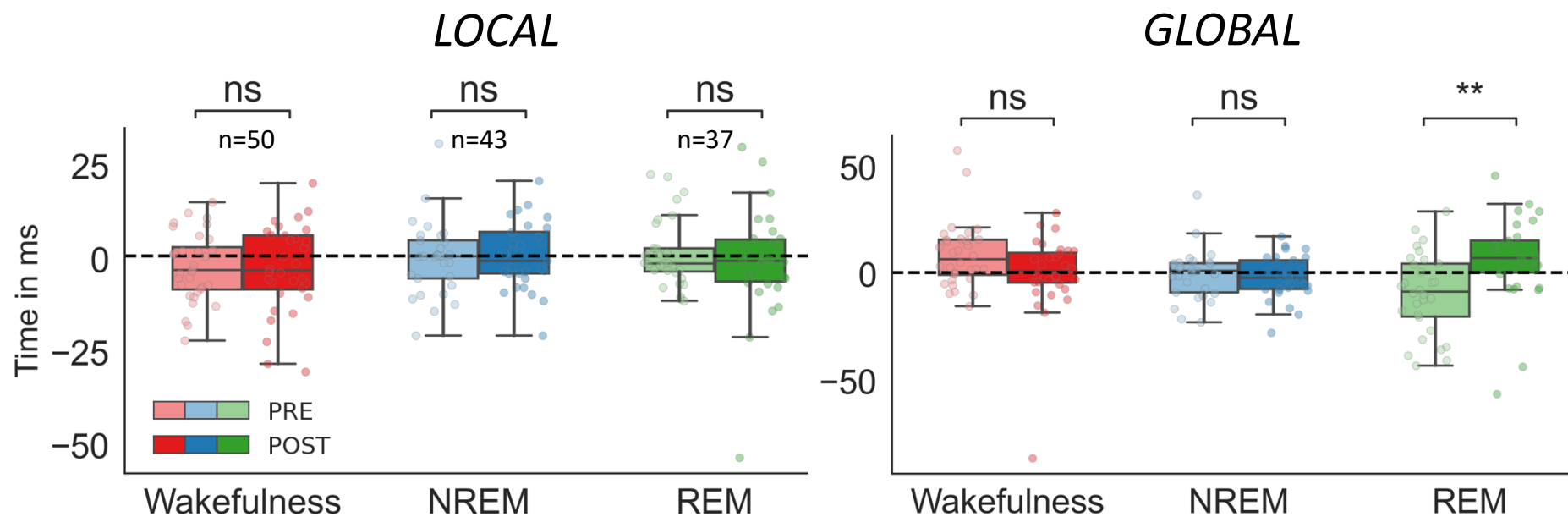
Electrocardiographic markers carry
independent information from EEG



Raimondo, Rohaut, Demertzi, Valente, Engemann, Salti, Fernandez Slezak, Naccache, Sitt. *Annals of Neurology* 2017

