



Deriving Aspects of Consciousness from Unconscious States

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Consciousness

awareness

perception

cognition

imagination

thought

mind

experience

self-awareness



NeuroEthics

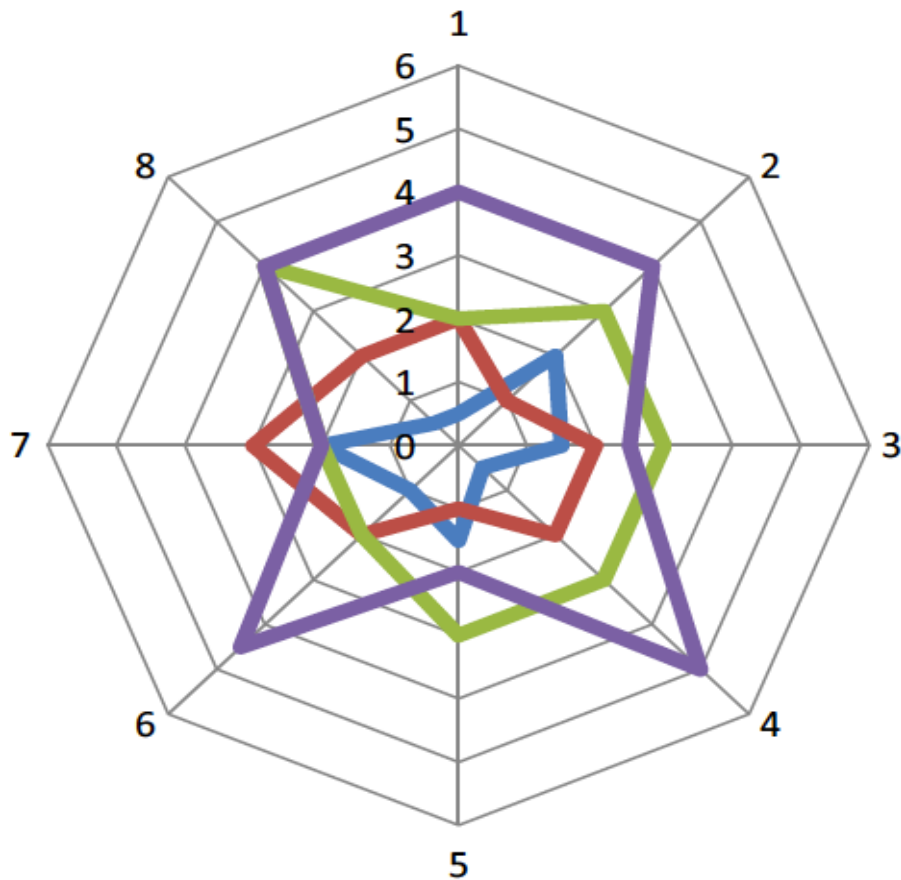


Animals



Psychotherapy

Consciousness is multidimensional



Bayne, Hohwy, Owen. *Trends Cogn Sci* 2016

Questions

Which are these dimensions?

Which mechanisms support them?

States of “Unconsciousness”



Clinical
Disorders of Consciousness
Anaesthesia

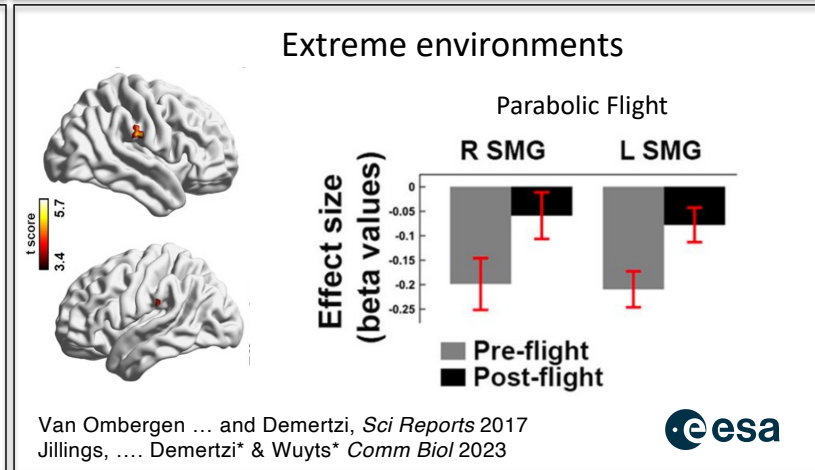
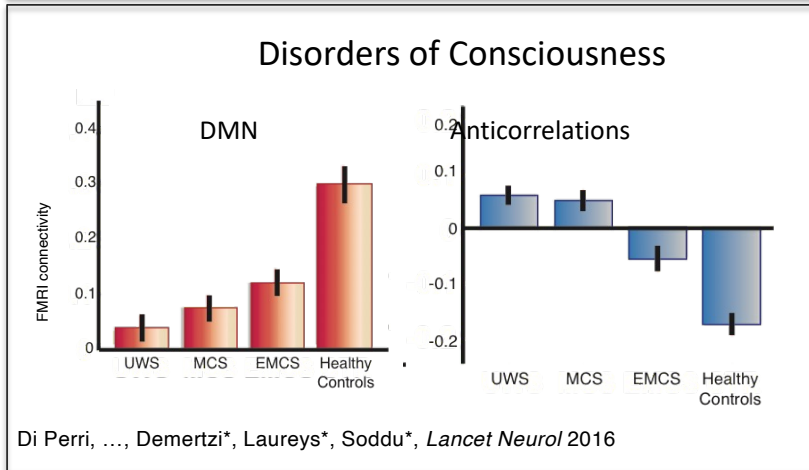
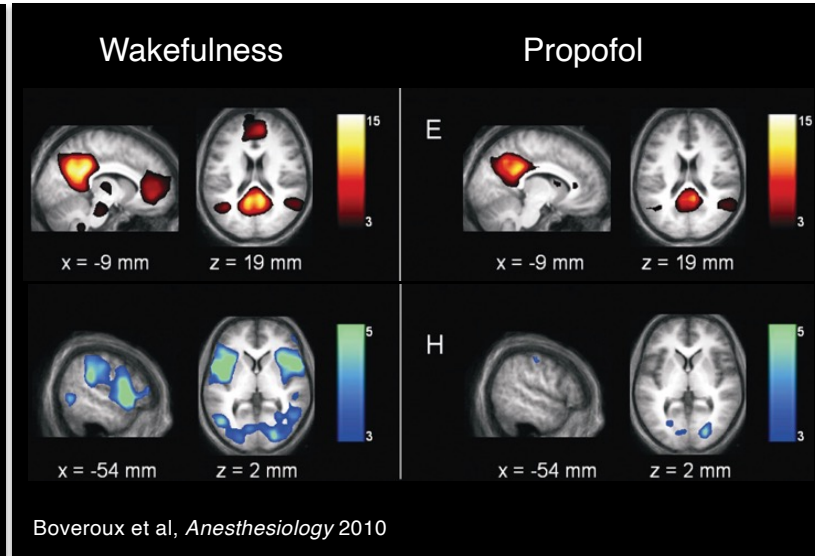
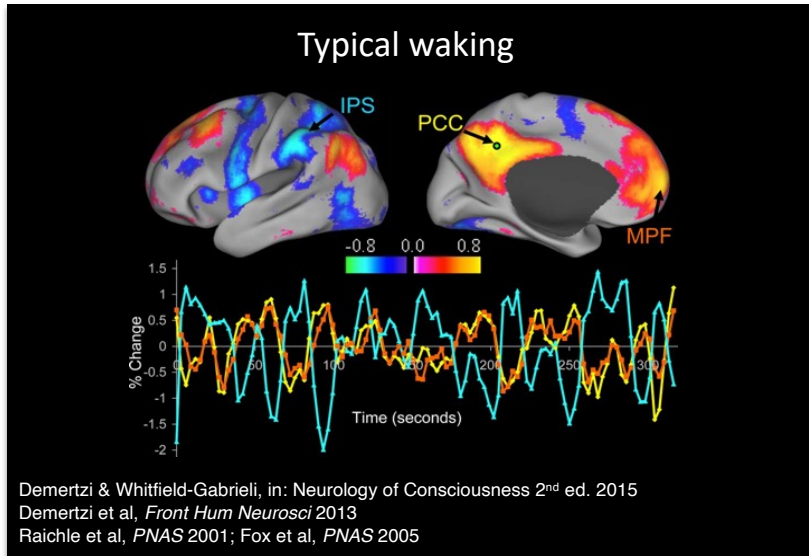


