



Spontaneous EEG and Sleep

Donders MEG/EEG Toolkit

Martin Dresler

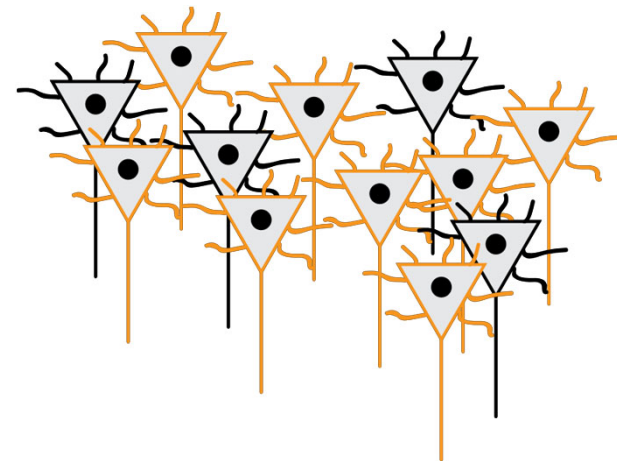
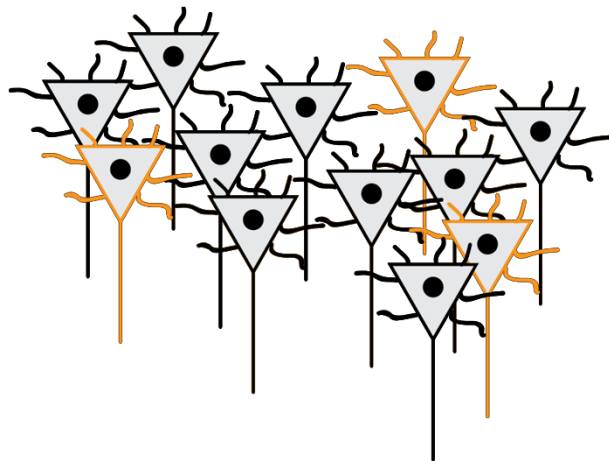
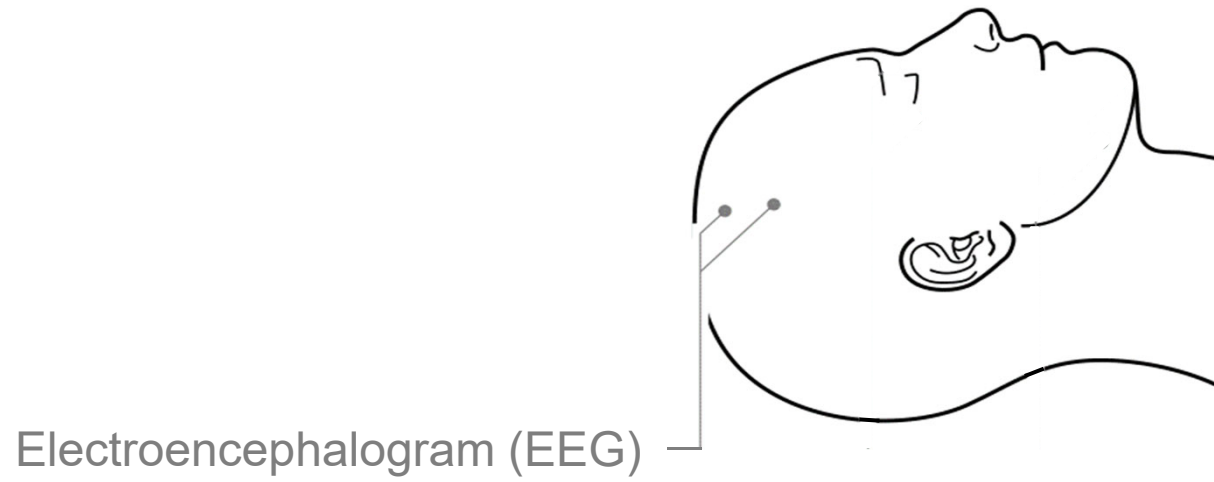
Spontaneous EEG and Sleep



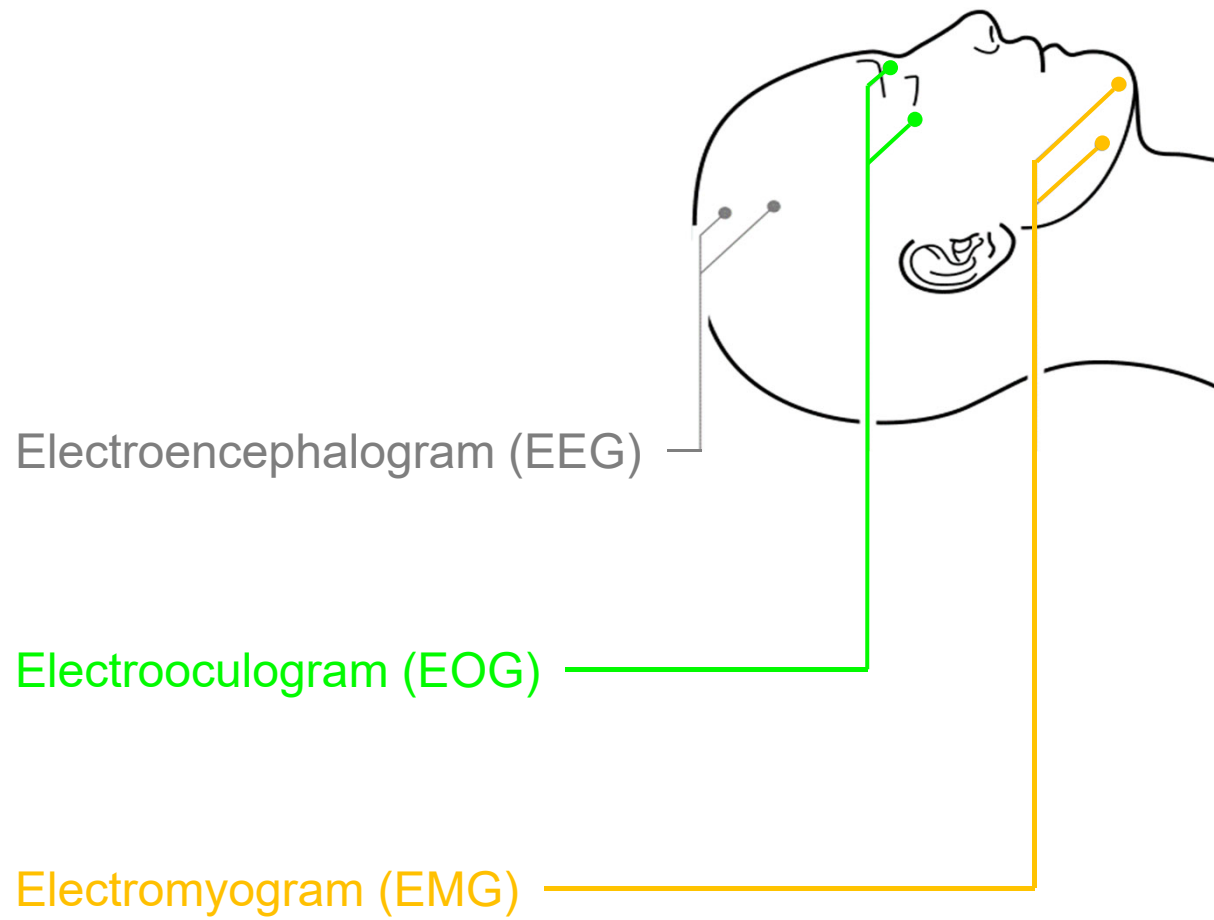
Agenda

- Recording methods
- Oscillations on different time scales
- Examples: functions of sleep

