Brain networks underlying dream activity

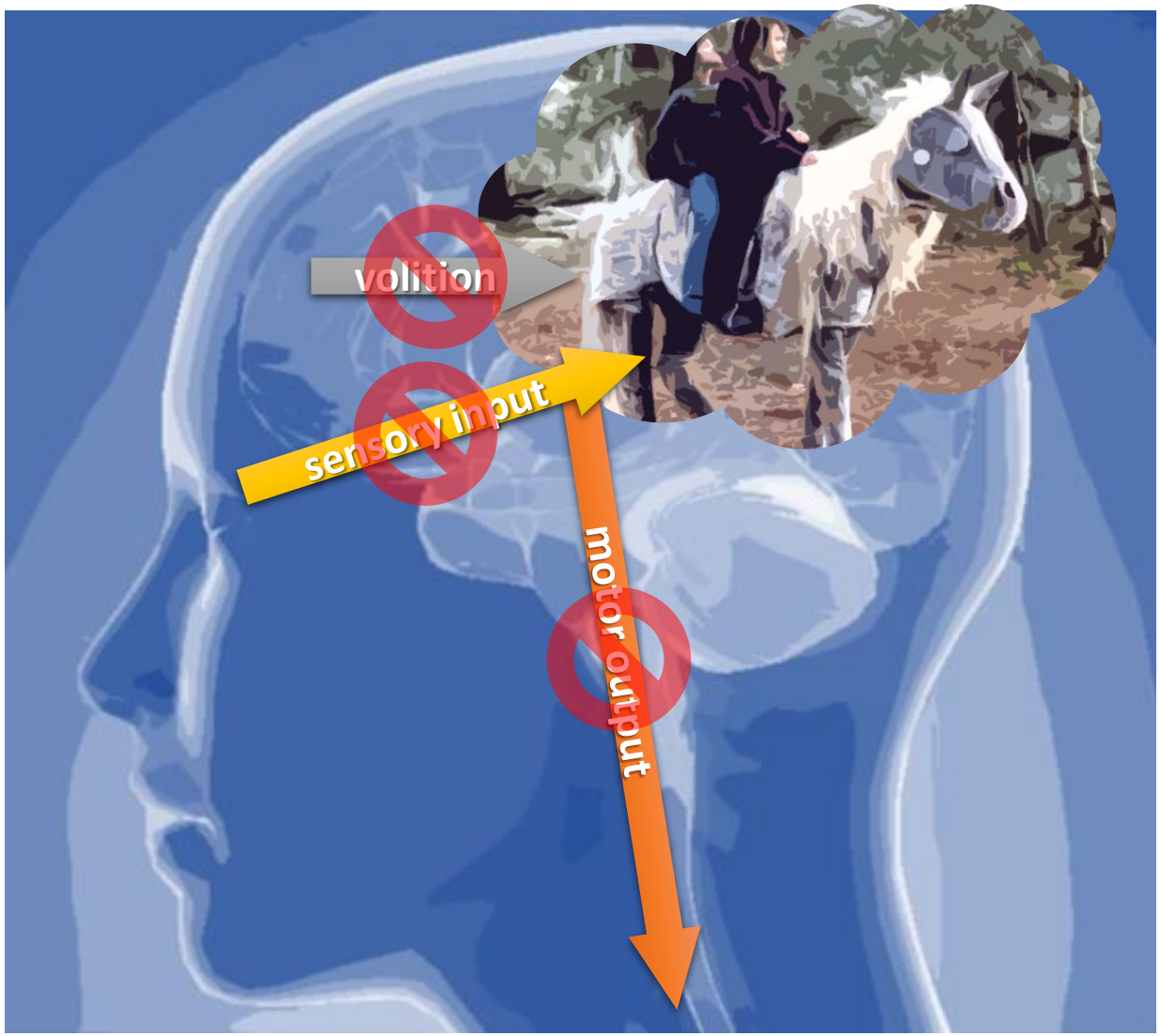
IMT LUCCA

Giulio Bernardi

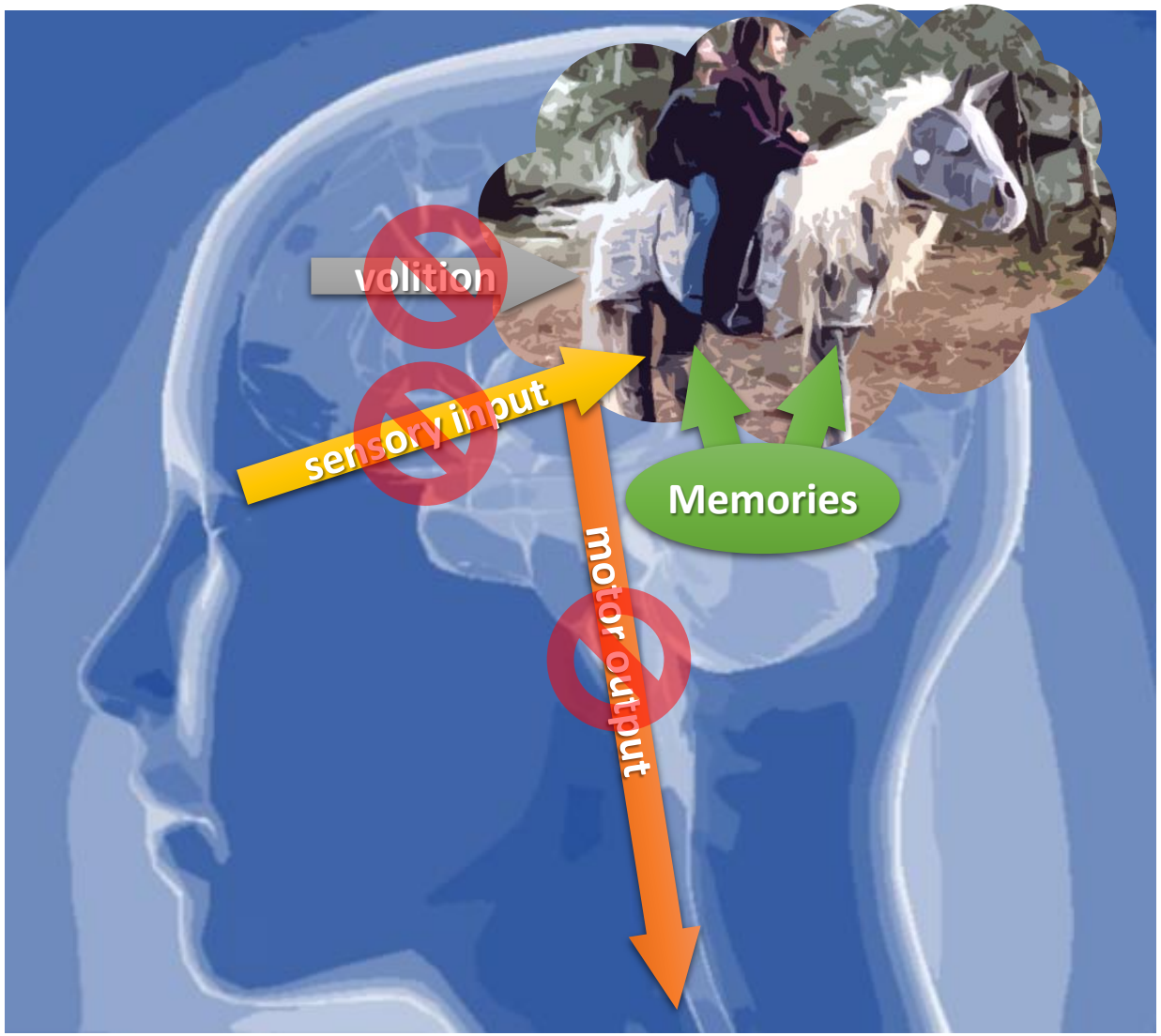
SPACE

Sleep, Plasticity And Conscious Experience
Research Group

Dream Experience (DE)



Dream Experience (DE)



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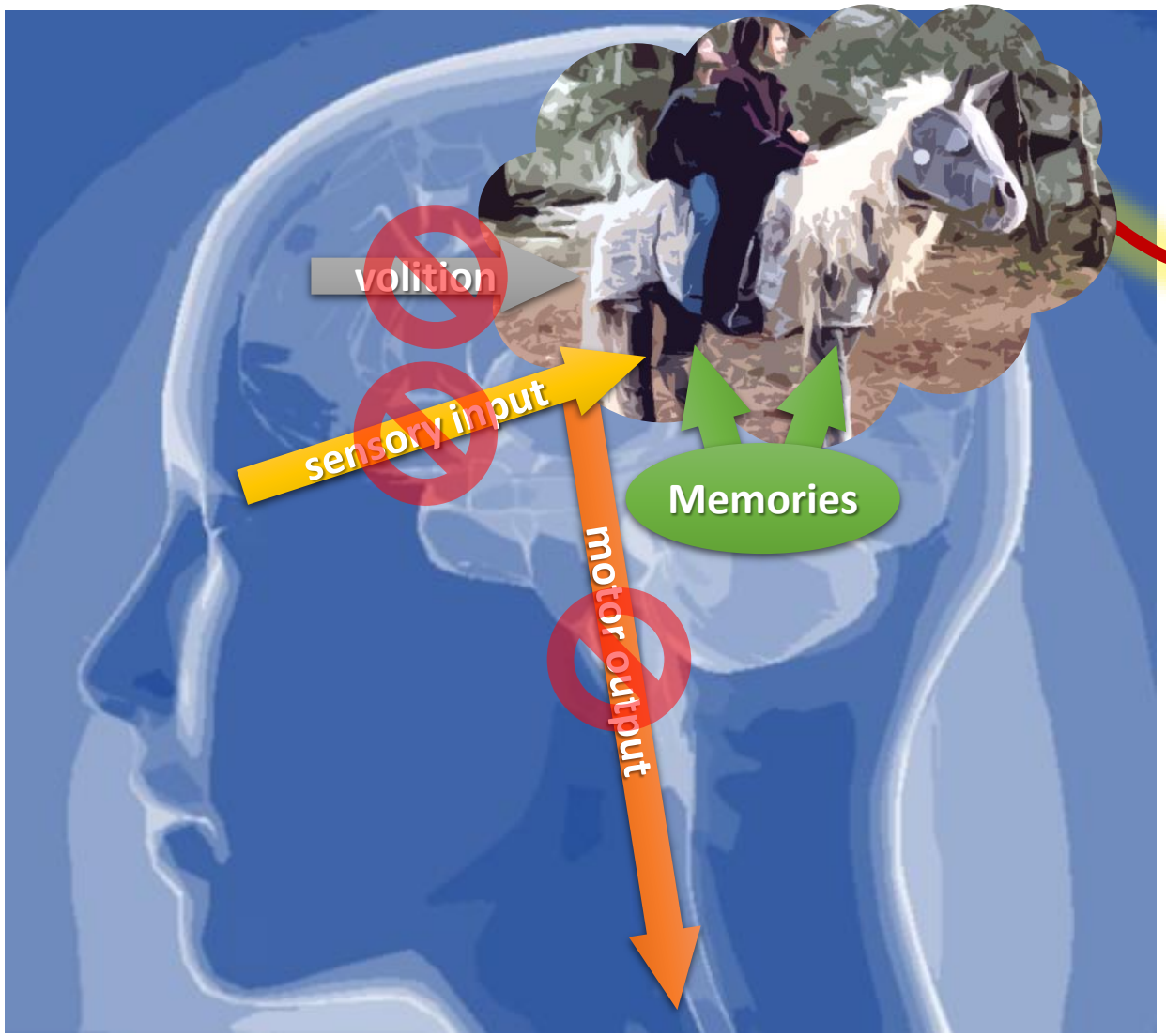

*Represent an important window on, and may have a direct role in, sleep-dependent processes involving **learning** and **memory consolidation**.*