Physiological
Sleep

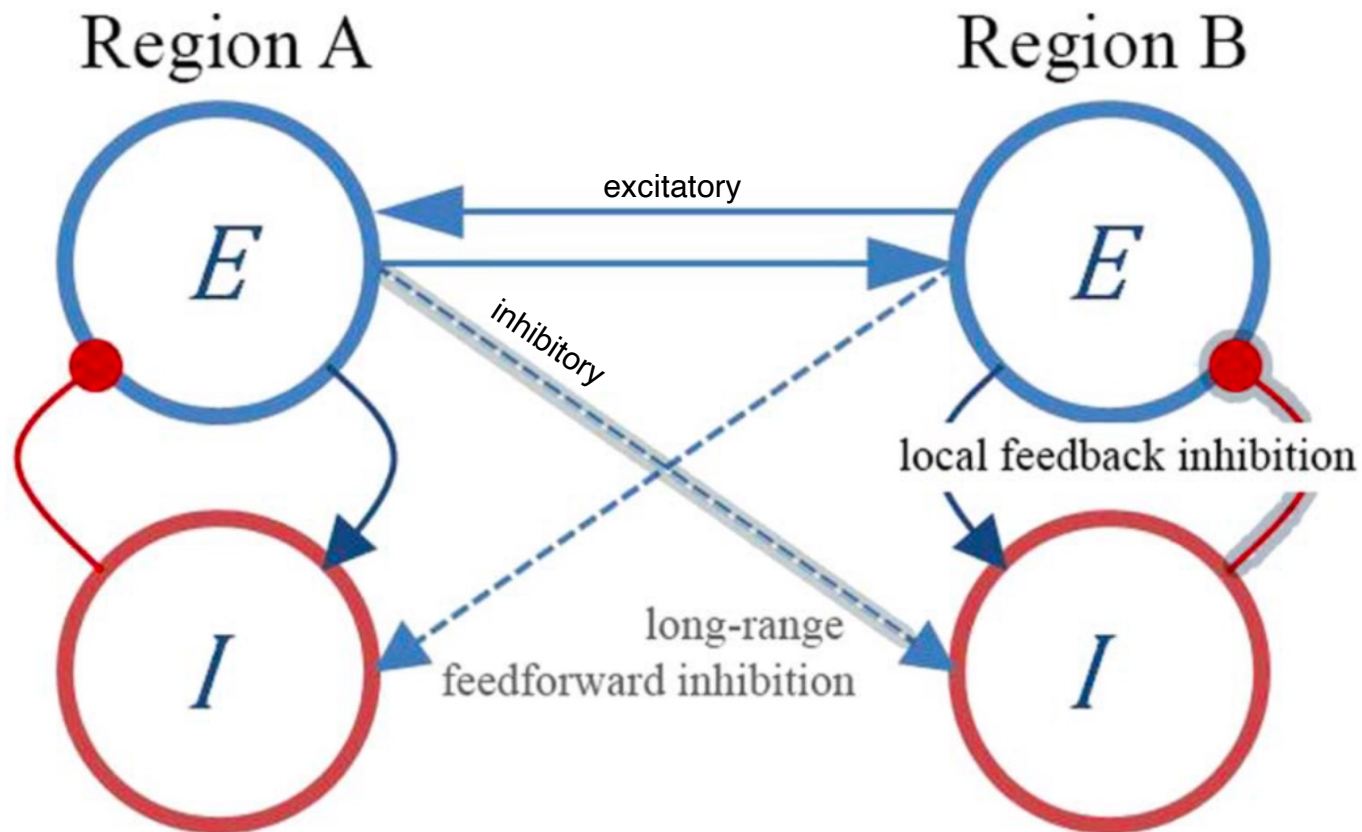


Wakefulness
Mind Blanking

Functional anticorrelations



Anticorrelations as a result of neural inhibition

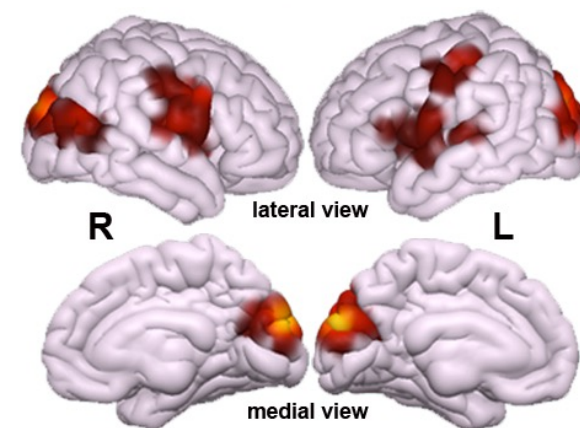
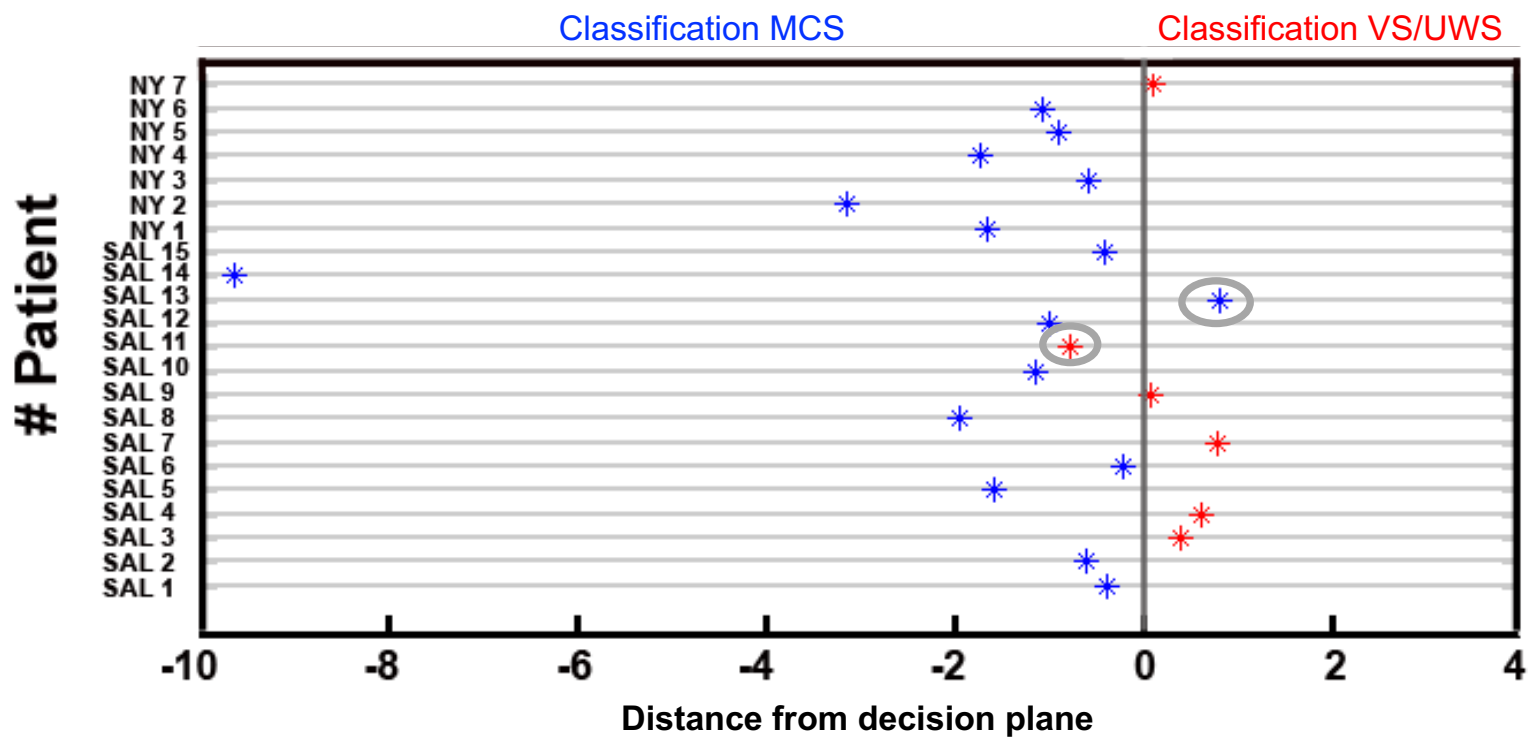