Polysomnography



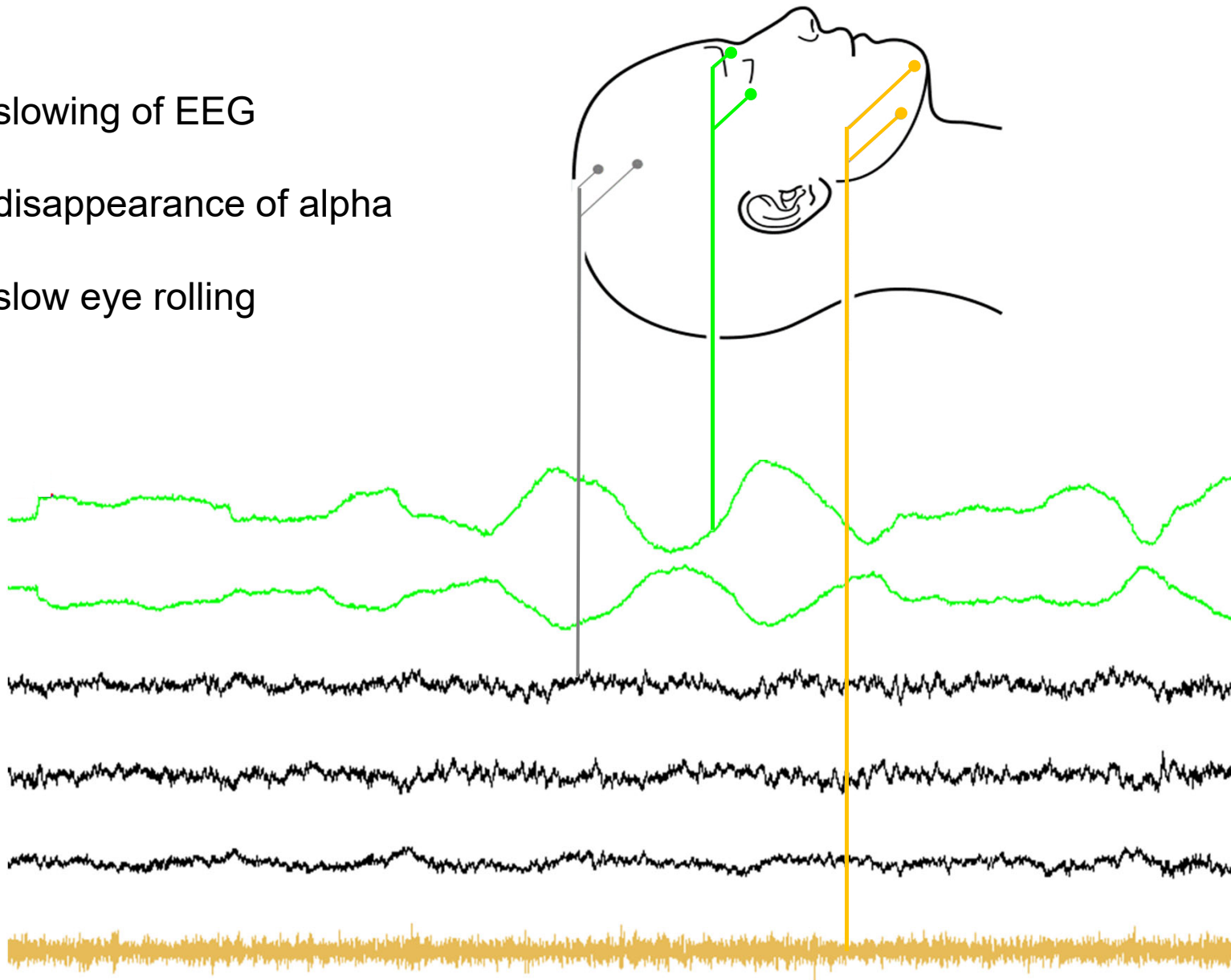
Polysomnography



Sleep stages: N1





- slowing of EEG
- disappearance of alpha
- slow eye rolling

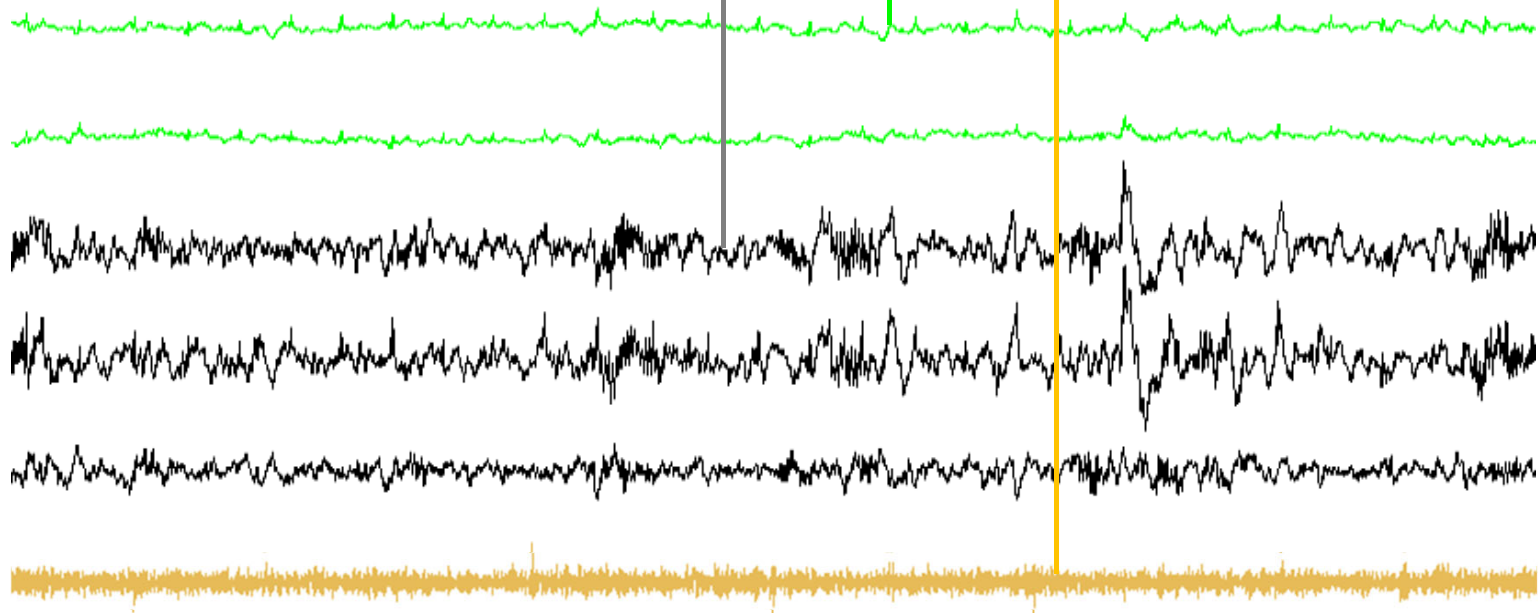
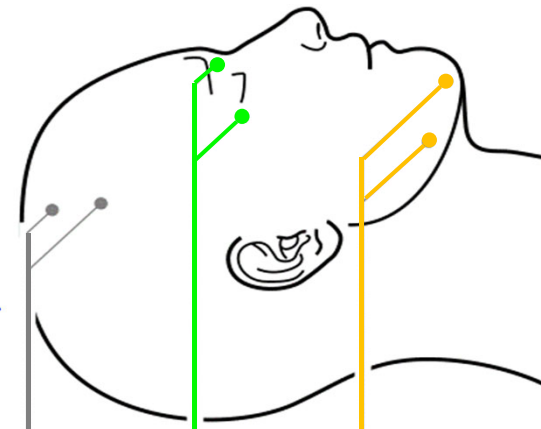