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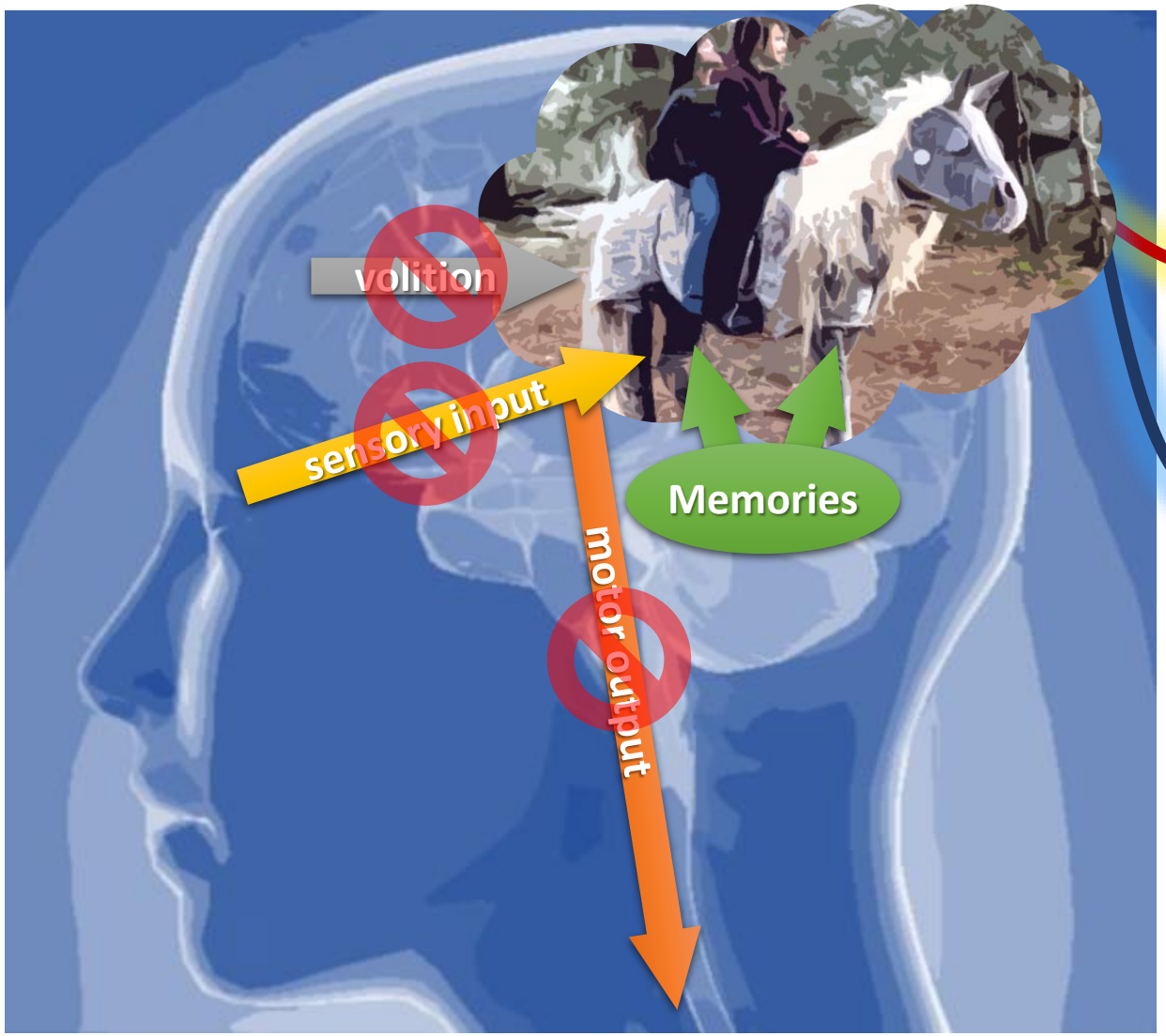

*Represent an important window on, and may have a direct role in, sleep-dependent processes involving **learning** and **memory consolidation**.*

*Have a tight relationship with **psychophysical health**: alterations of DEs may accompany or precede, the waking manifestation of symptoms related to **psychiatric** and **neurological** disorders.*

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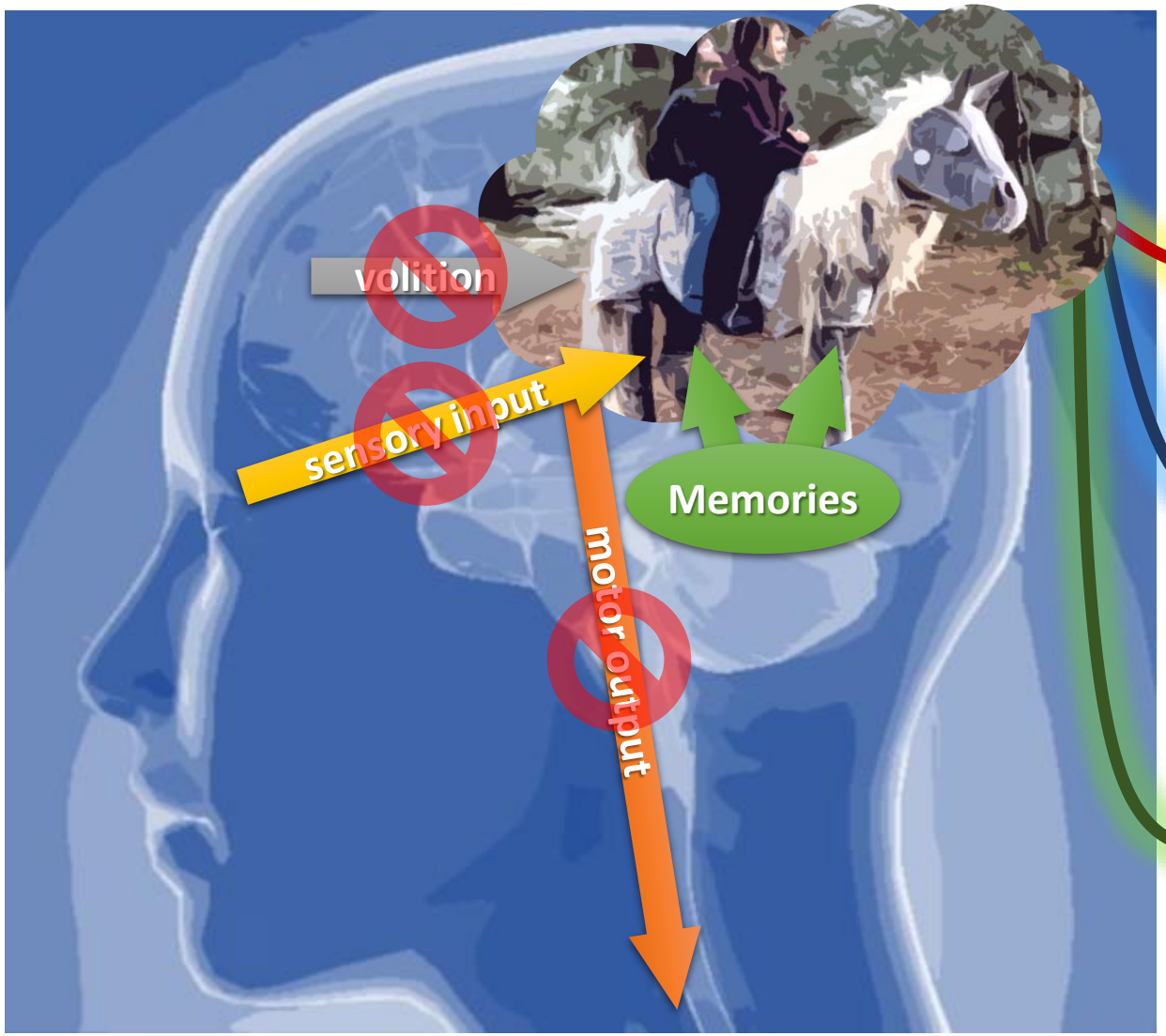


*Represent an important window on, and may have a direct role in, sleep-dependent processes involving **learning** and **memory consolidation**.*

*Have a tight relationship with **psychophysical health**: alterations of DEs may accompany or precede, the waking manifestation of symptoms related to **psychiatric** and **neurological** disorders.*

*Offer a fundamental model for the study of consciousness due to their nature of "**islands of consciousness**", independent from sensory input, motor output, and volitional processes.*

Dreams in Rapid Eye Movement (REM) sleep

Facevo una specie di concorso per ricercatore che si svolgeva in una specie di cattedrale trasparente, e c'era tutta la gente seduta sulle panchine. Era una specie di competizione alla Italia's Got Talent. C'erano quelli che ballavano, che cantavano. Io facevo un discorso e alla fine vinceva un'altra persona. […]

Vivid perceptual experience

Often long and movie-like

High degree of emotionality

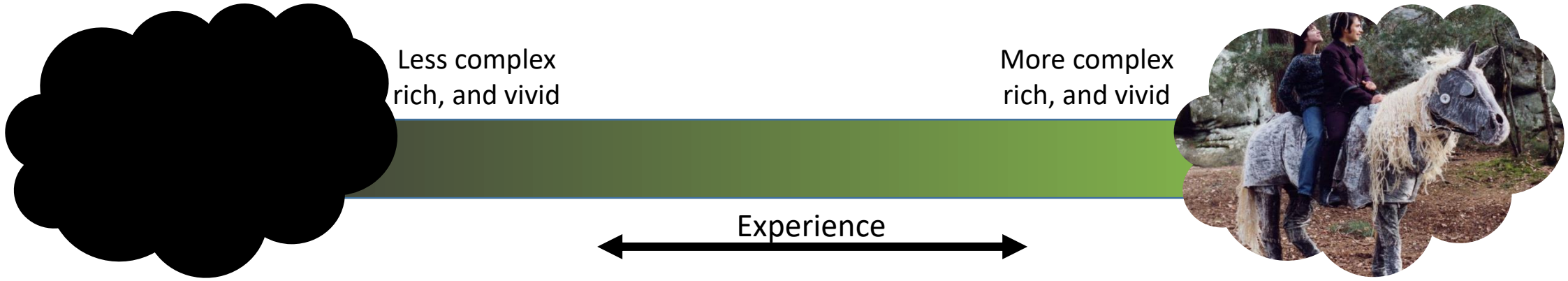
Common social interactions

Clips from: La science des rêves, 2006

The spectrum of possible dreams

No experience

Vivid and rich experience



Less complex
rich, and vivid

More complex
rich, and vivid

Experience

*L'**ansia** e la **fretta**, il dover correre come se fossi sempre indietro rispetto a qualcosa da fare. […]*

*Questa **frase**: "foglie bollenti«; e la natura, il sottobosco per la precisione, pieno di funghi, foglie e io che cammino all'interno […].*

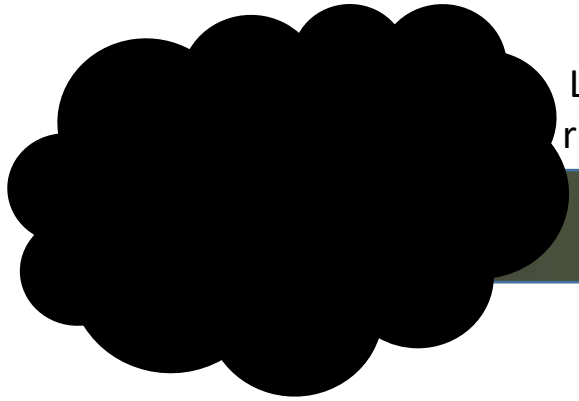
*C'erano alcuni vecchi amici dell'università nella mia casa attuale. […] Non vedevo i volti ma **sentivo le voci**. […]*

Dovevo registrare il sogno e nel sogno mi sono svegliato e ho registrato appunto quello che che stavo sognando, cioè il fatto di dover registrare il sogno.