Ignition

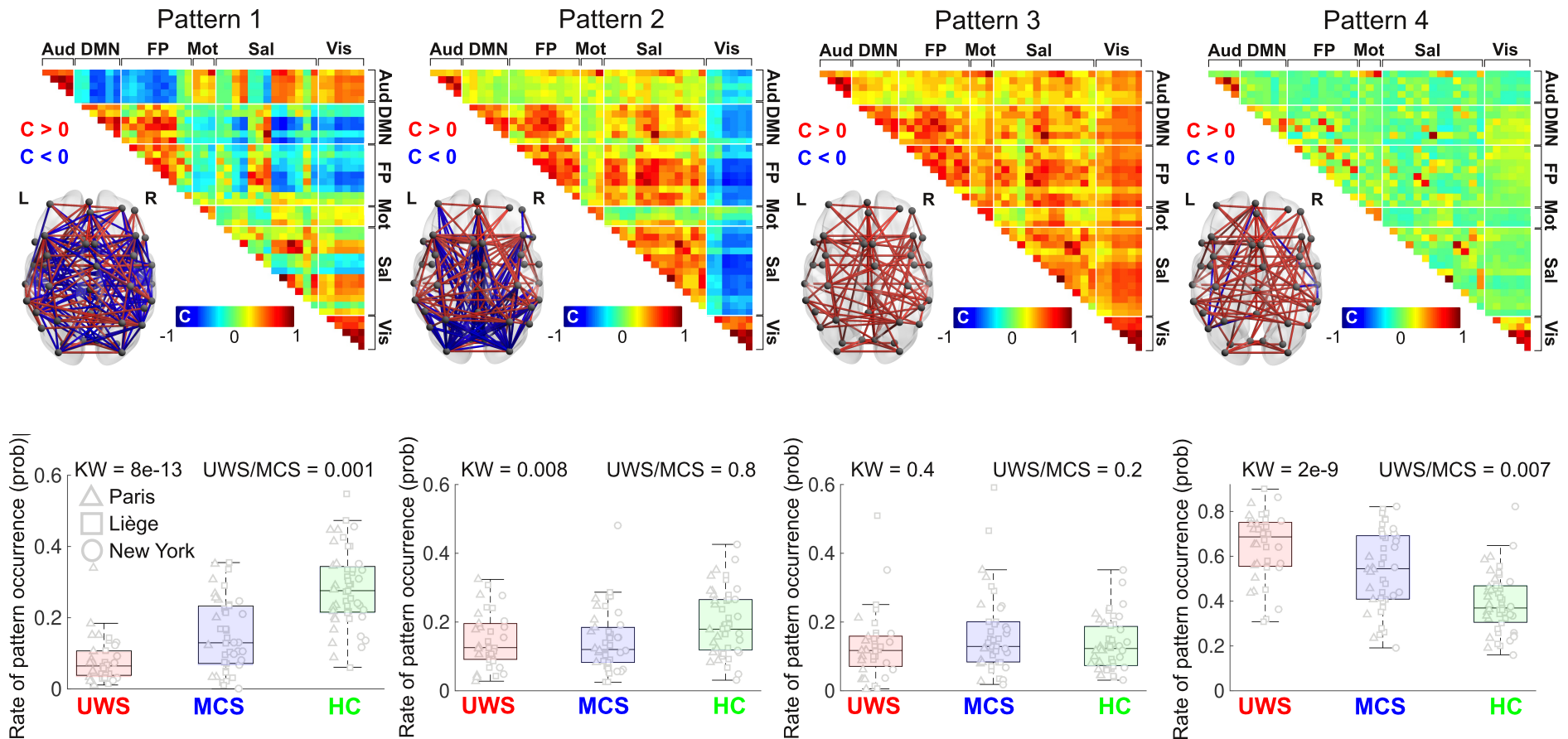
Deco et al., *Sci Adv* 2021
Joglekar et al., *Neuron* 2018

DOC separation based on cross-modal interactions

- Training set: 45 DOC (26 MCS, 19 VS/UWS)
 - 14 trauma, 28 non-trauma, 3 mixed
 - 34 patients assessed >1m post-insult
- Test set:
 - 16 MCS, 6 VS/UWS (15 non-trauma; all chronic)
 - 2 different centers

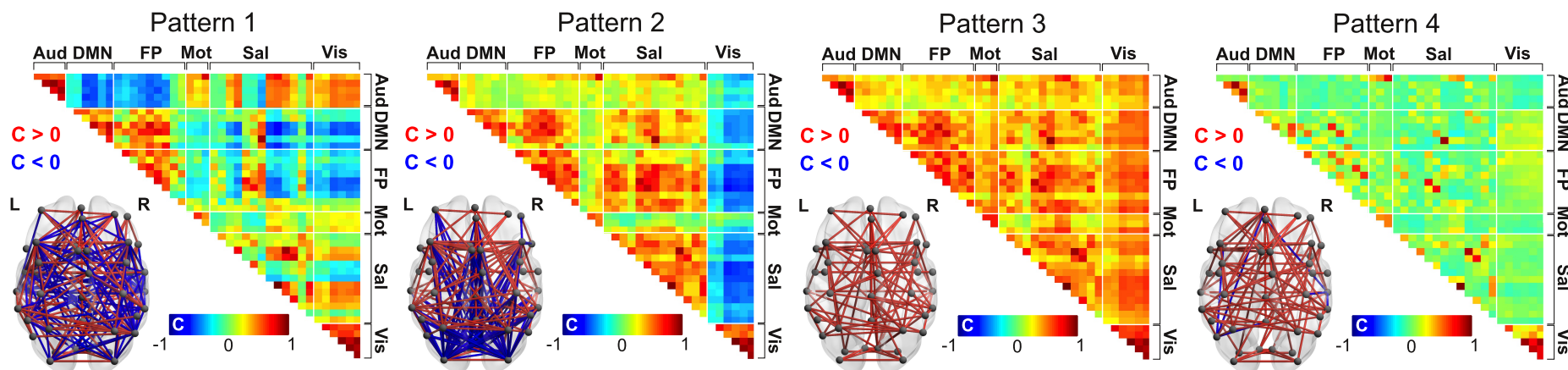


“Rich” connectivity in communicating states

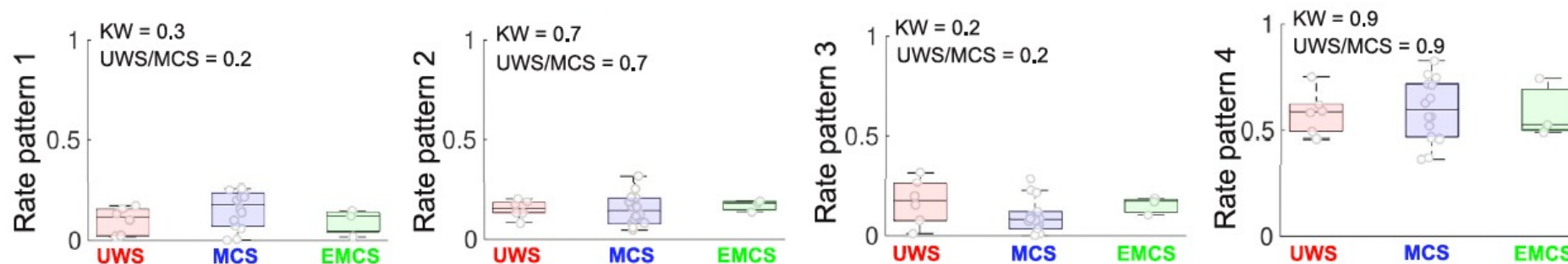


Demertzi & Tagliazucchi, Dehaene, Deco, Barttfeld, Raimondo, Martial, Fernández-Espejo, Rohaut, Voss, Schiff, Owen, Laureys, Naccache, Sitt. *Science Advances* 2019