Sleep stages: N2



- sleep spindles (10-16Hz) 

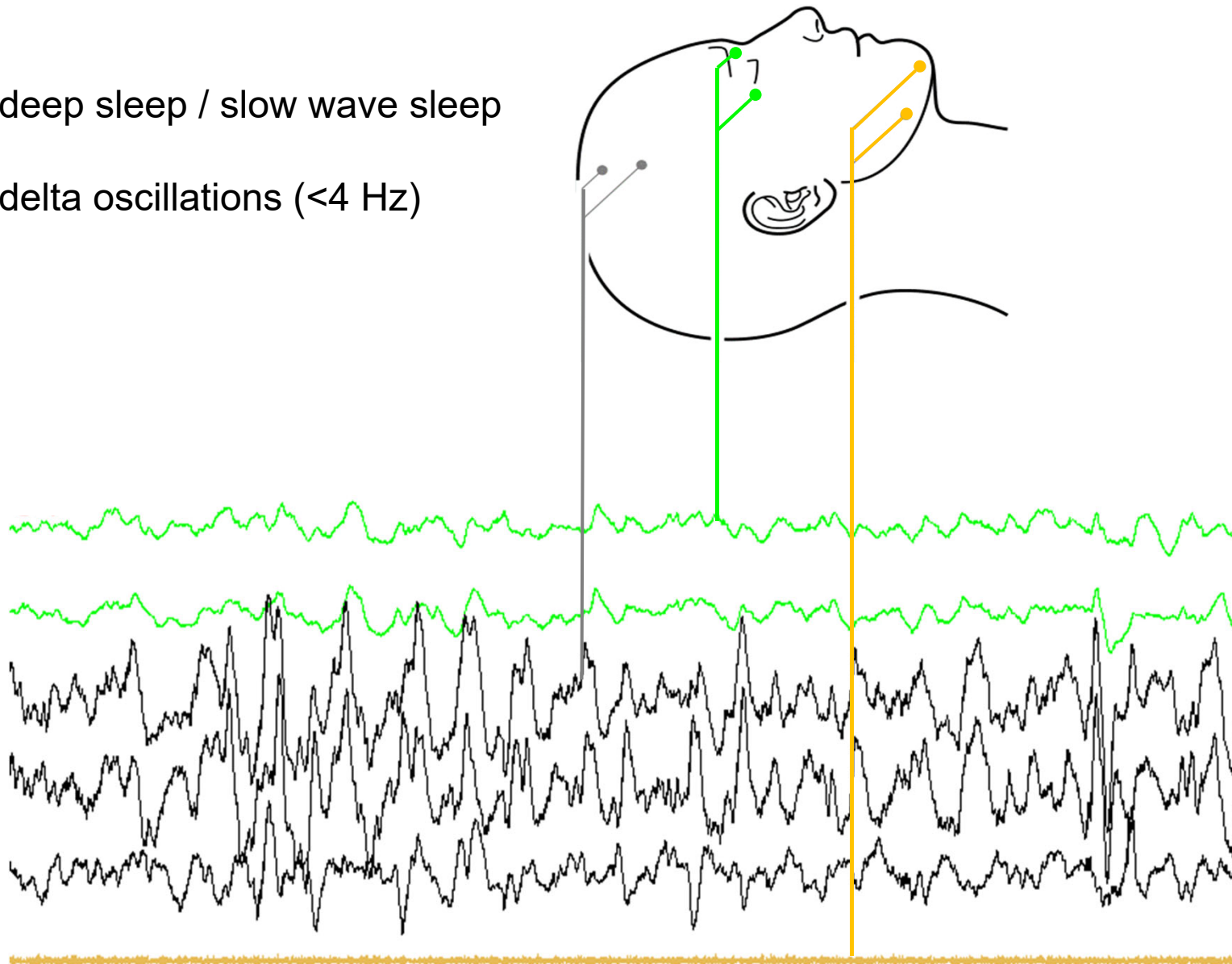
- K-complexes (0.5-1Hz) 



Sleep stages: N3



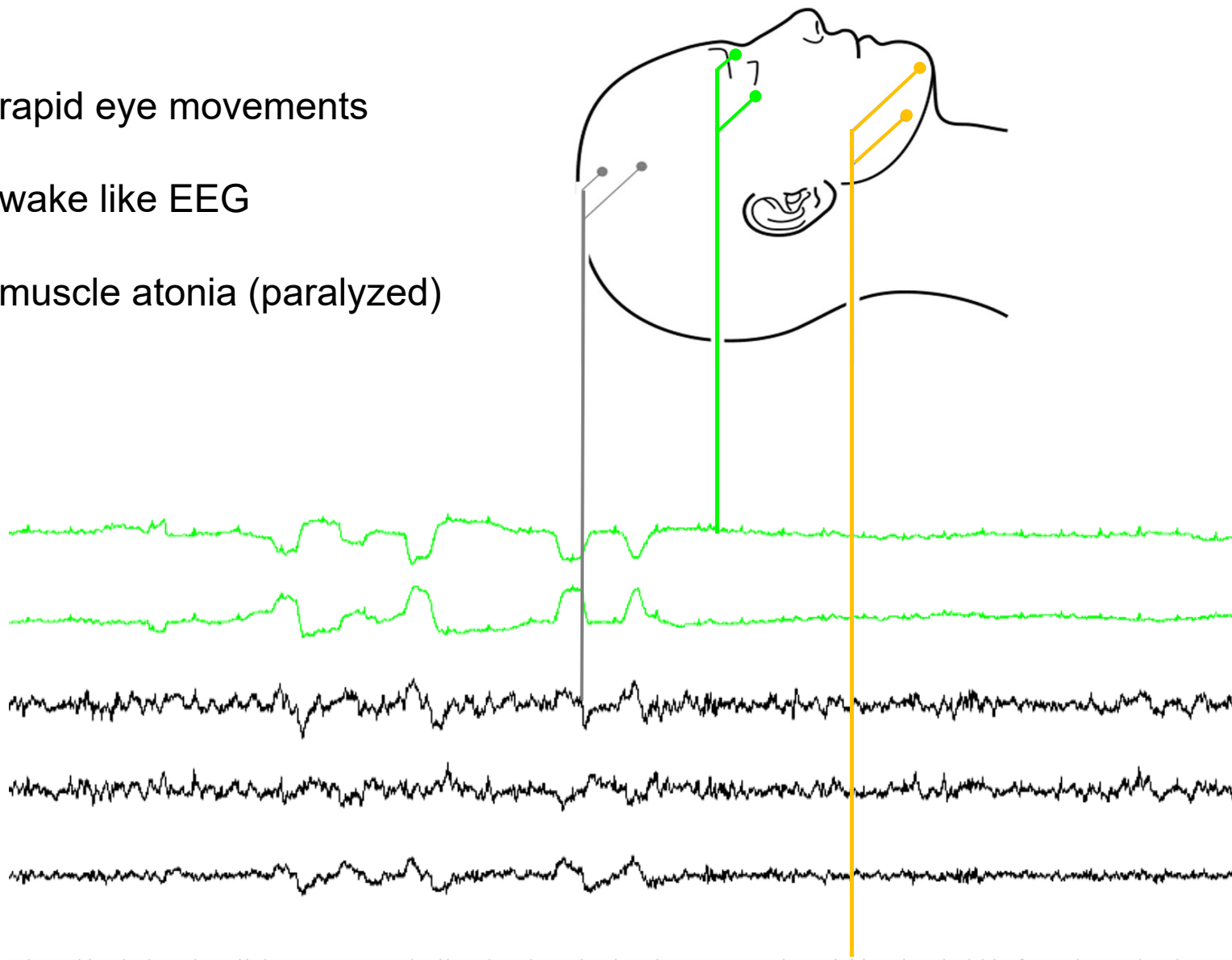
- deep sleep / slow wave sleep
- delta oscillations (<math><4\text{ Hz}</math>)