The spectrum of possible dreams

No experience

Vivid and rich experience



Less complex
rich, and vivid

More complex
rich, and vivid

Experience

Abstract/thought-like experiences

Feelings

Thoughts

Emotions

Perceptual experiences

Images

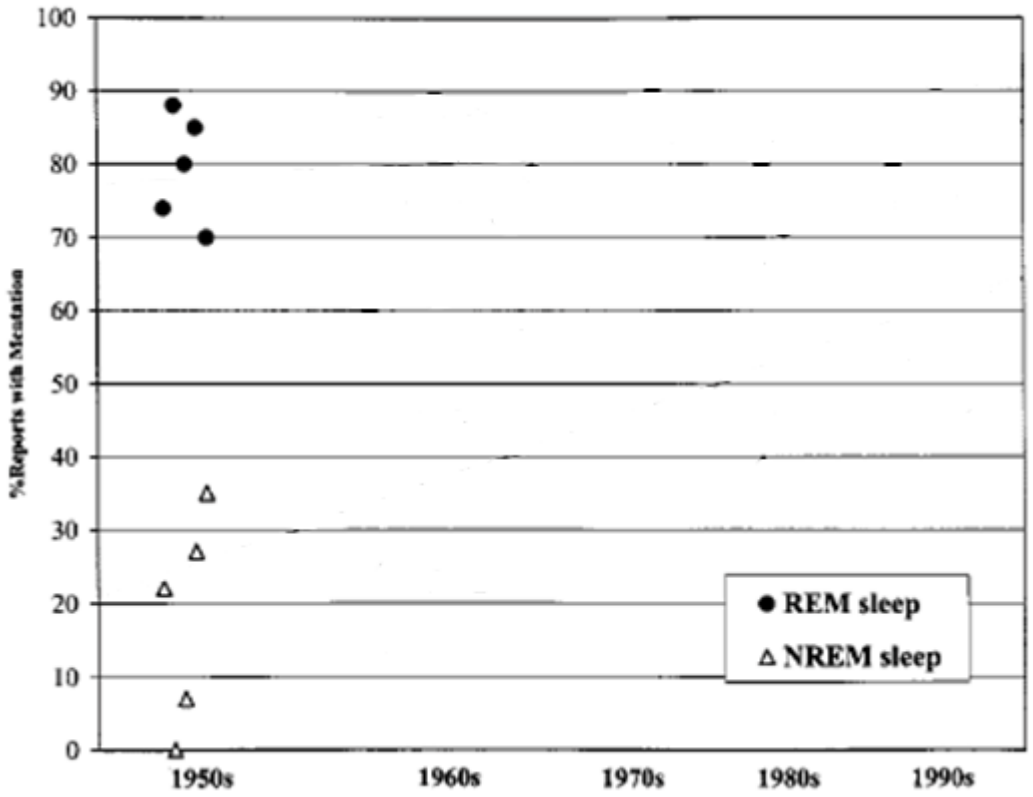
Sounds

Touches

Odors

Tastes

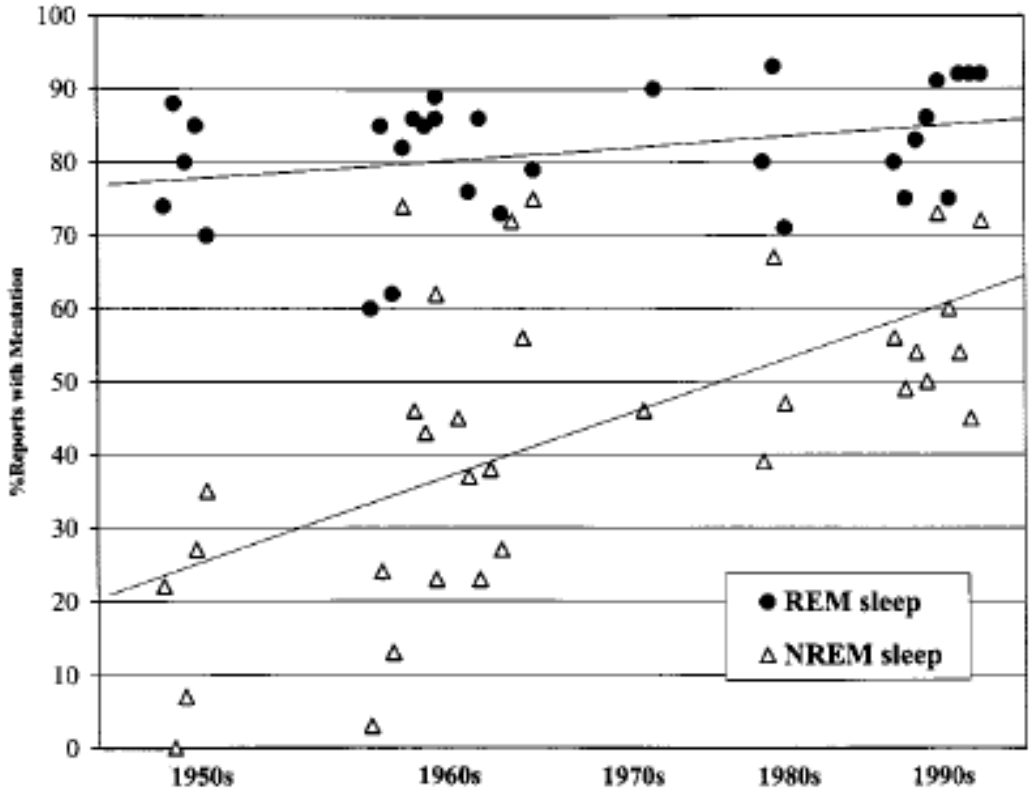
Did you have a dream? vs. Did you have any subjective experience?



'Tell me whether you had a dream'

Nielsen, Behav Brain Sci, 2000

Did you have a dream? vs. Did you have any subjective experience?



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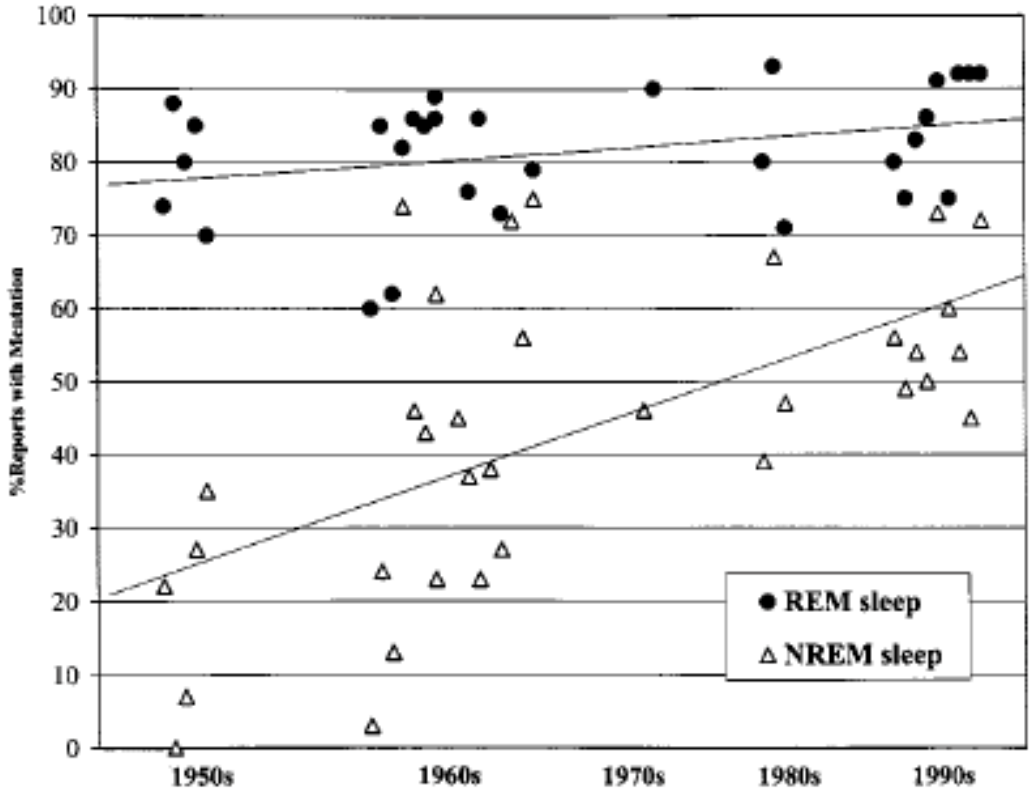


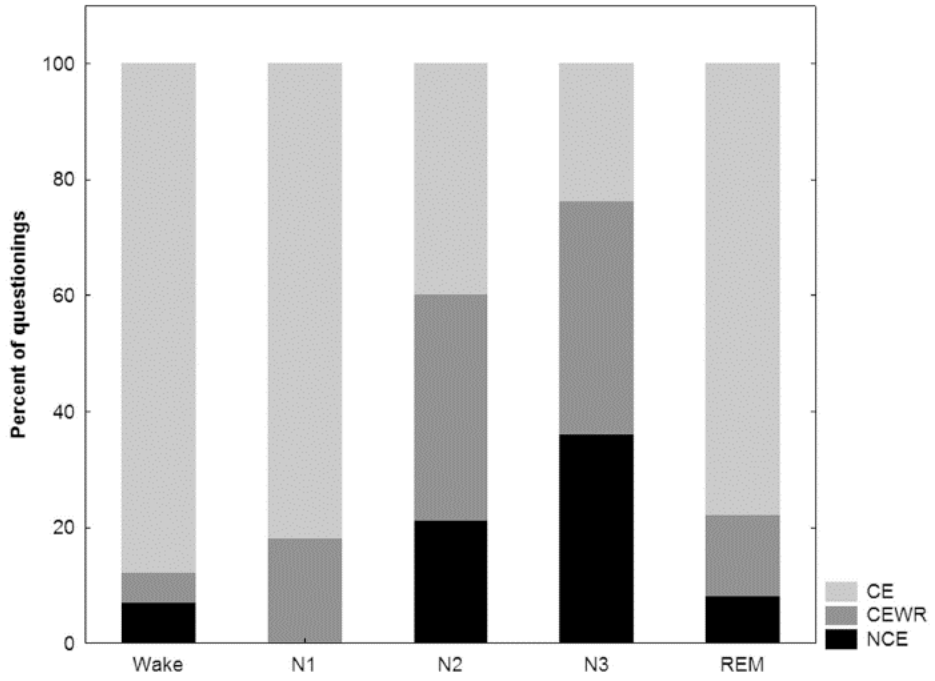
'Tell me whether you had a dream'

'What was going through your mind before you woke up ?'

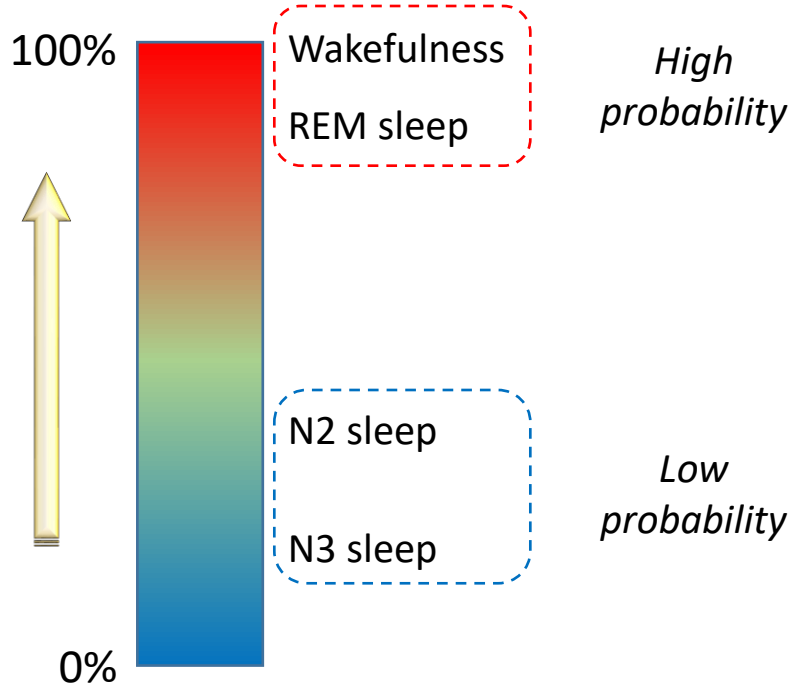
Nielsen, Behav Brain Sci, 2000

The neural correlates of dream experiences

Proportion of dream experiences across sleep stages

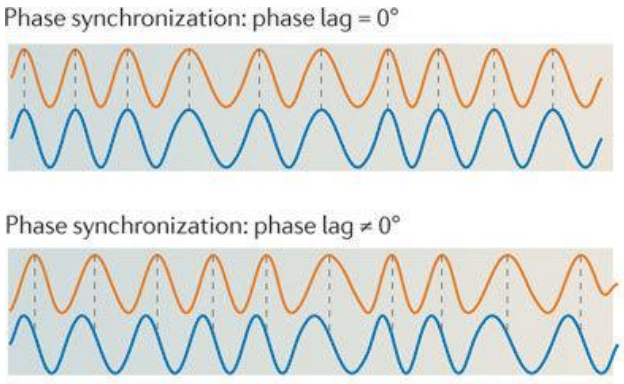


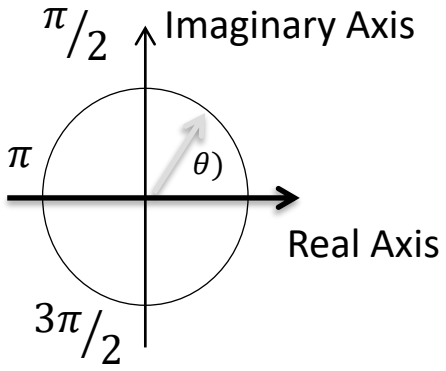
Probability of reporting conscious experiences