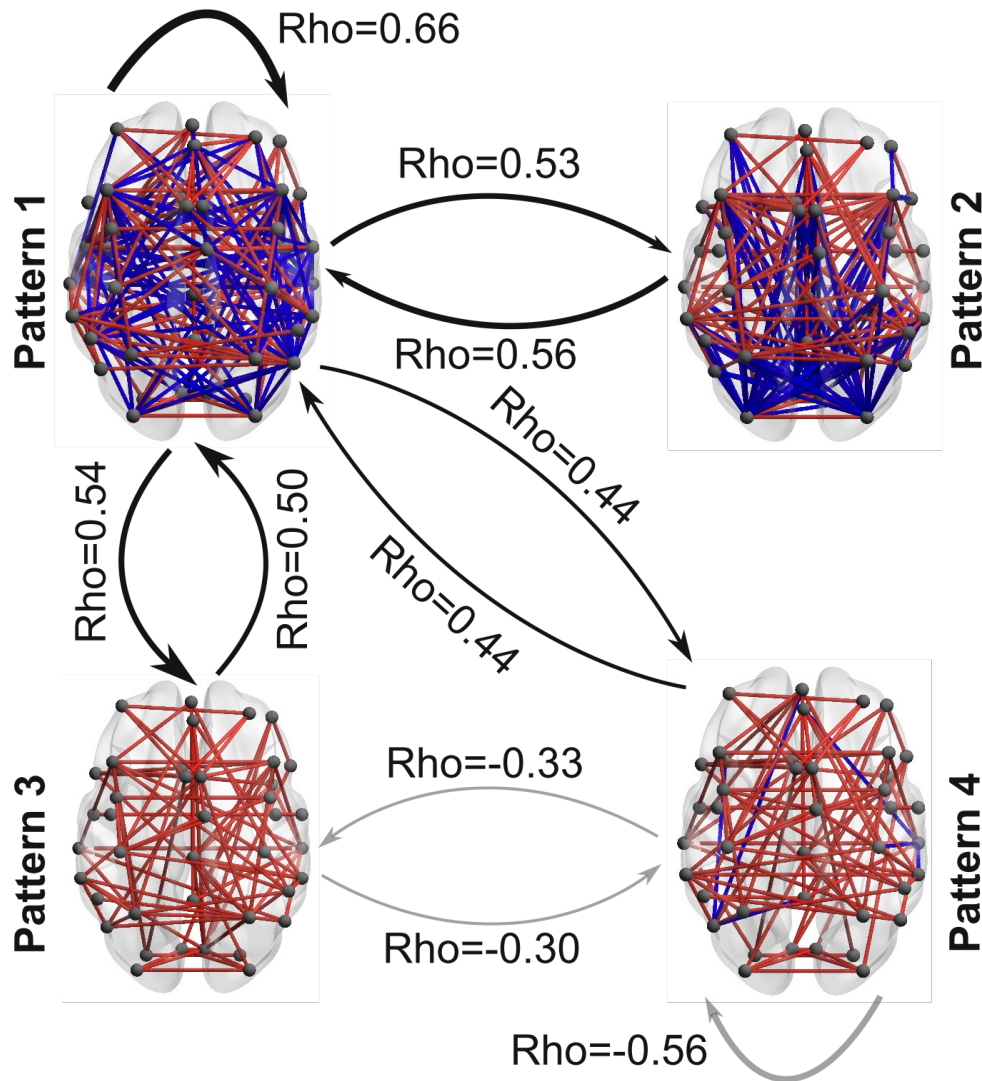
Simple connectivity in “unconsciousness”



Propofol anesthesia



Higher dynamism in conscious states

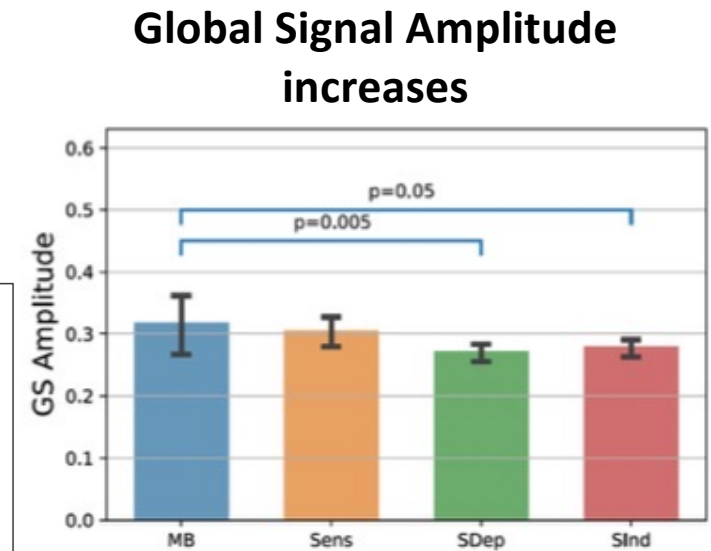
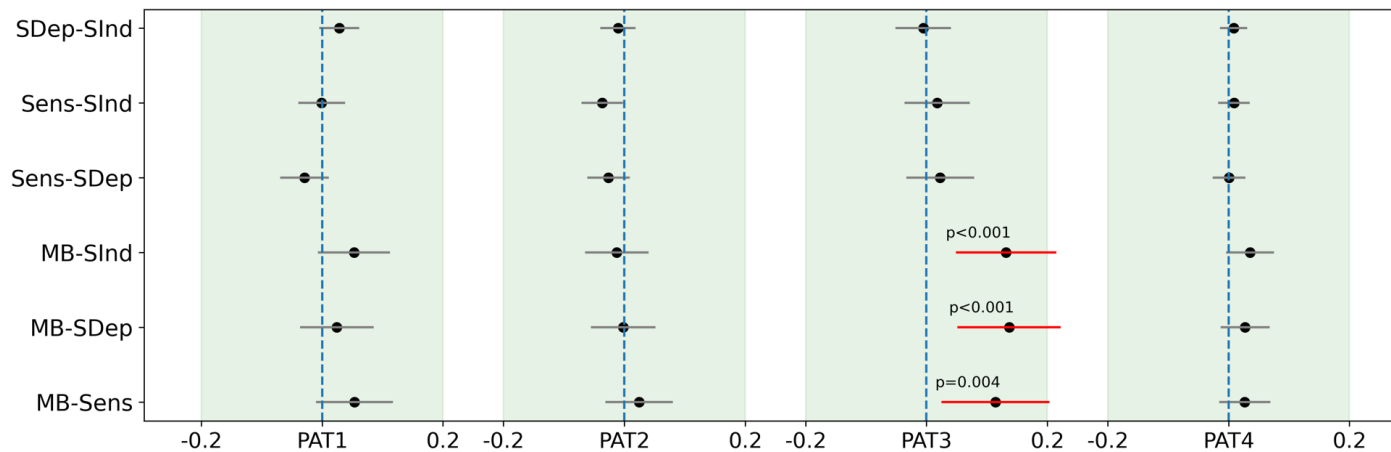
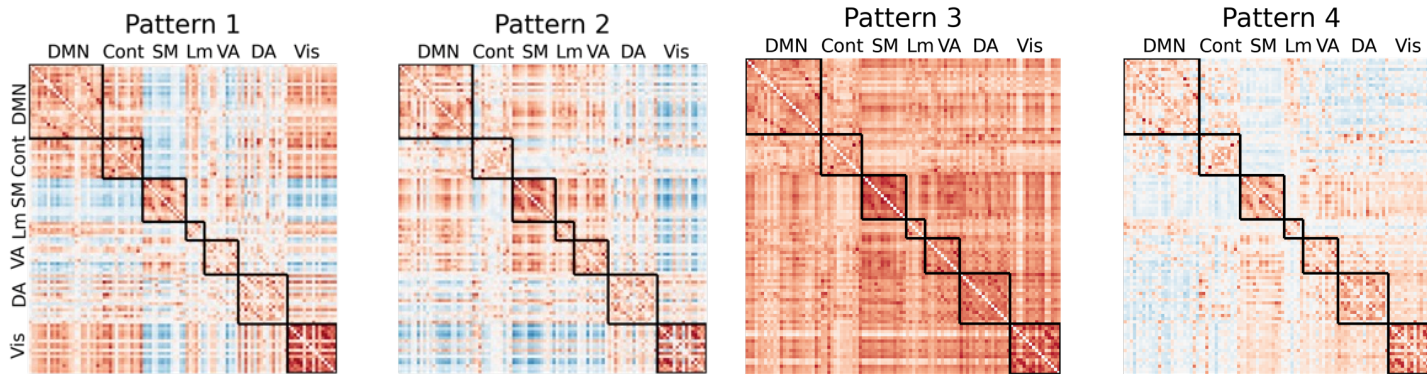