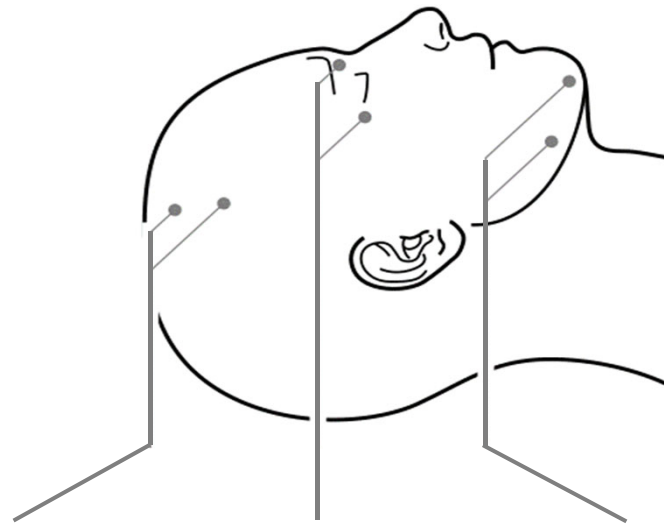


Sleep stages: REM

- rapid eye movements
- wake like EEG
- muscle atonia (paralyzed)

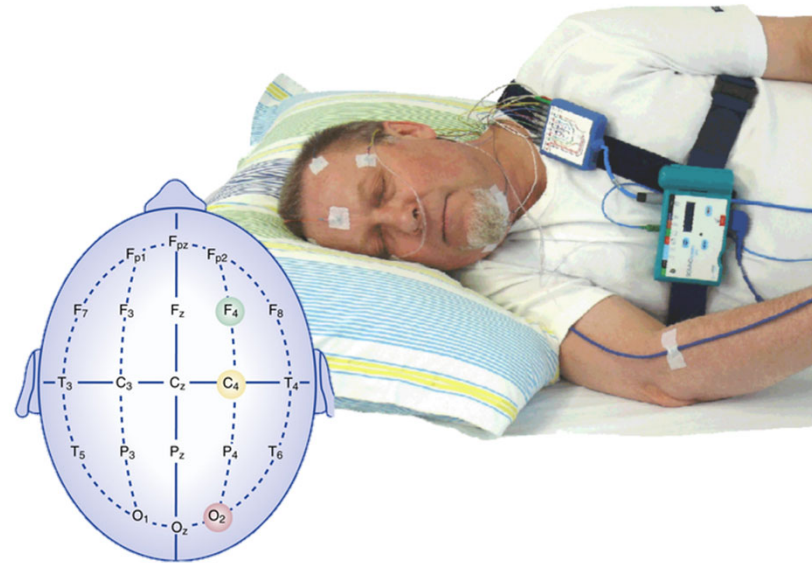
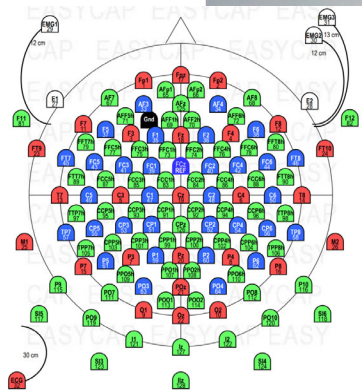
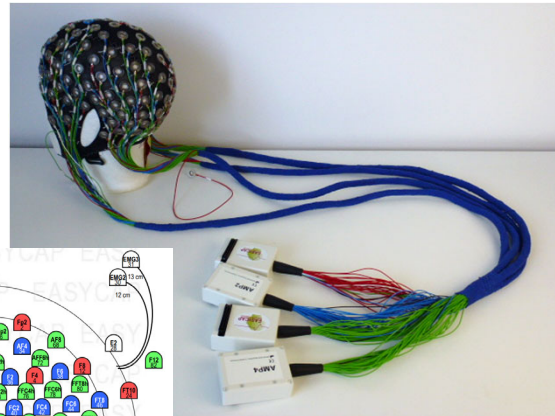


Sleep stages: overview



	Brain / EEG	Eyes / EOG	Muscles / EMG
wake			
REM			
N1			
N2			
N3			

Sleep EEG: lab vs. home recordings





Sleep EEG headbands

Aurora (iWinks)



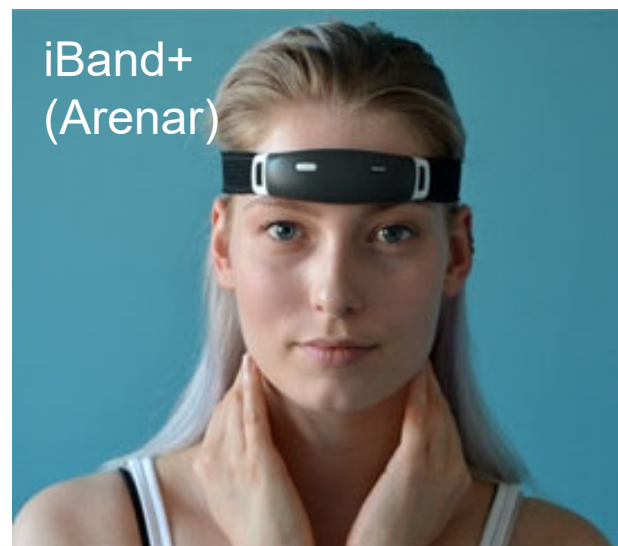
Dreem
(rythm)