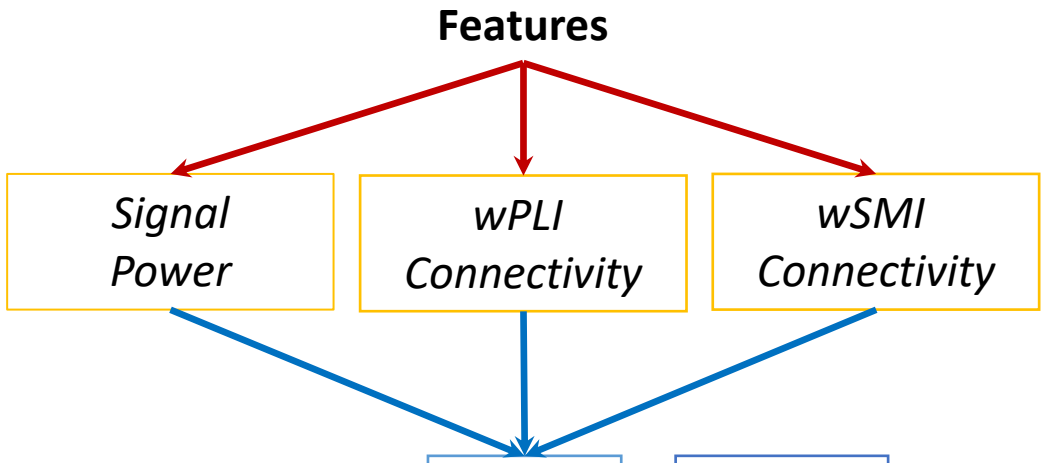


Siclari et al., Front Psych, 2013; Imperatori et al., SLEEP, 2021

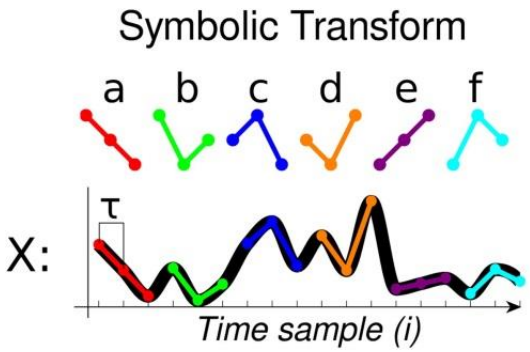
Weighted phase-lag index (wPLI)

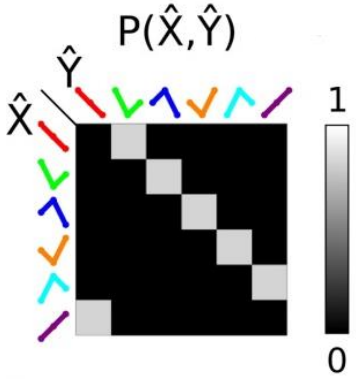


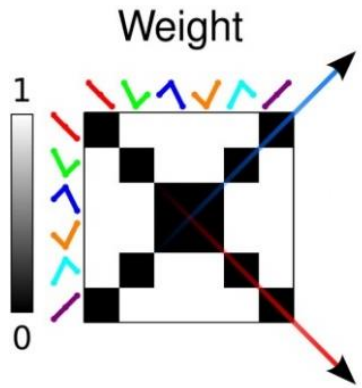




Weighted symbolic mutual information (wSMI)