— Healthy > MCS > UWS

— UWS > MCS > Healthy

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

Simple connectivity in Mind Blanking: Low arousal



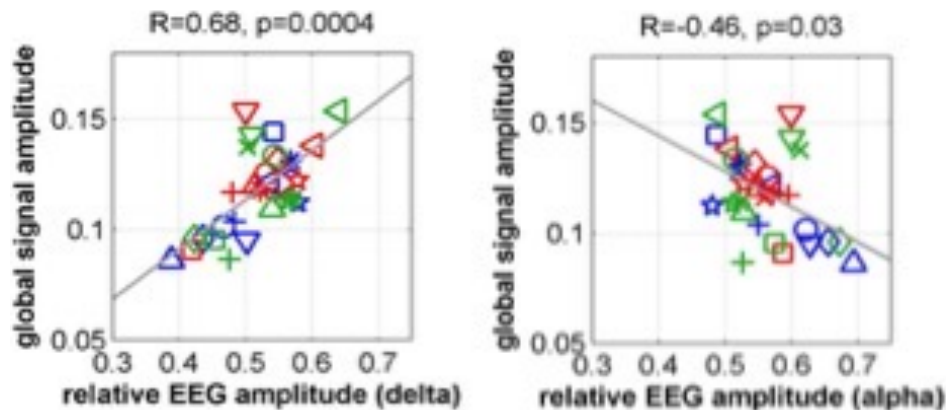
Mortaheb, Van Calster, Raimondo, Klados, Boulakis, Georgoulas, Majerus, Van De Ville*, Demertzi*. *PNAS* 2022

Van Calster, D'Argembeau, Salmon, Peters, Majerus, *J Cogn Neurosci* 2017

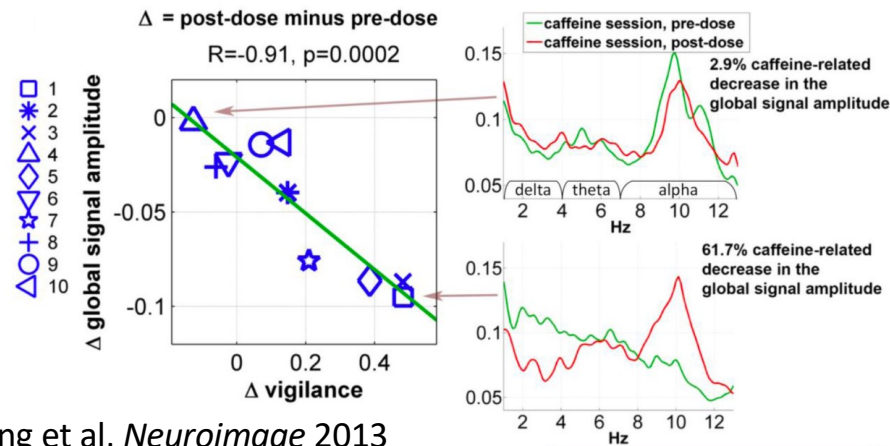
Global Signal amplitude reflects levels of arousal

GS amplitude is linked to low arousal

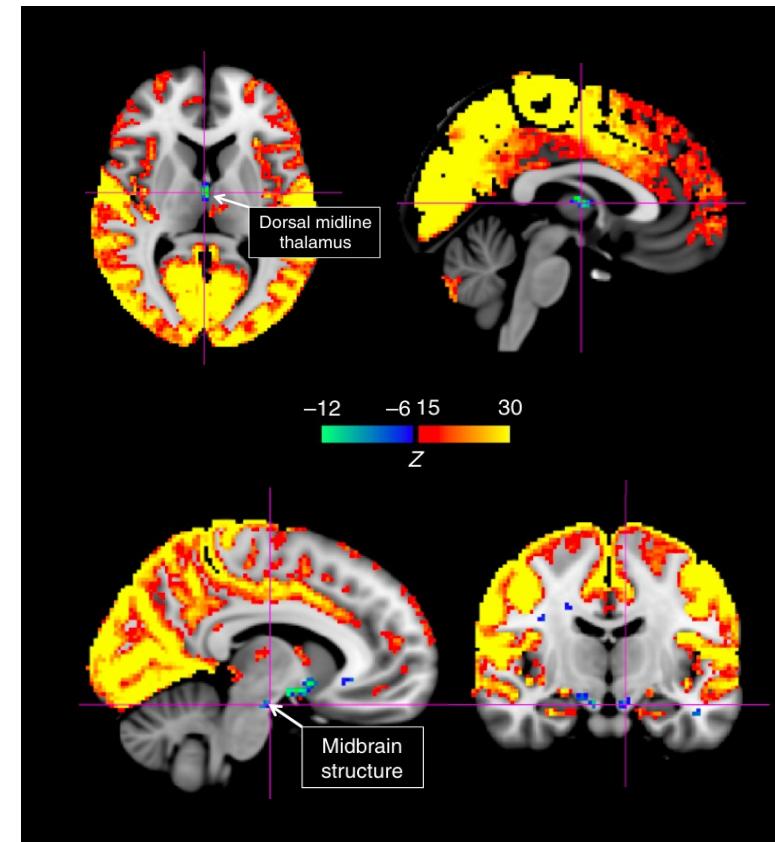
GS amplitude linked to signal decreases in subcortical structures supporting arousal