Cardiac reactions to oddballs in sleep

Cardiac deceleration for global deviants only in REM

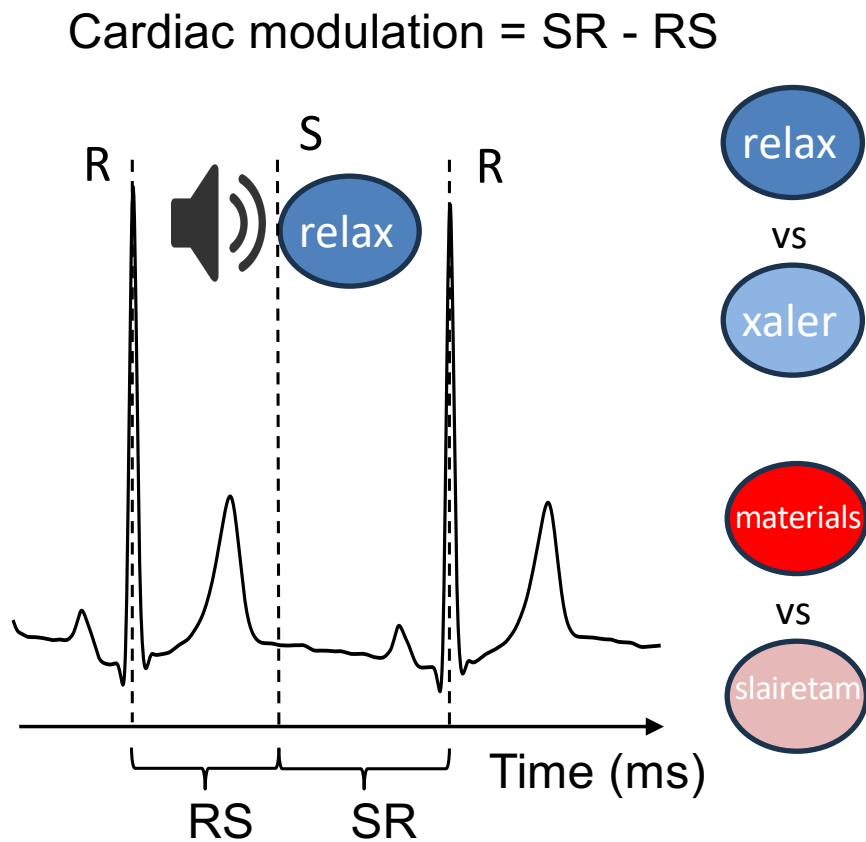


Koroma, Boulakis, Raimondo, Blume, Strauss, Demertzi. *In prep*

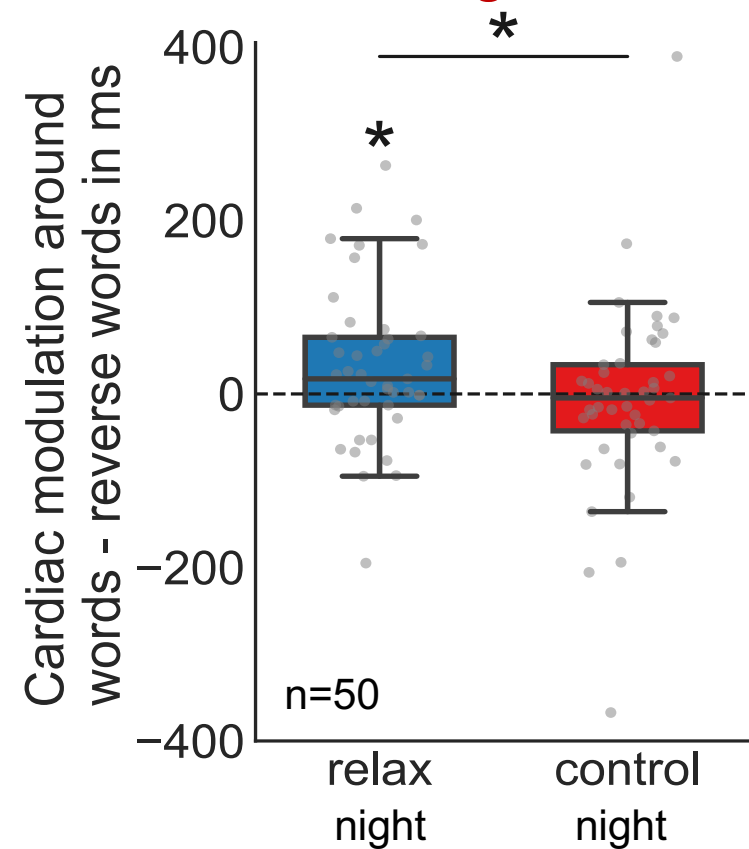
EEG: Strauss, Sitt, King, Elbaz, Azizi, Buiatti, Naccache, van Wassenhove, Dehaene, S, *PNAS* 2015

EEG: Blume, Niedernhuber, Spitschan, Slawik, Meyer, Bekinschtein, & Cajochen. *Sleep* 2022

Cardiac responses to word-induced relaxation during sleep



Cardiac deceleration after relaxing words



Consciousness is multidimensional