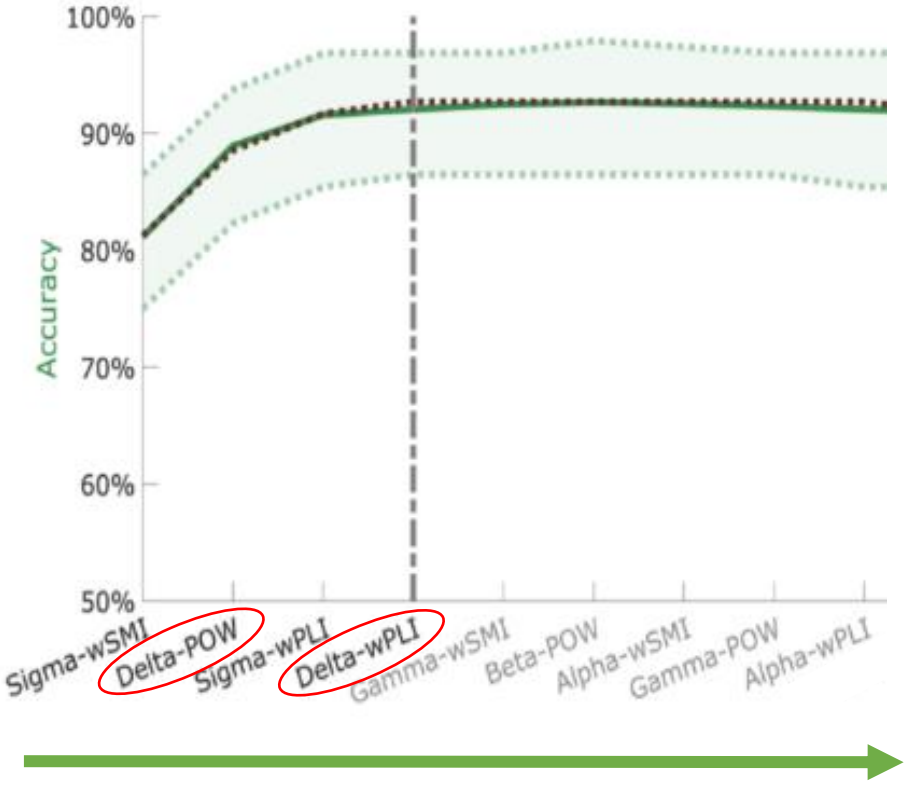


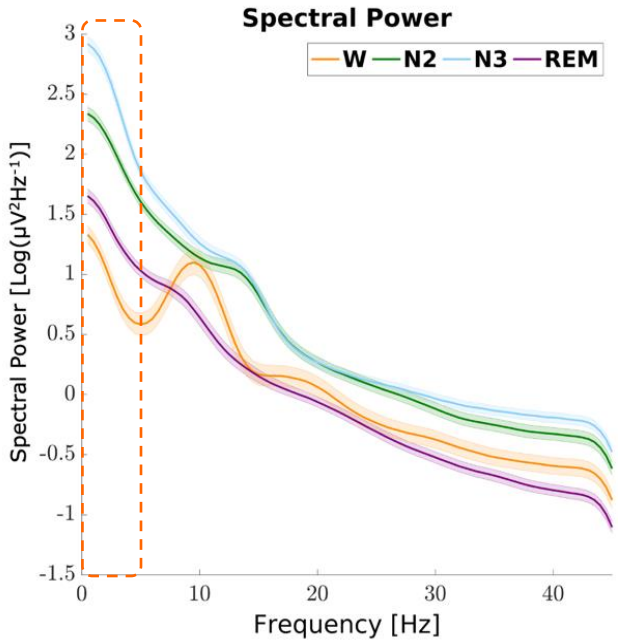


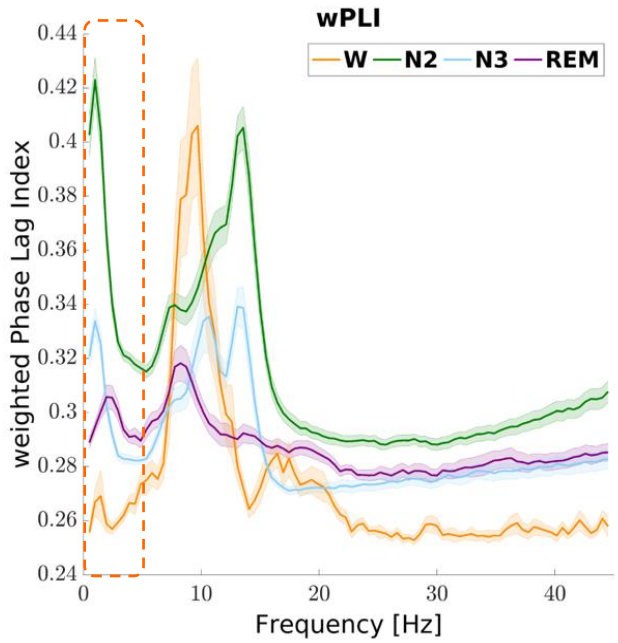


The neural correlates of dream experiences

2-way classifier W+REM vs. N2+N3

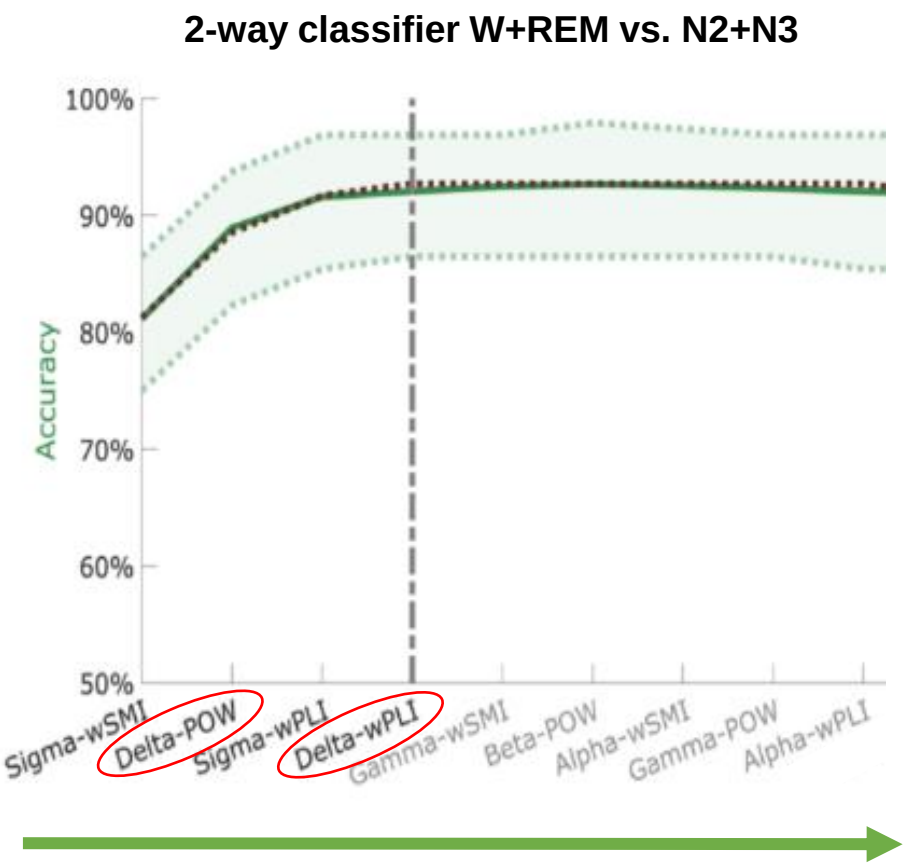




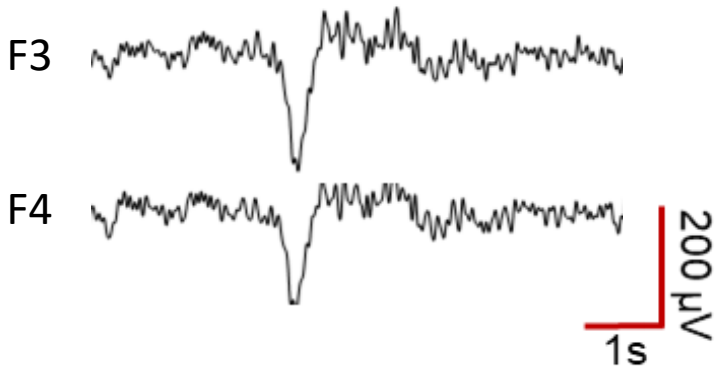


Imperatori et al., SLEEP, 2021

The neural correlates of dream experiences



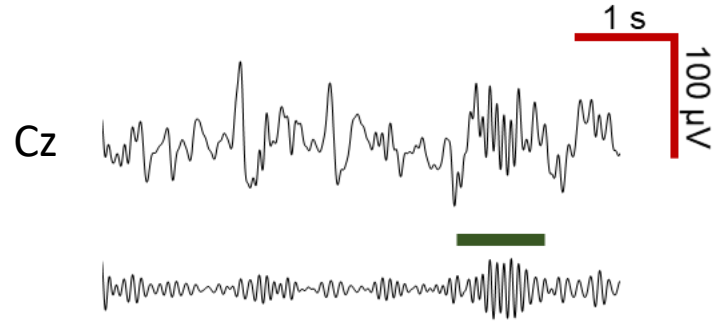
Slow waves



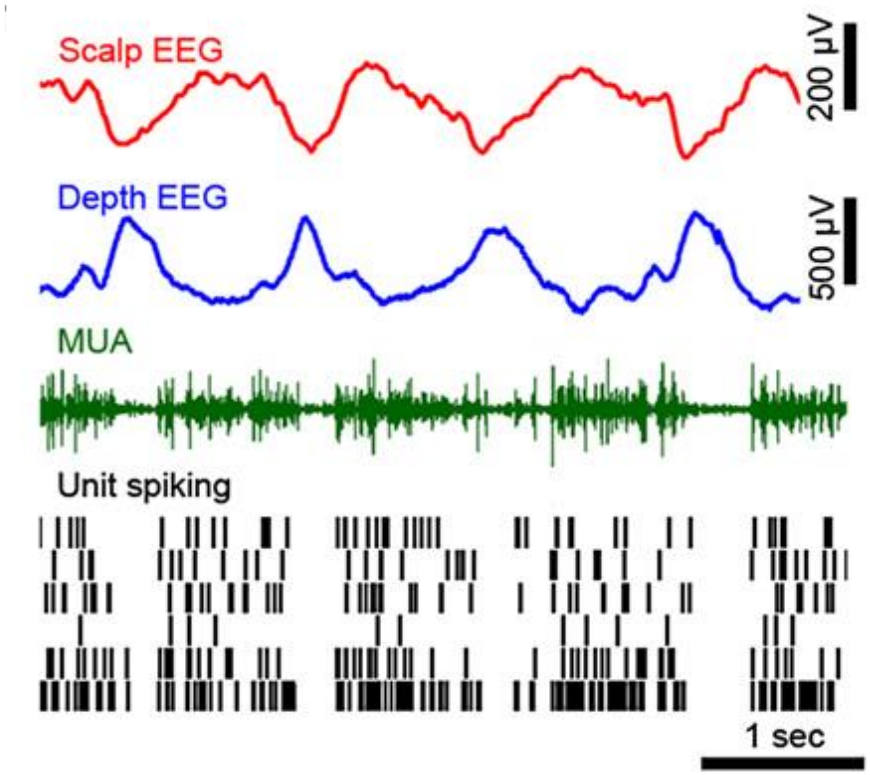
0.5-4 Hz

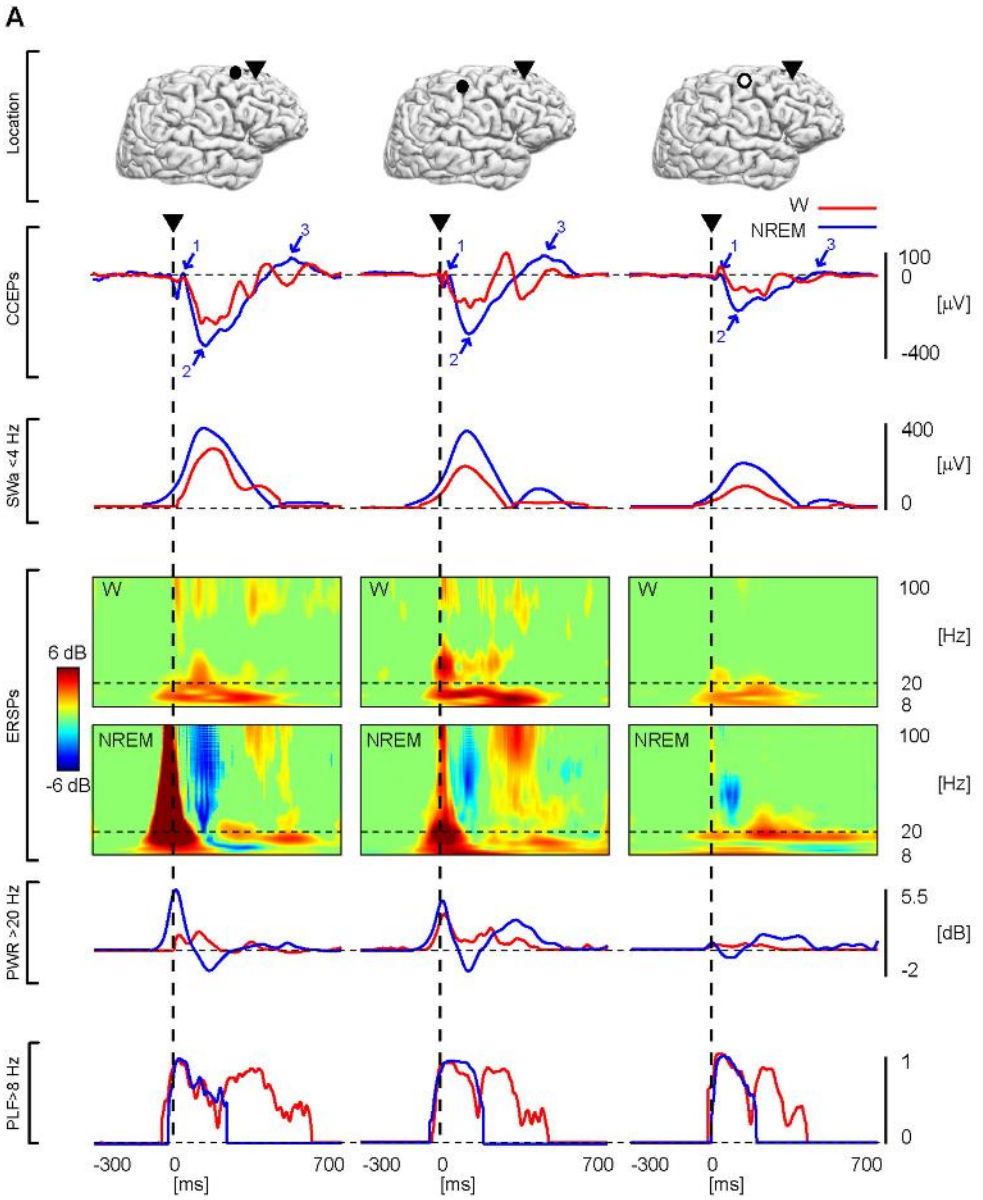
Spindles

12-16 Hz

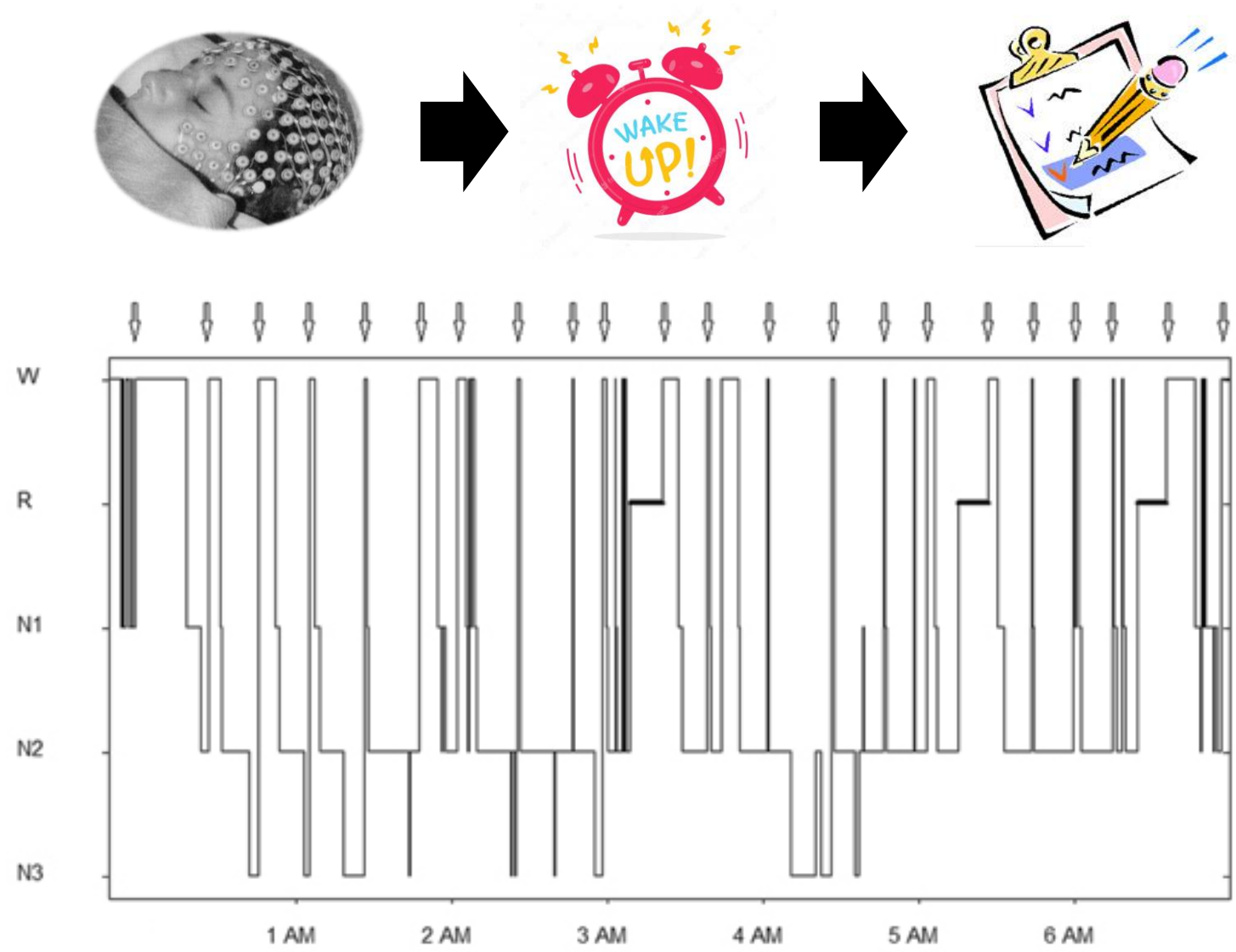


Bistability breaks-off deterministic responses to intracortical stimulation during non-REM sleep