GS amplitude decreases with caffeine intake

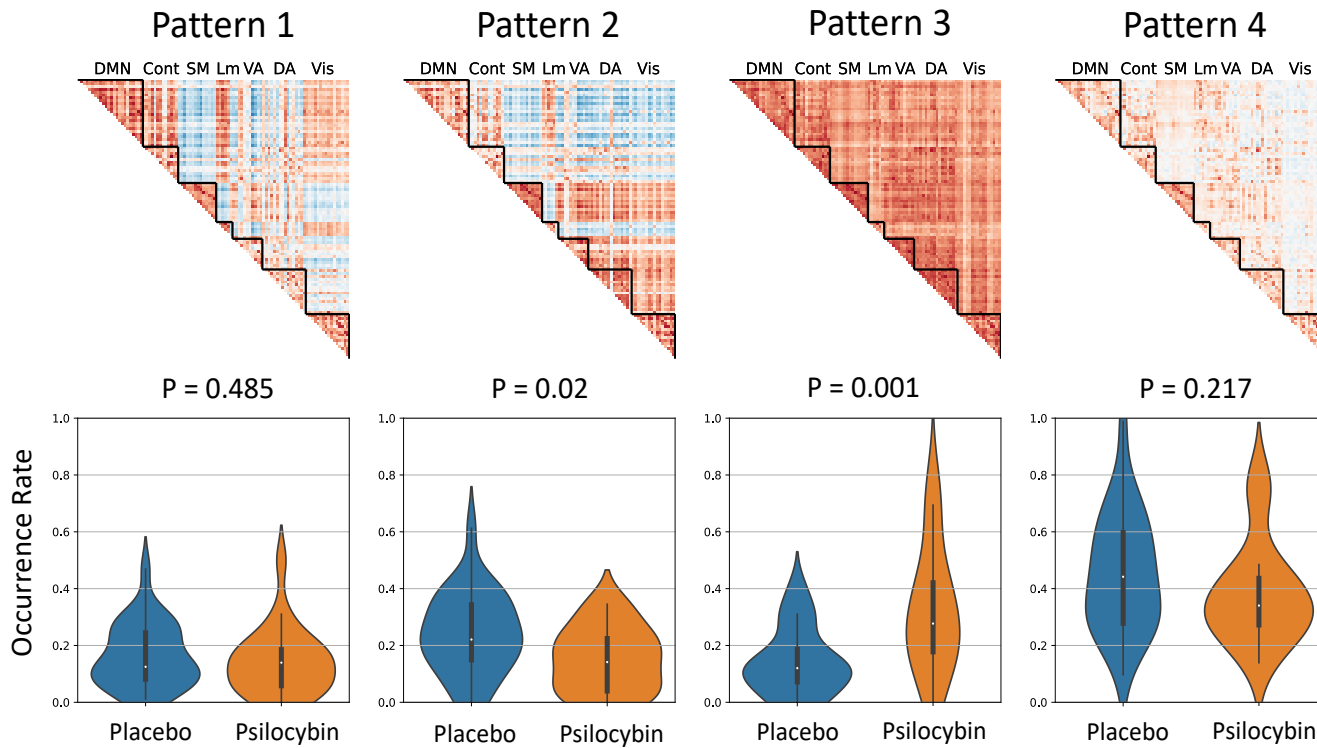


Wong et al, *Neuroimage* 2013

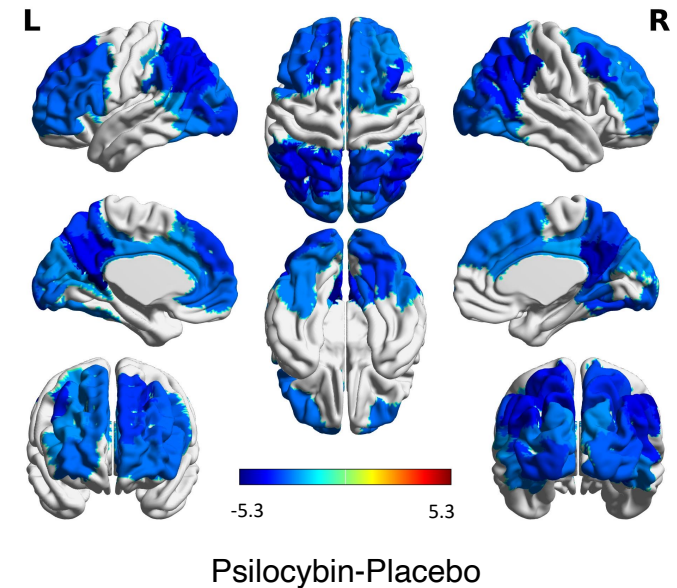


Liu et al, *Nat Communications* 2018

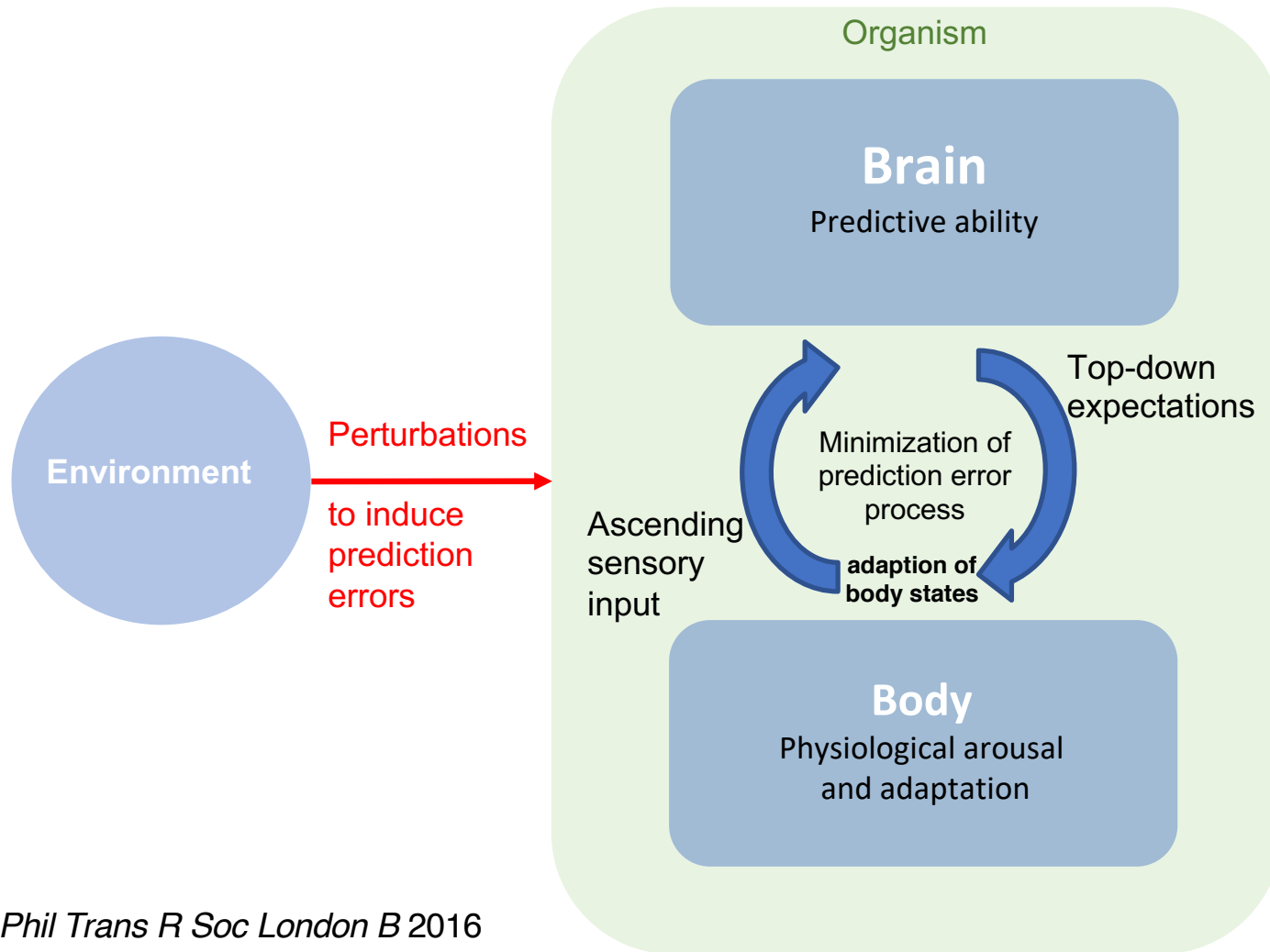
Simple connectivity under Psilocybin: High Arousal



BOLD amplitude reductions



The embodied perspective

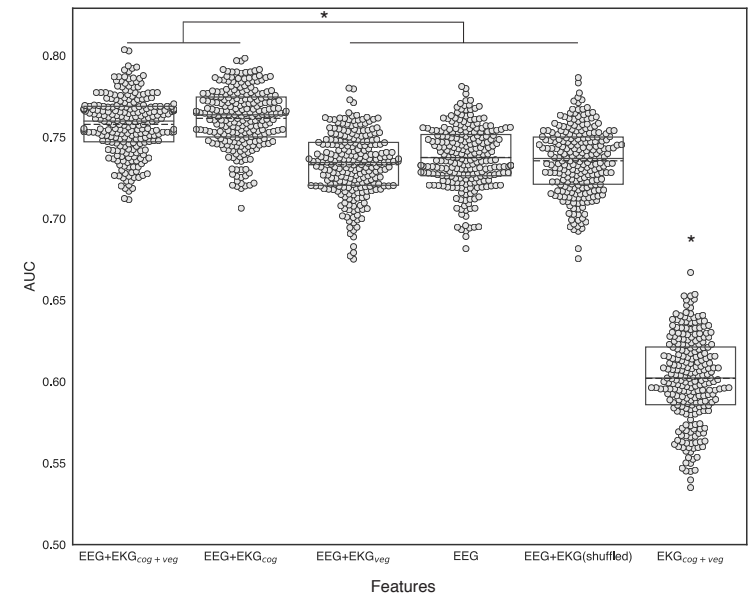
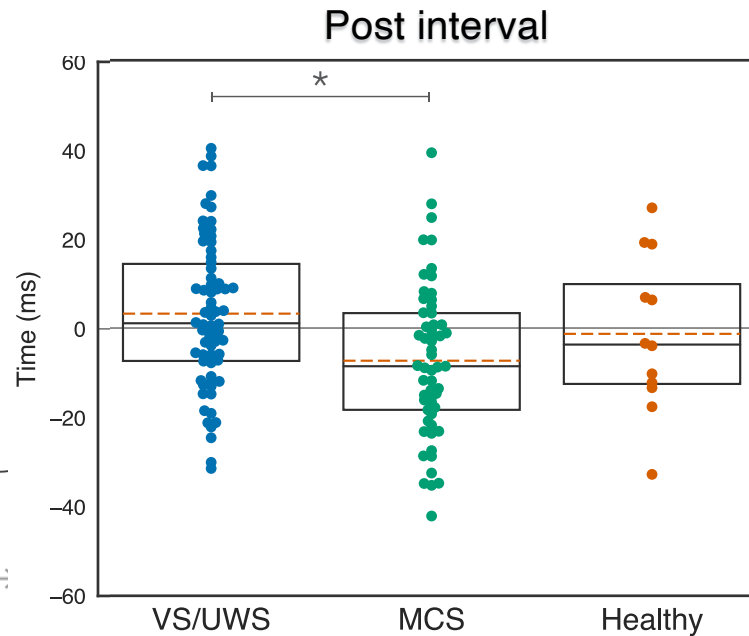
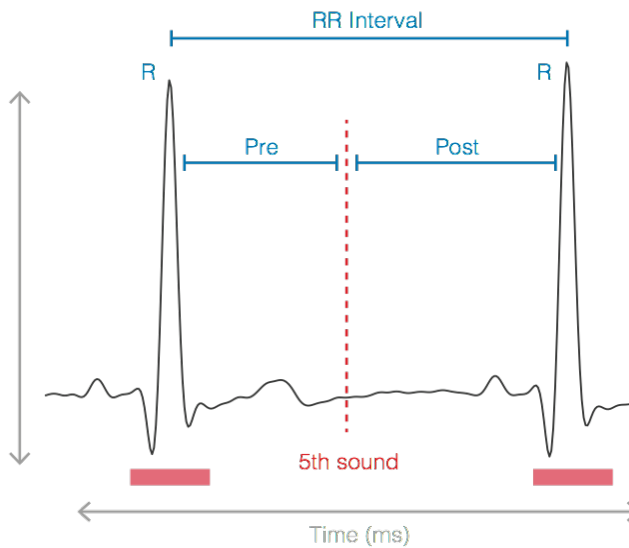