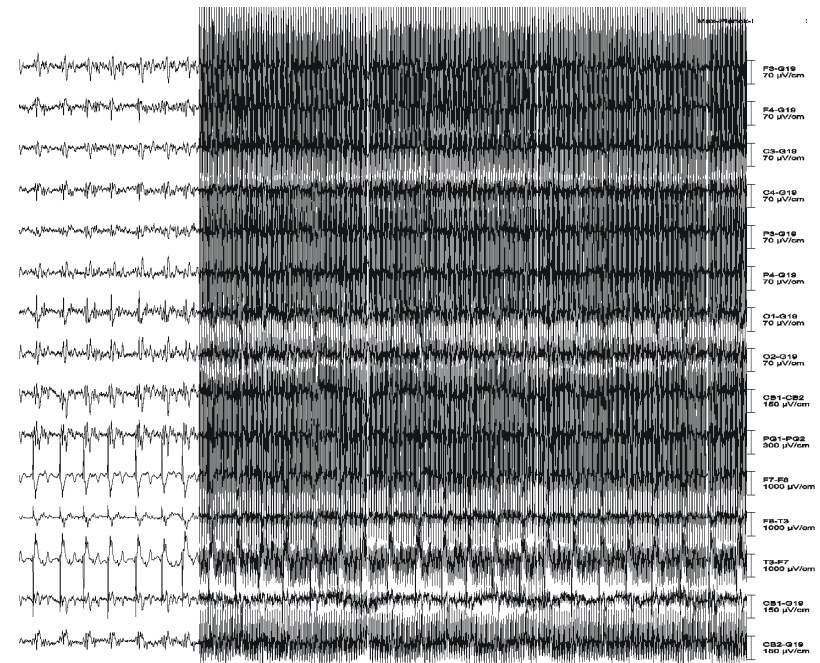
zMax (Hypnodyne)



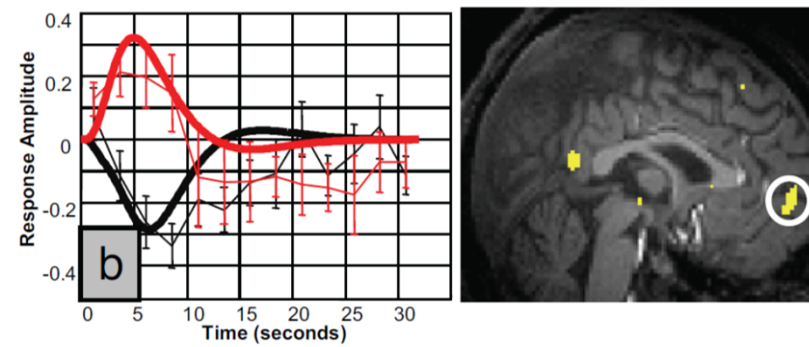
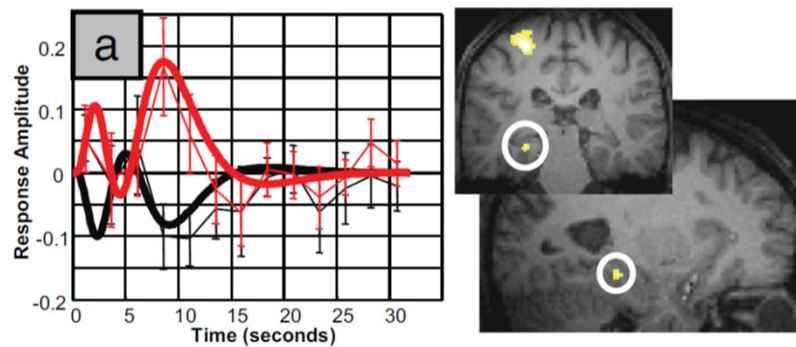
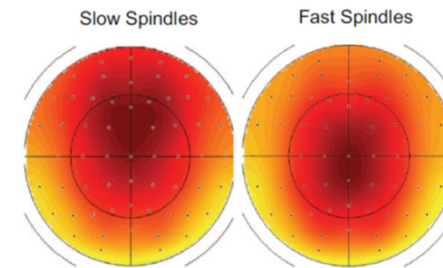
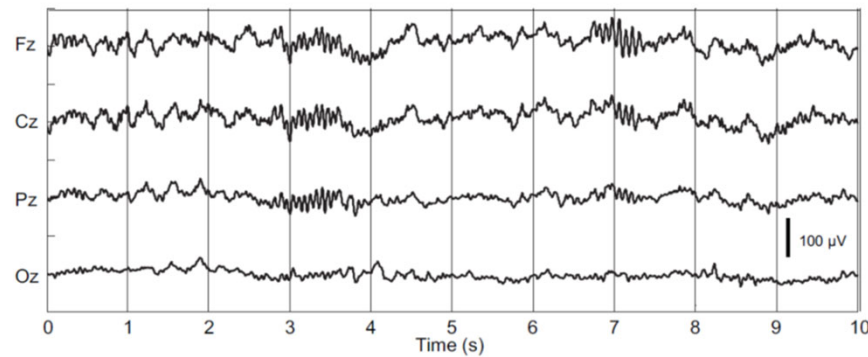
iBand+
(Arenar)



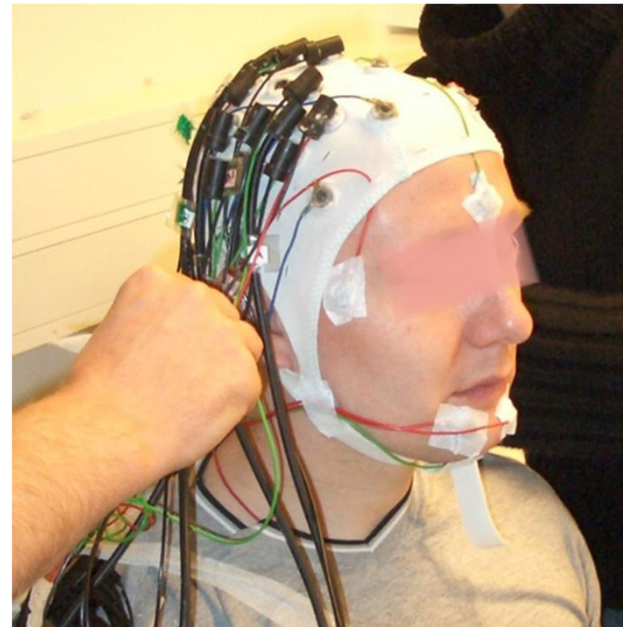
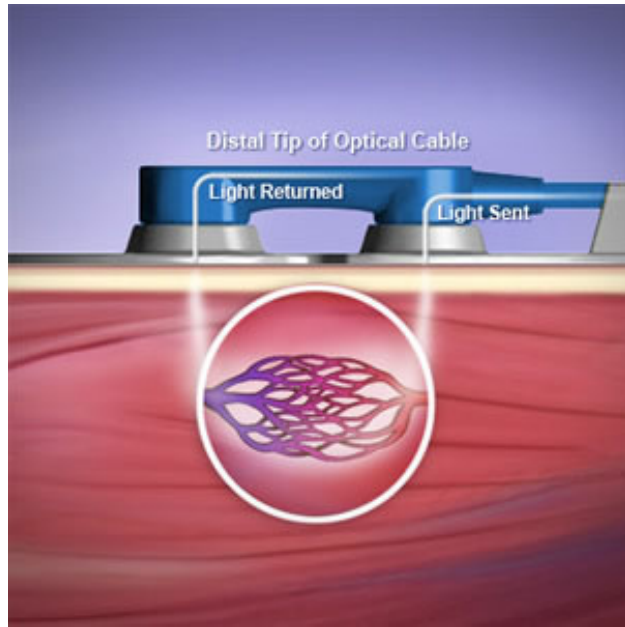
Combined EEG/fMRI