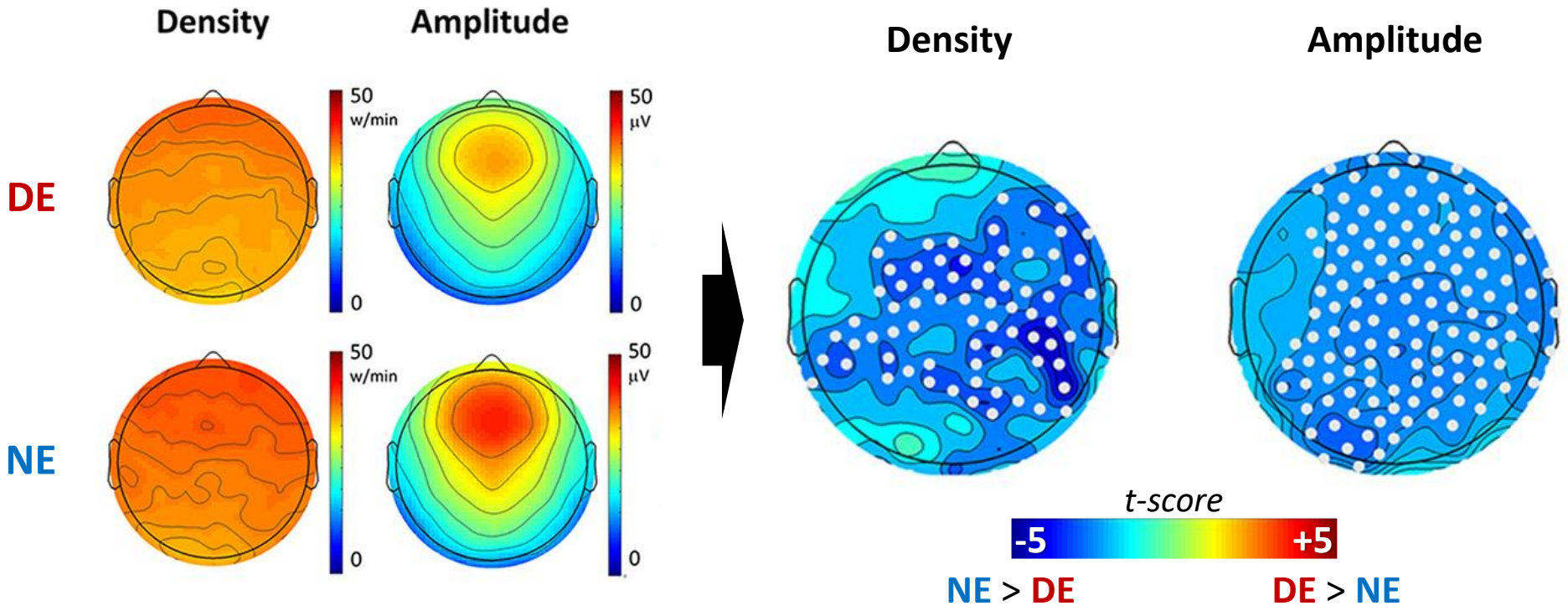
Serial awakening paradigm in combination with high-density EEG recordings



1011 analyzed awakenings

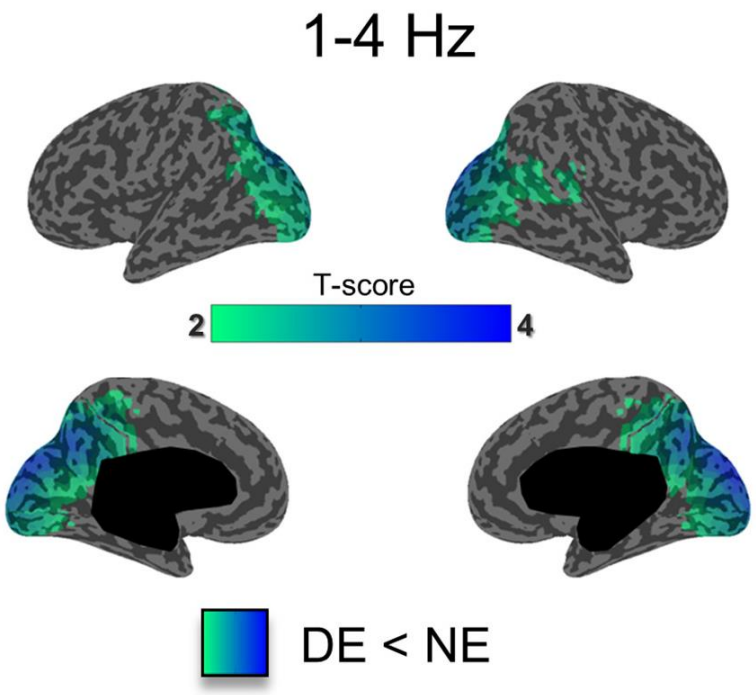
Siclari et al., Front Psych, 2013; Siclari et al., Nat Neurosci, 2017

Neural correlates of dream experiences in NREM sleep



Brain activity patterns associated with dream experiences (NREM sleep)

Neural correlates of dream experiences in NREM sleep



Low-frequency activity

Siclari et al., Nat Neurosci, 2017

Brain activity patterns associated with dream experiences (NREM sleep)

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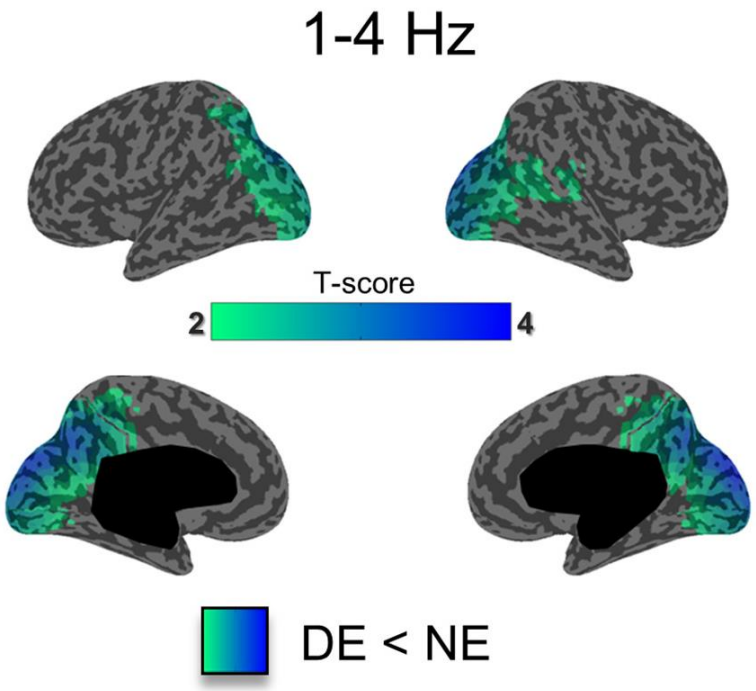

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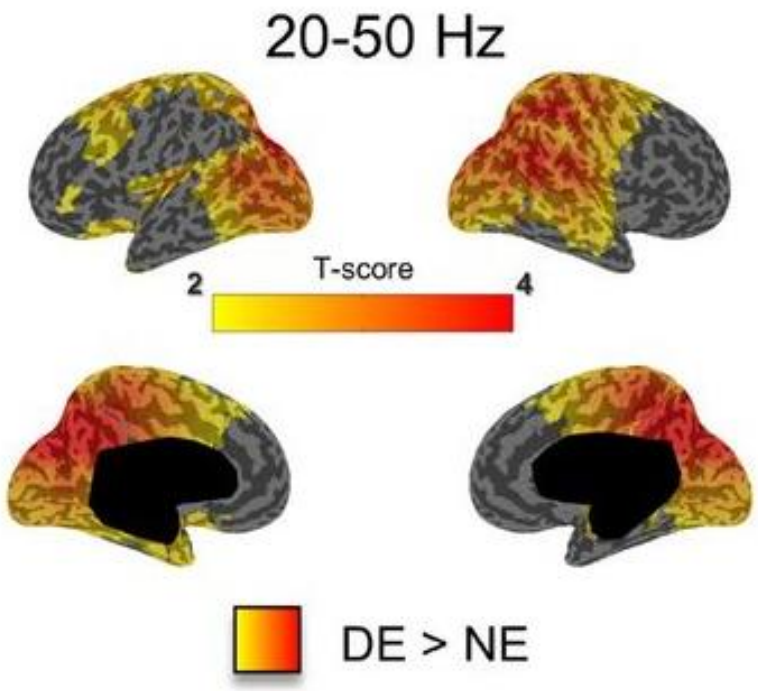
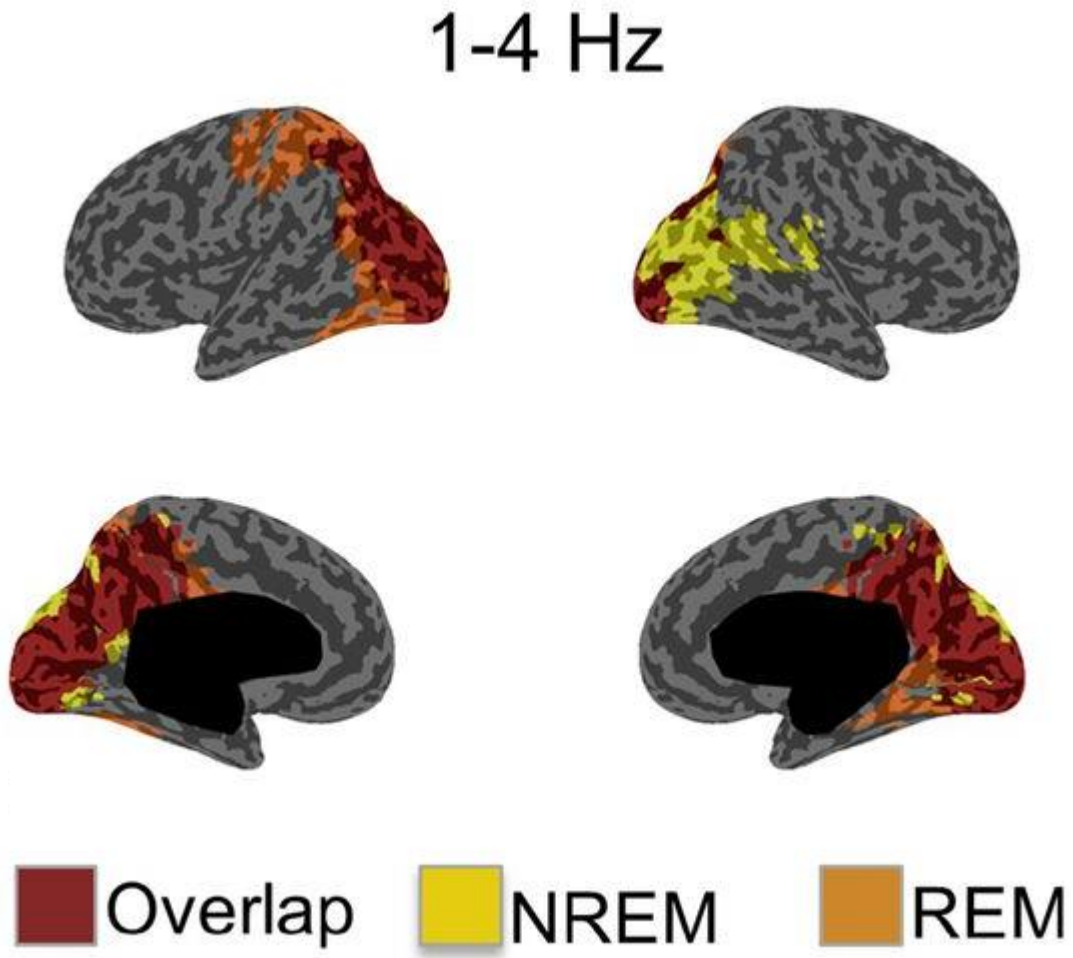