Cardiac reactions to oddballs in MCS

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

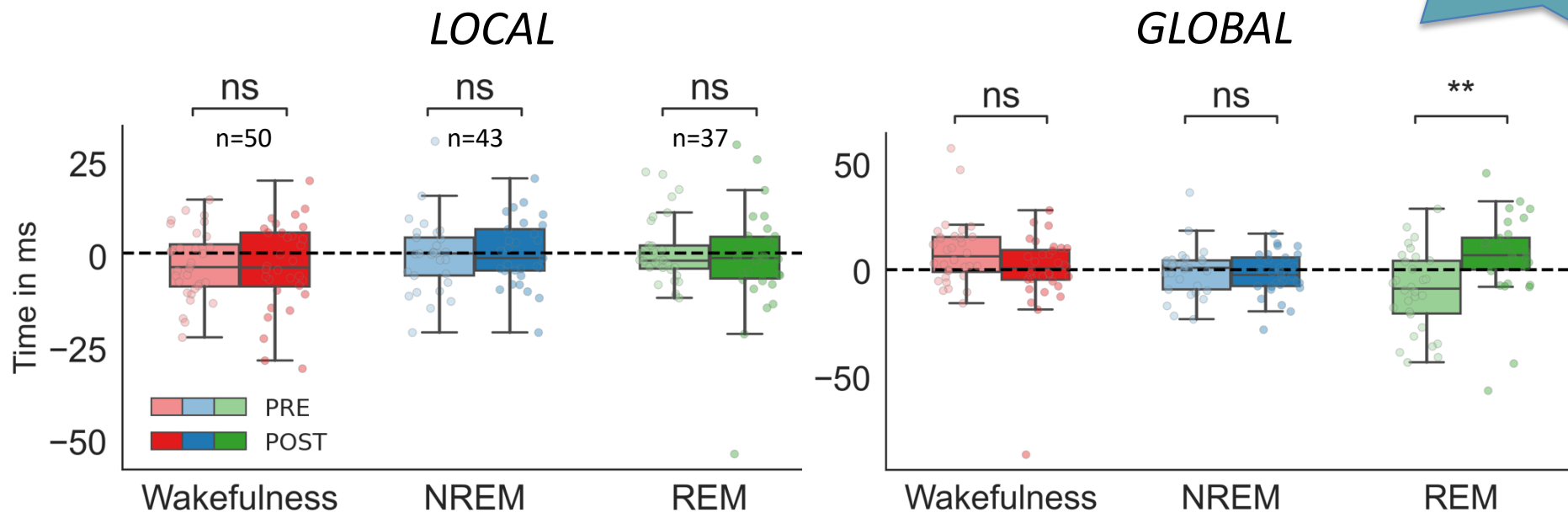
Cardiac reactions to oddballs in sleep

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

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

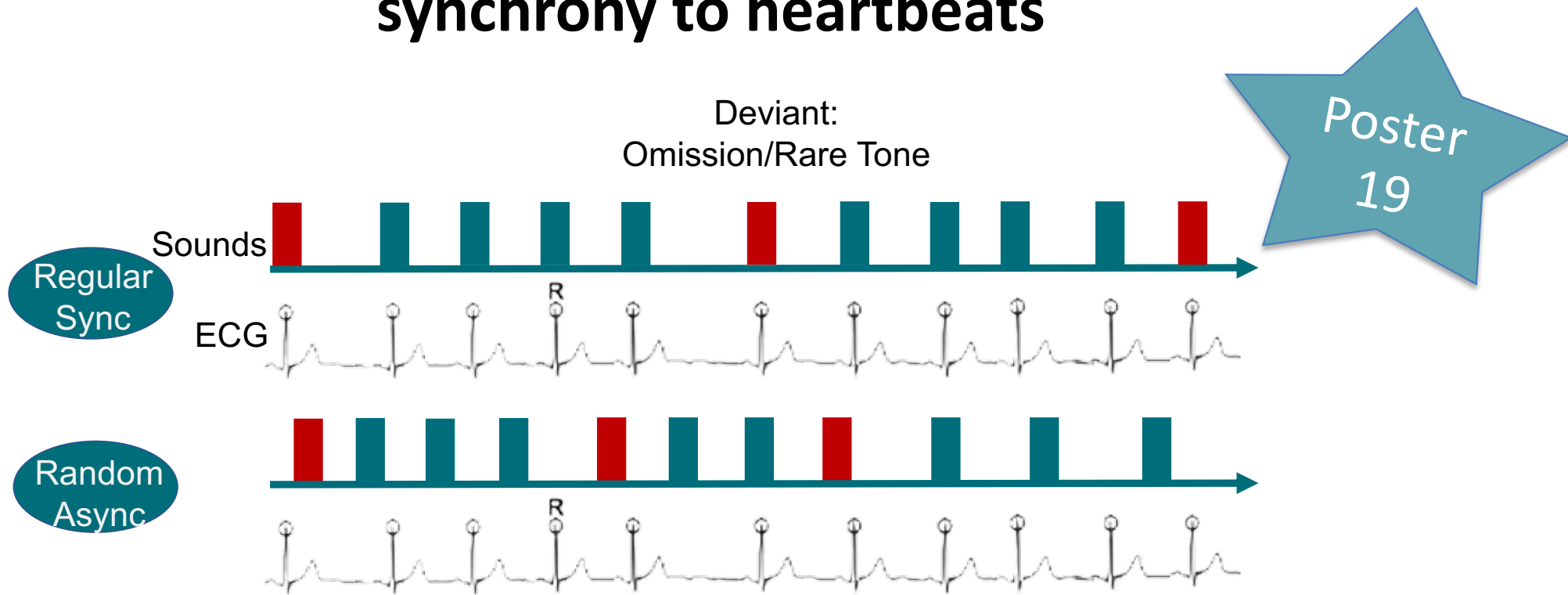


Cardiac deceleration for global deviants only in REM



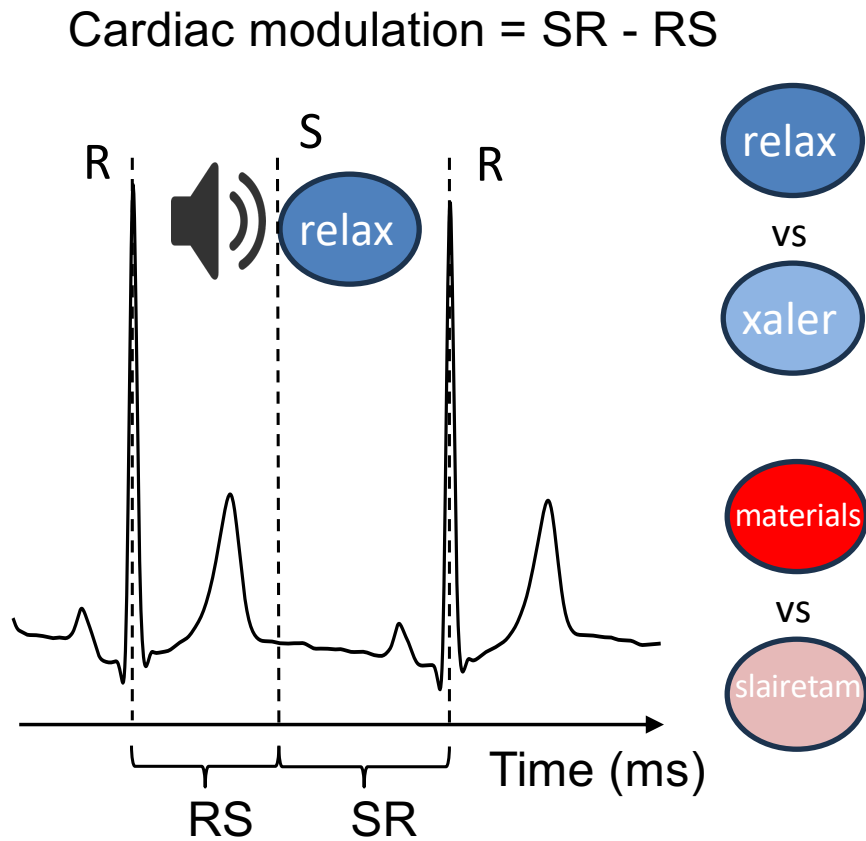
Koroma, Boulakis, Raimondo, Blume, Strauss, Demertzi. *In prep*