Combined EEG/fMRI: sleep spindles



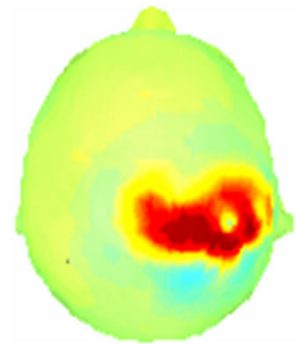
Combined EEG/NIRS



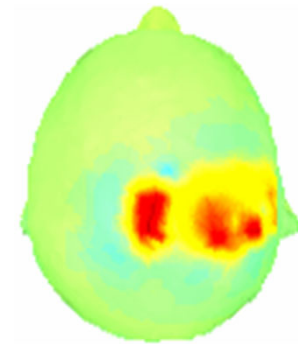
Combined EEG/NIRS



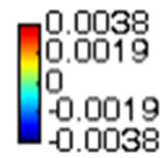
real hand movements



dreamed hand movements



HbO



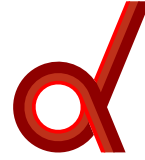
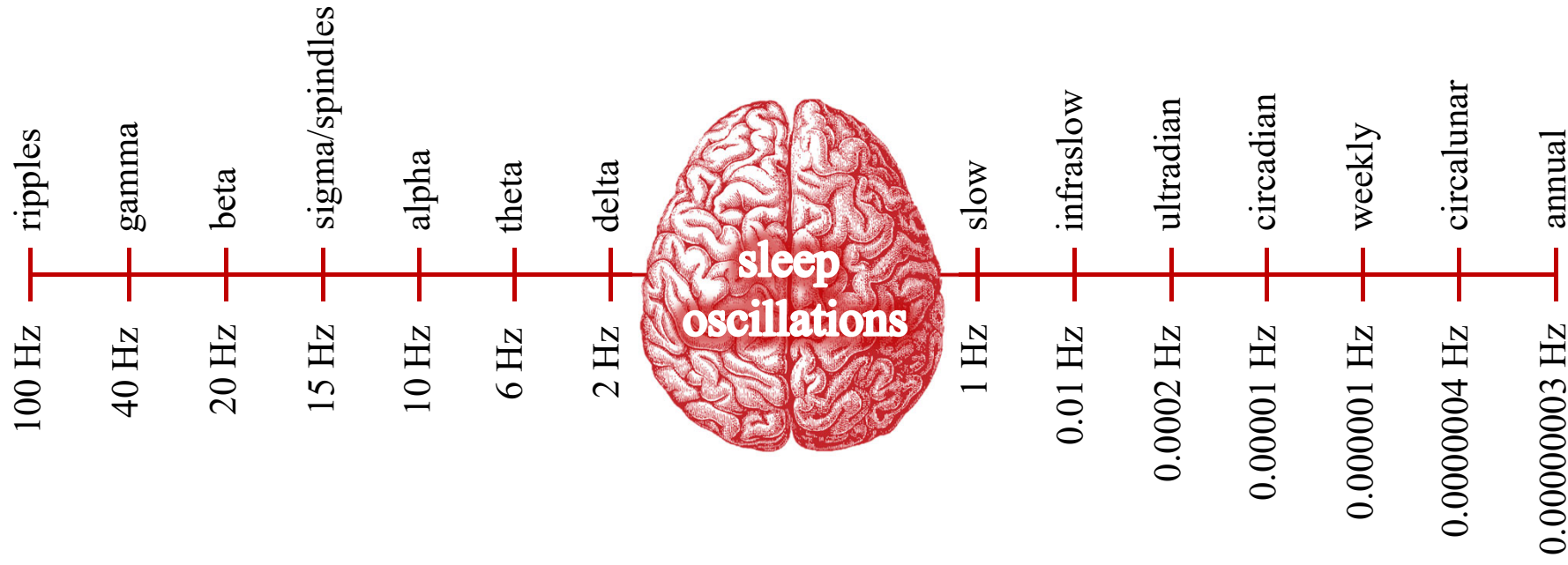
Spontaneous EEG and Sleep



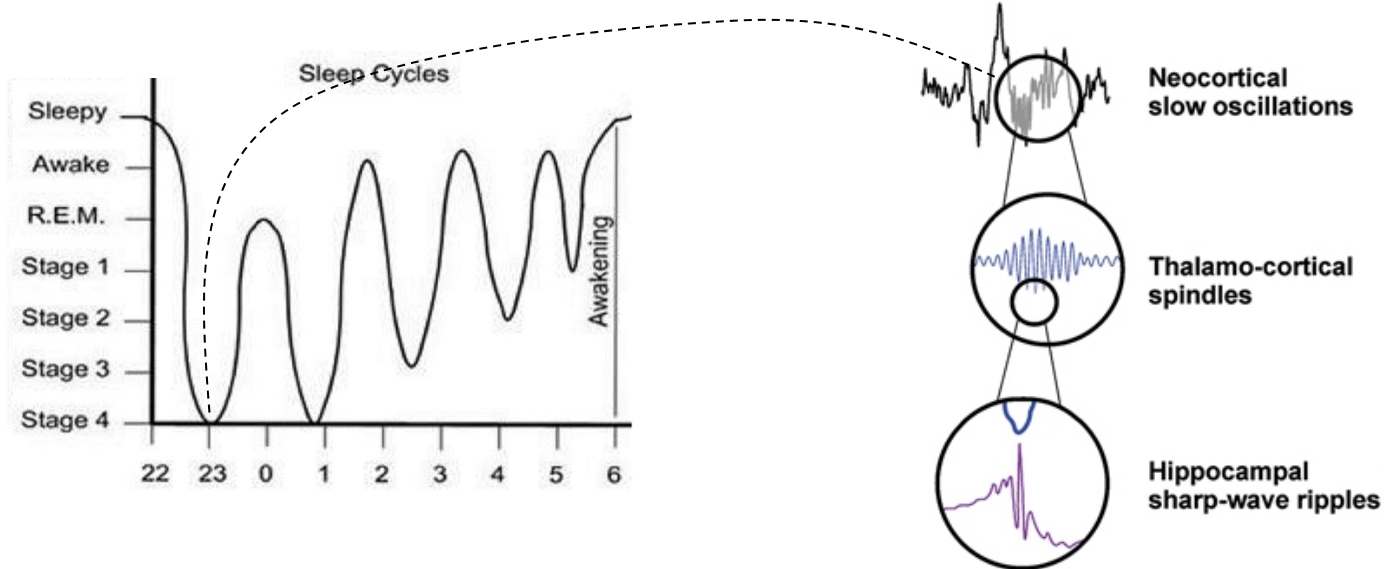
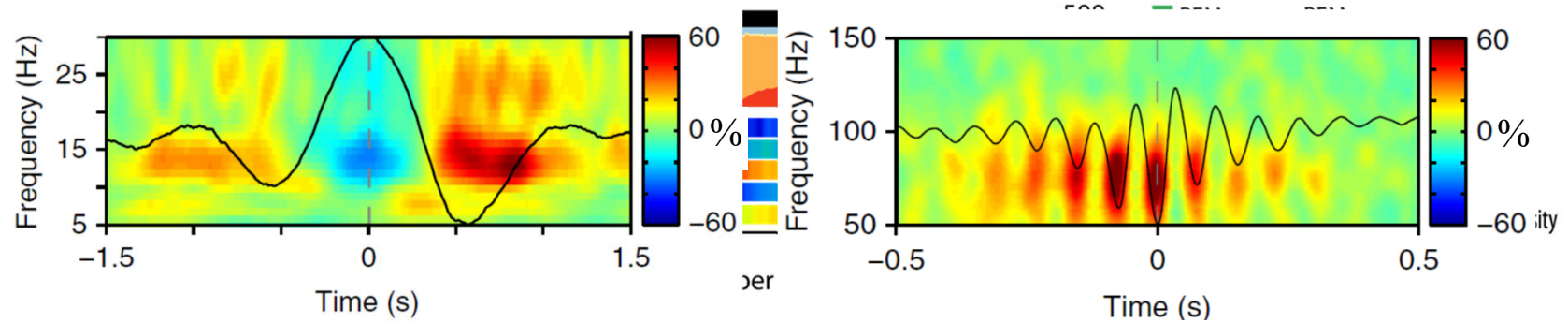
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- Examples: functions of sleep