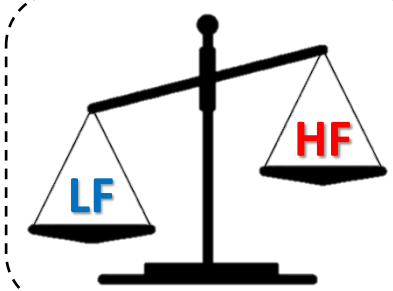
High-frequency activity

Siclari et al., Nat Neurosci, 2017

Similarities between NREM and REM sleep



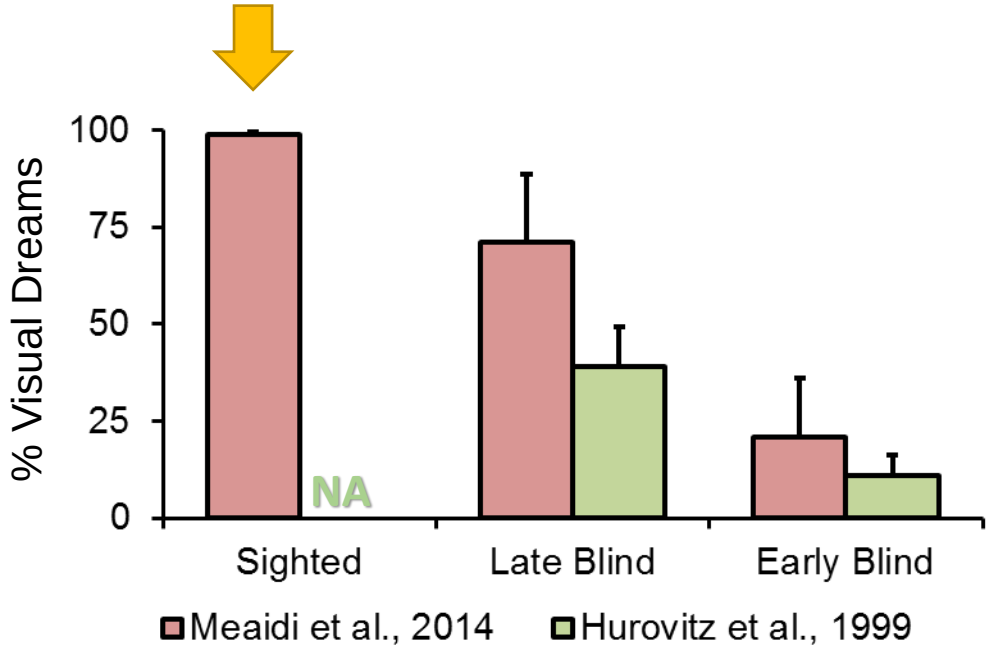
wake-like activity

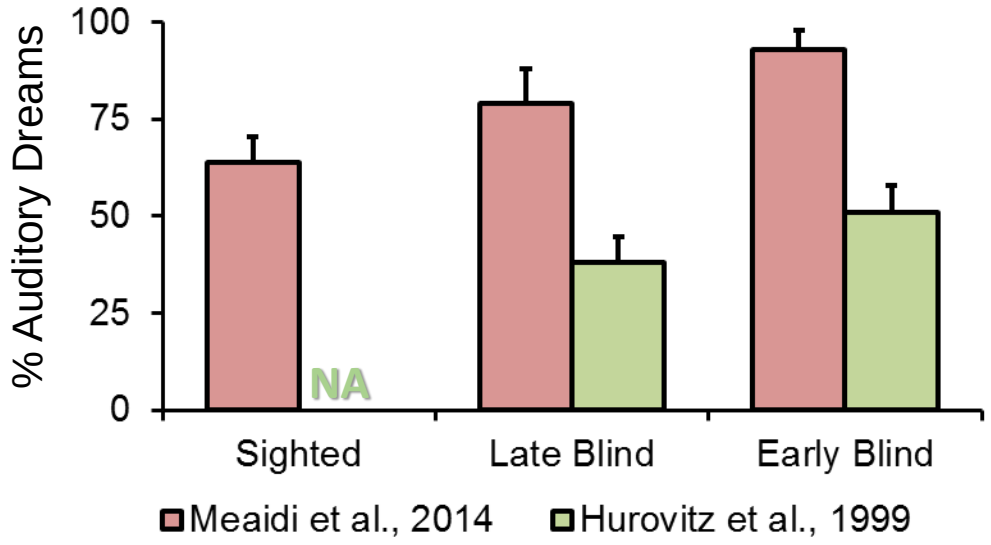


In both NREM and REM sleep, reports of dream experience are associated with local, wake-like activity in posterior cortical regions.

Siclari et al., Nat Neurosci, 2017

Dream experiences of sighted and blind individuals






~100%


~60%

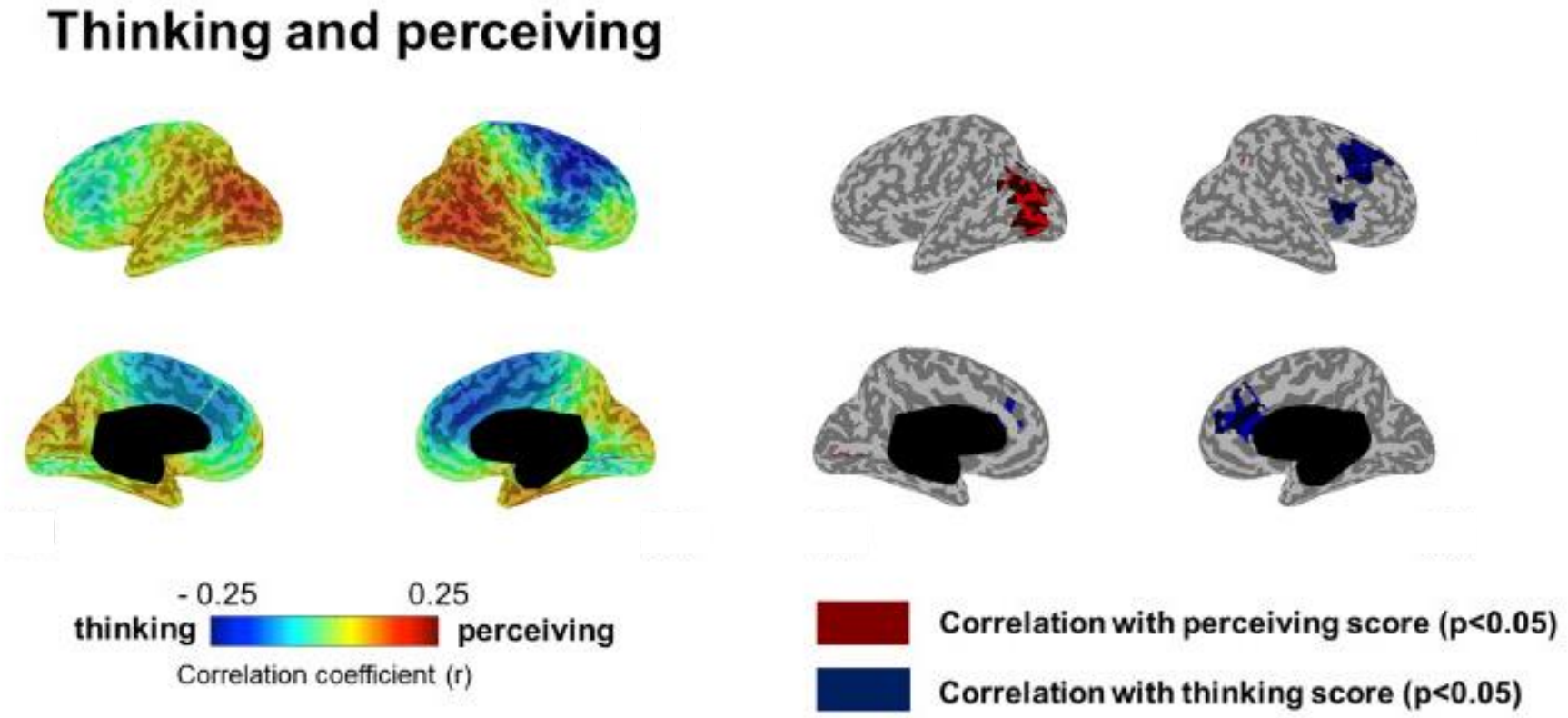

~40%


~2%


~1%

Sensory experiences in dreams

Perceptual vs. Thought-like dreams

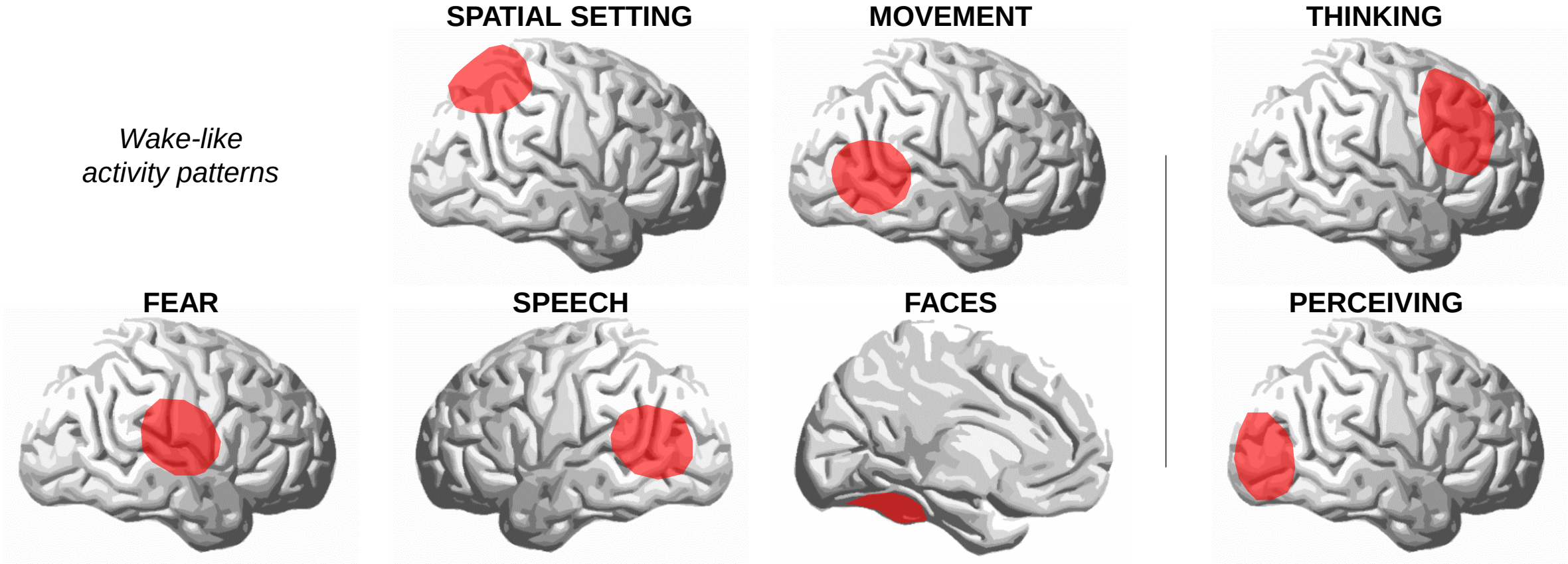


Siclari et al., Nat Neurosci, 2017

Dream content and brain activity patterns

The pattern of wake-like activity (↑ high-frequency, ↓ low-frequency) determines the content of conscious experiences

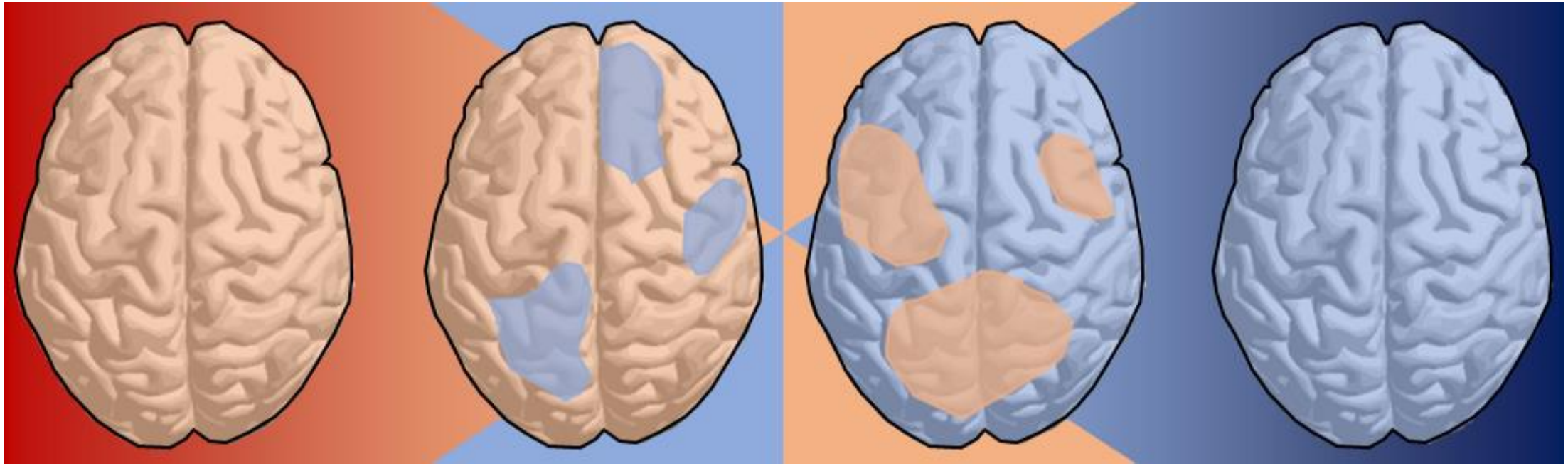
Wake-like activity patterns

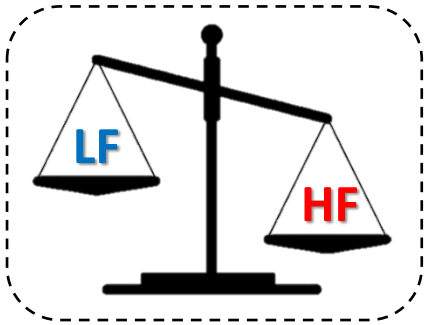


Siclari et al., Nat Neurosci, 2017; Perogamvros et al., J Cogn Neurosci, 2017; Sterpenich et al., Hum Brain Map 2019