Cardiac responses to omitted sounds presented in synchrony to heartbeats

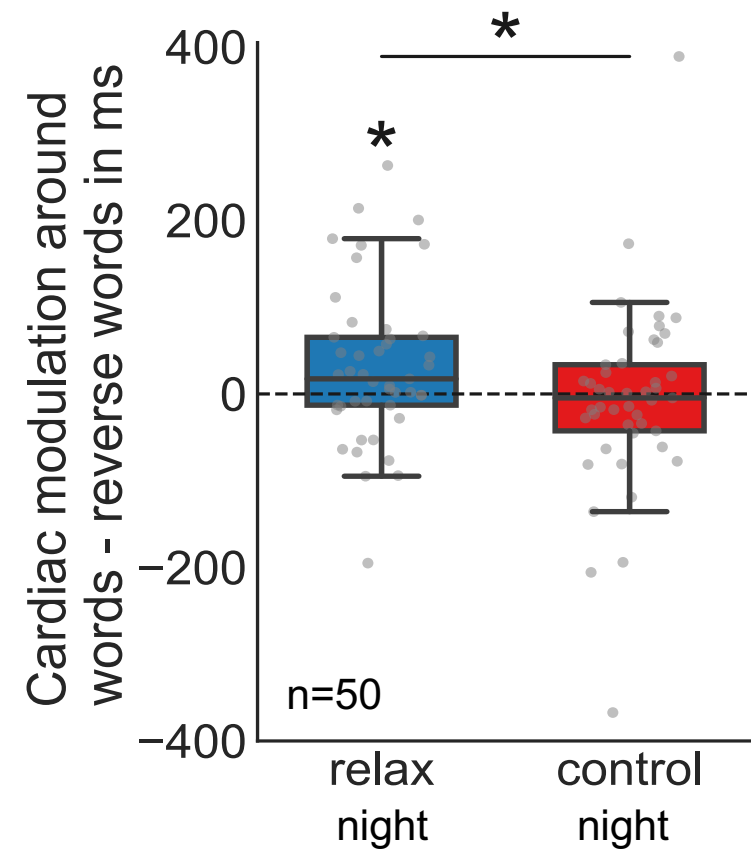


Cardiac deceleration for sound omissions and rare tones in synchronous condition only

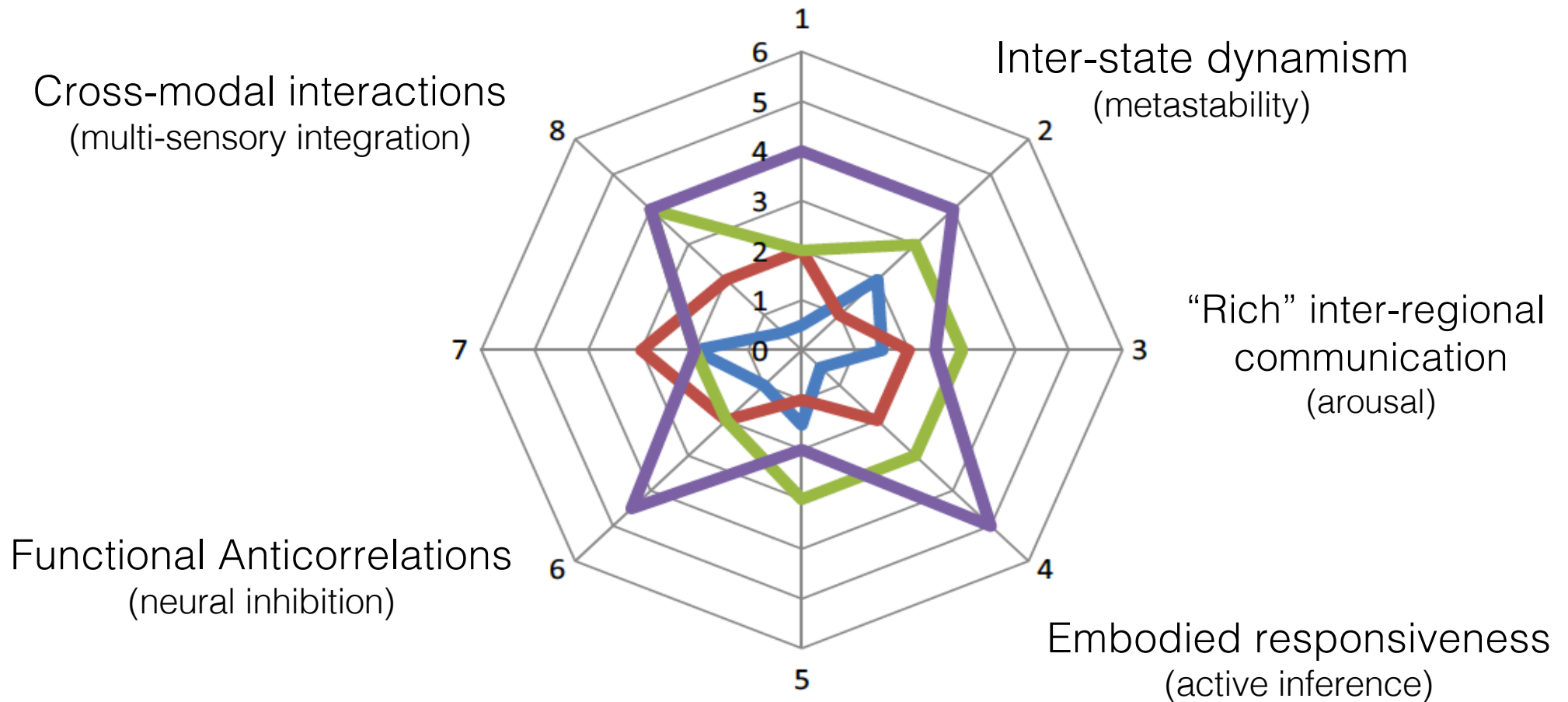
Cardiac responses to word-induced relaxation during sleep

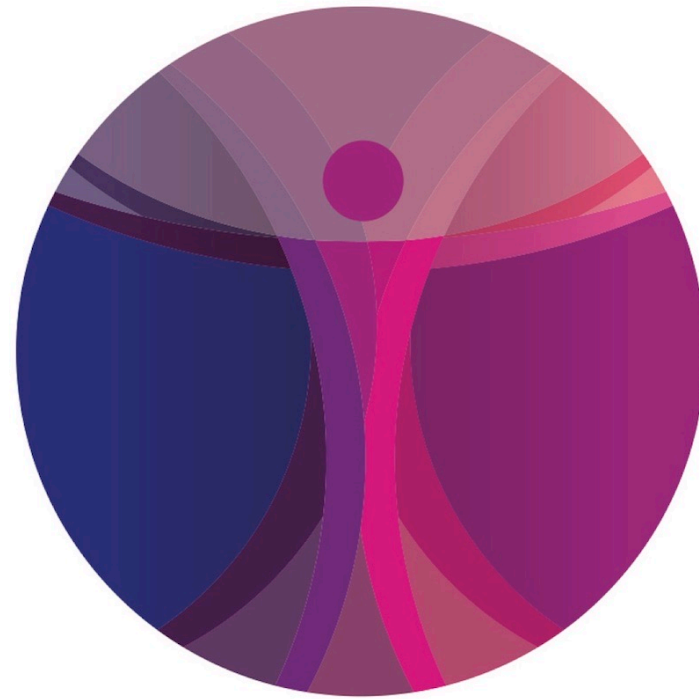


Cardiac deceleration after relaxing words



Consciousness is multidimensional





Thank you!