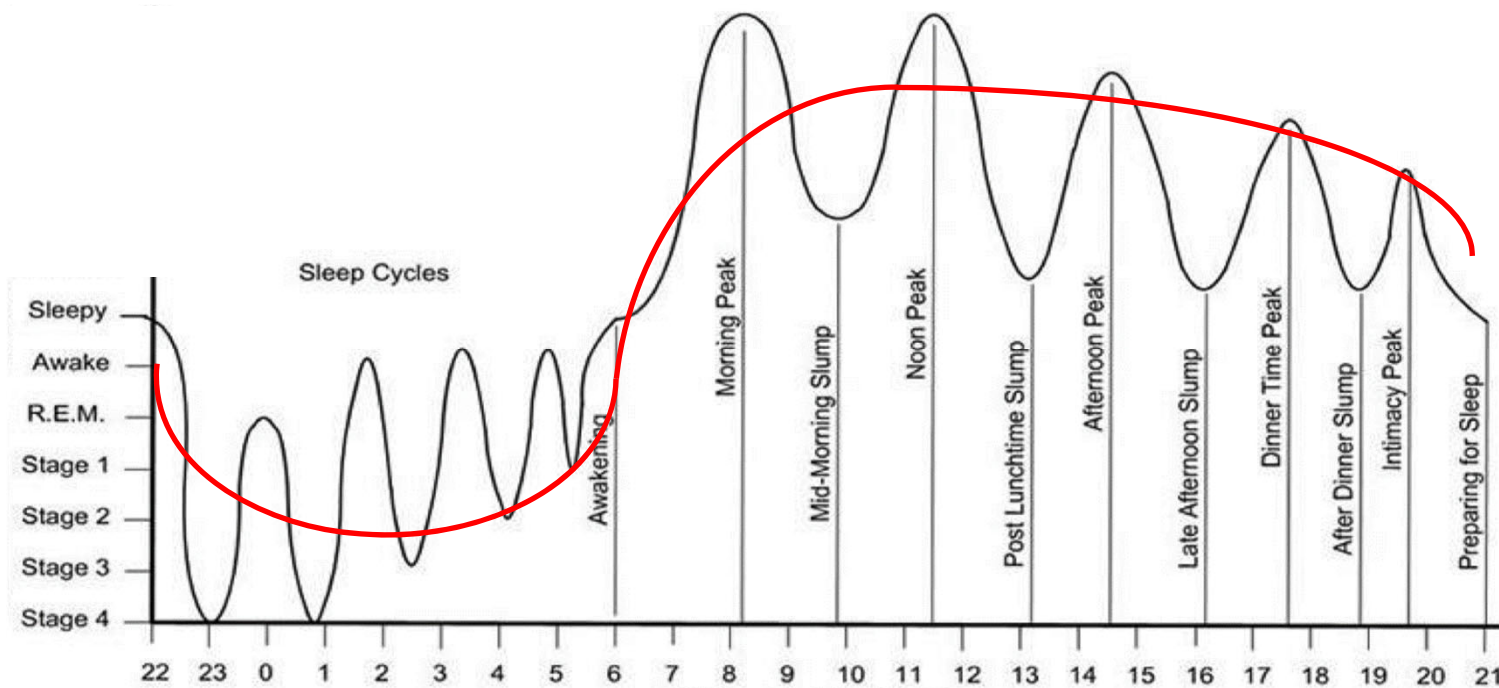
Sleep oscillations



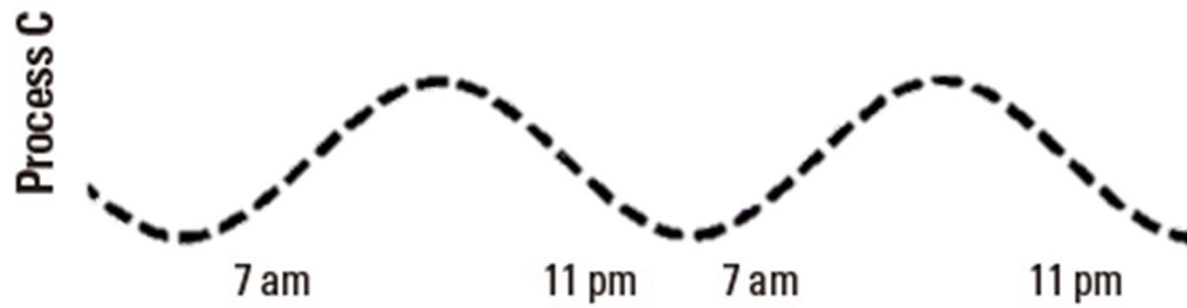
Sleep: nested oscillations



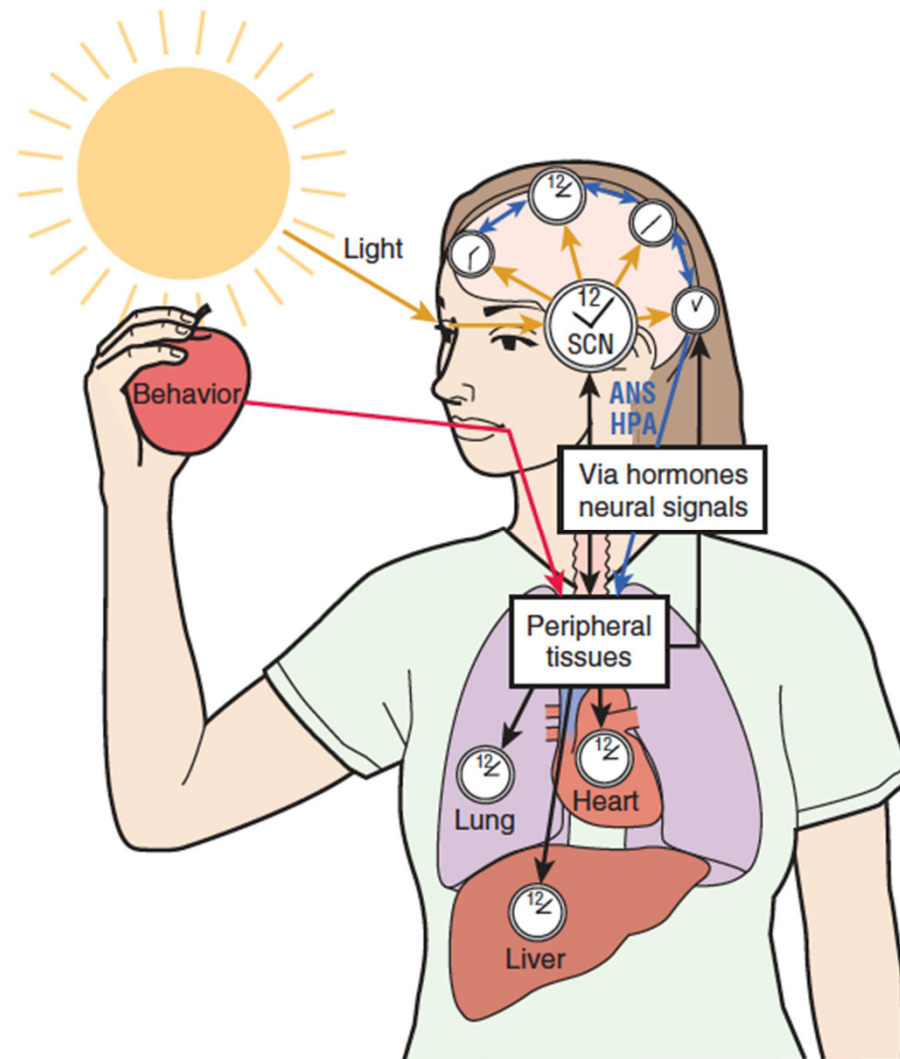