Local regulation of sleep and wakefulness

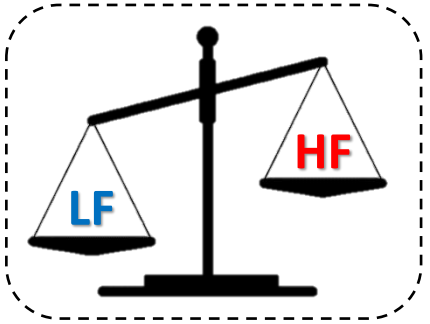
Wakefulness **Deep Sleep**





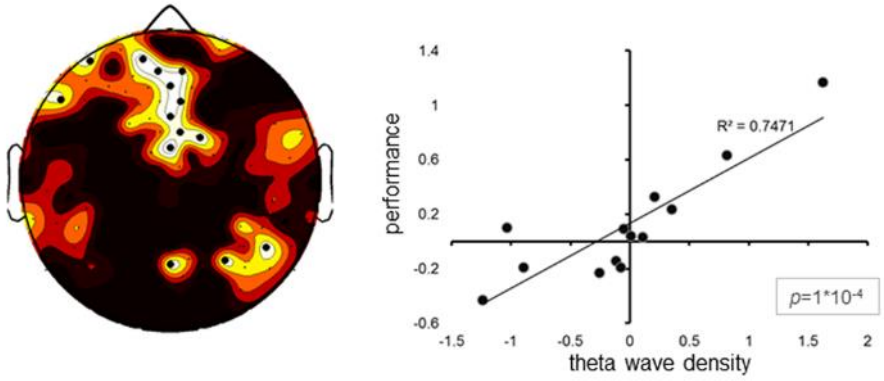
Local sleep-like activity in wakefulness

Local wake-like activity in sleep

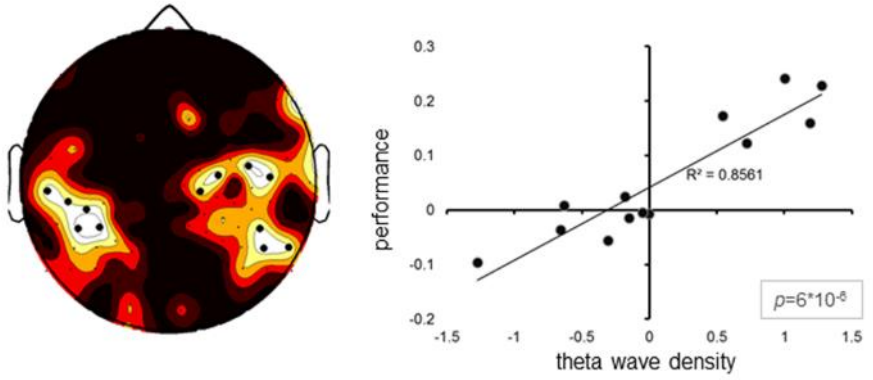


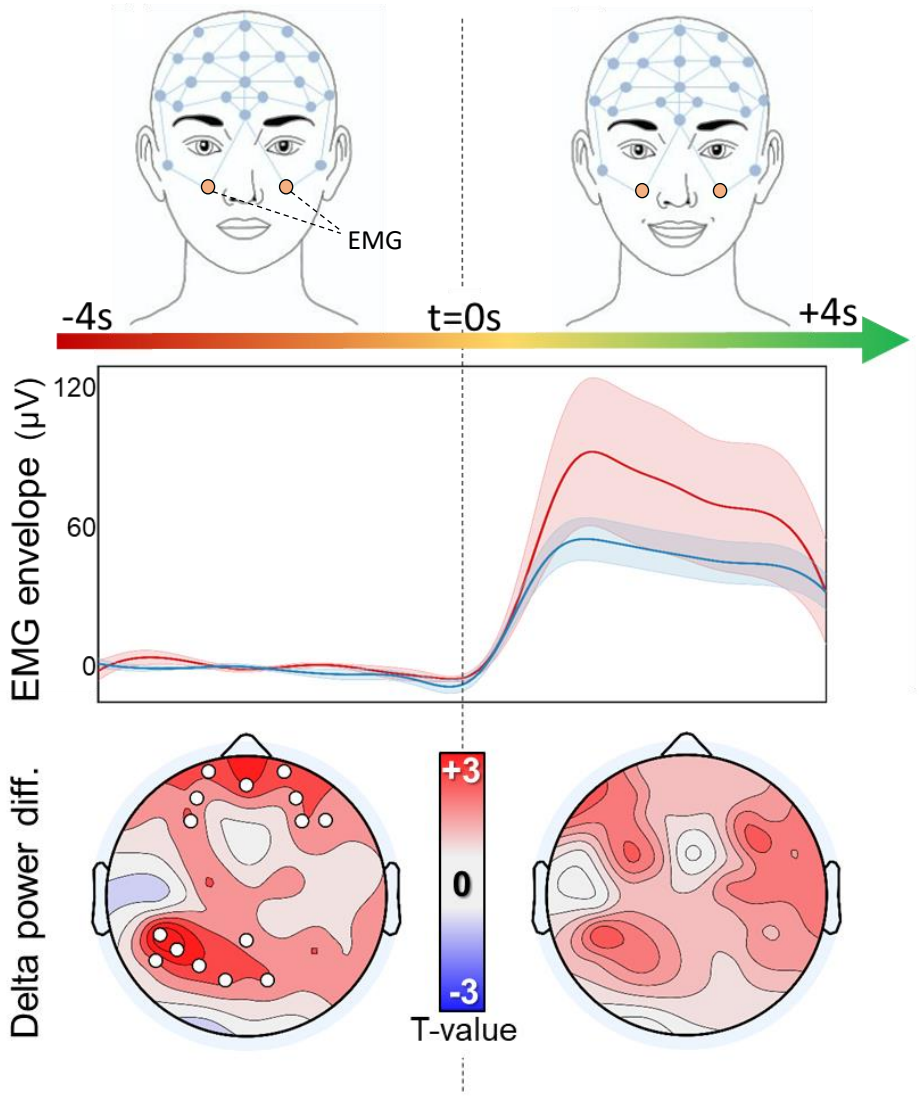
Local sleep-like activity during wakefulness

Commission Errors
(Go/NoGo Task)



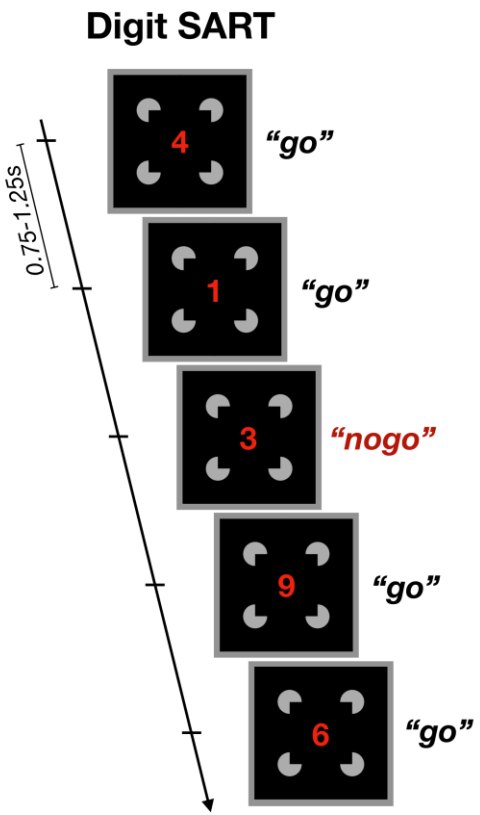
Movement Time
(Reaching Task)

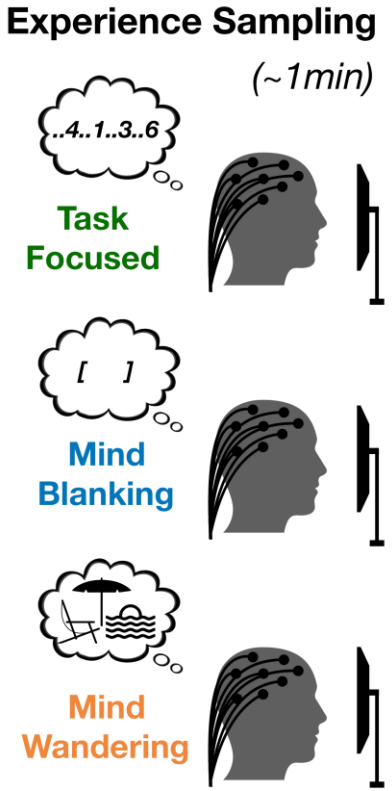


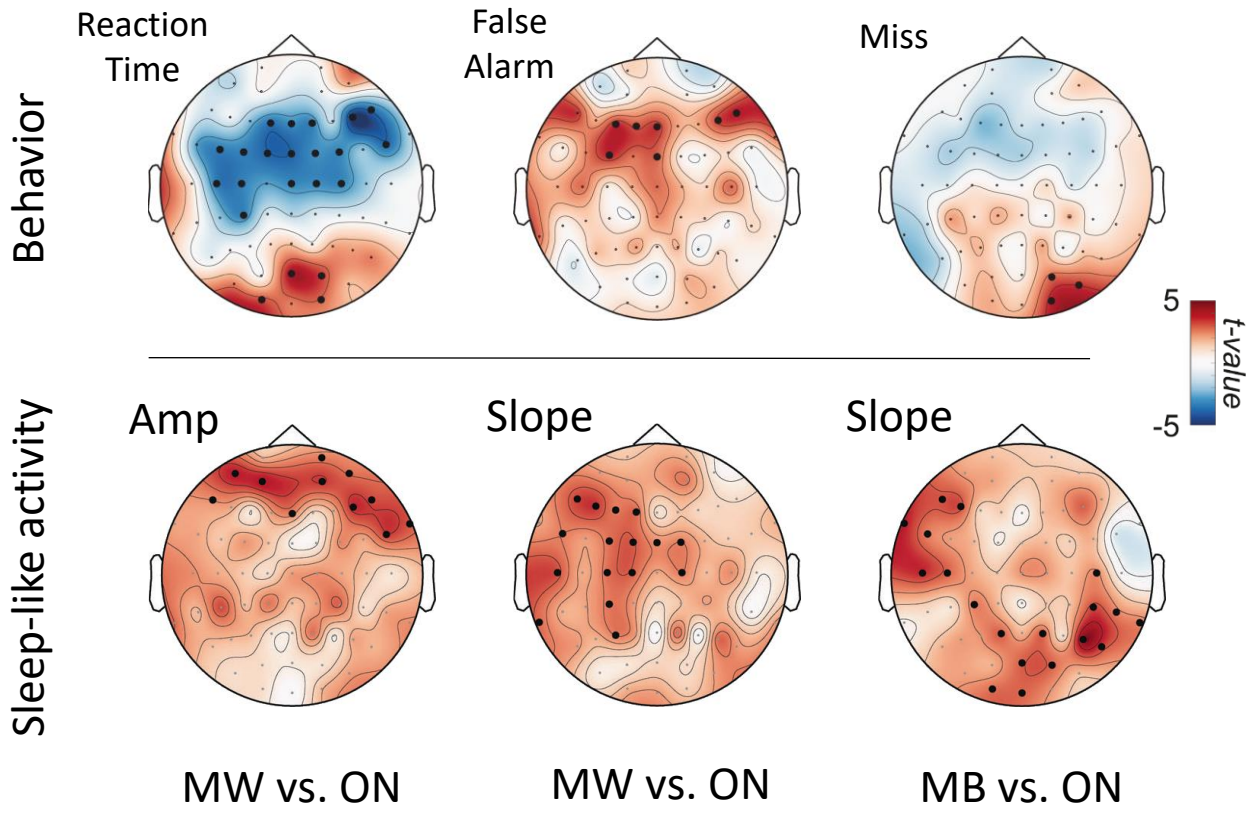


Bernardi et al., J Neurosci, 2015; Avvenuti et al., J Cogn Neurosci, 2021

Local sleep-like activity during wakefulness







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Benjamin Baird
Lampros Perogamvros
Josh LaRocque
Melanie Boly
Brad Postle
…