Sleep: ultradian oscillations



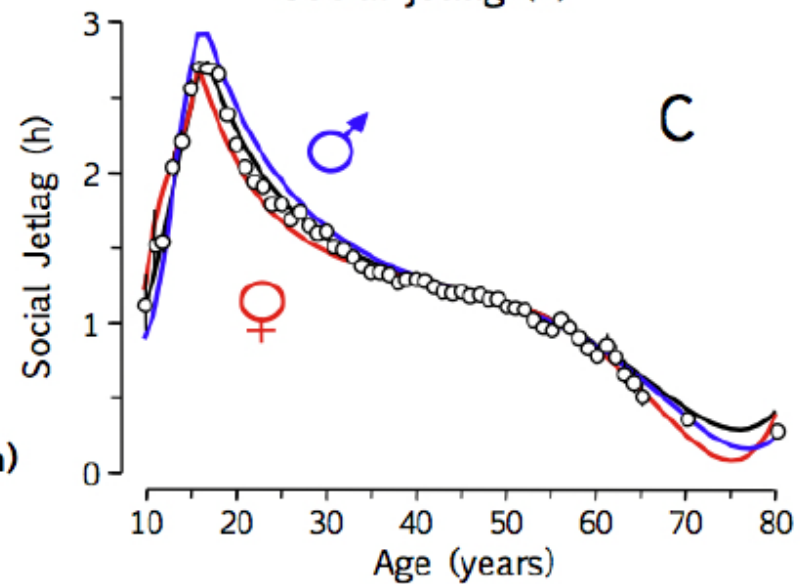
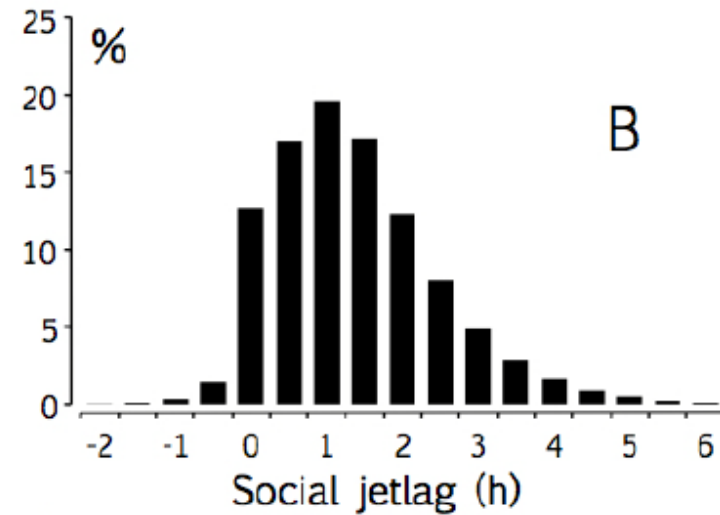
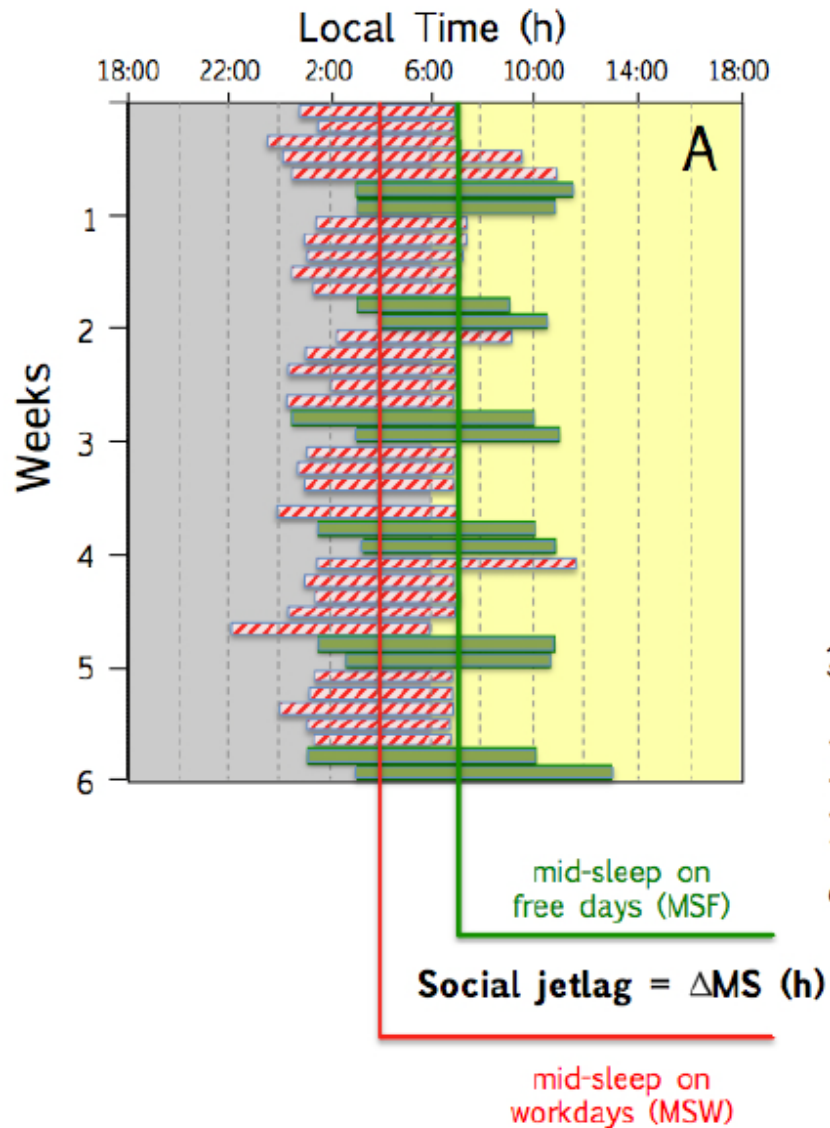
Sleep: circadian oscillations



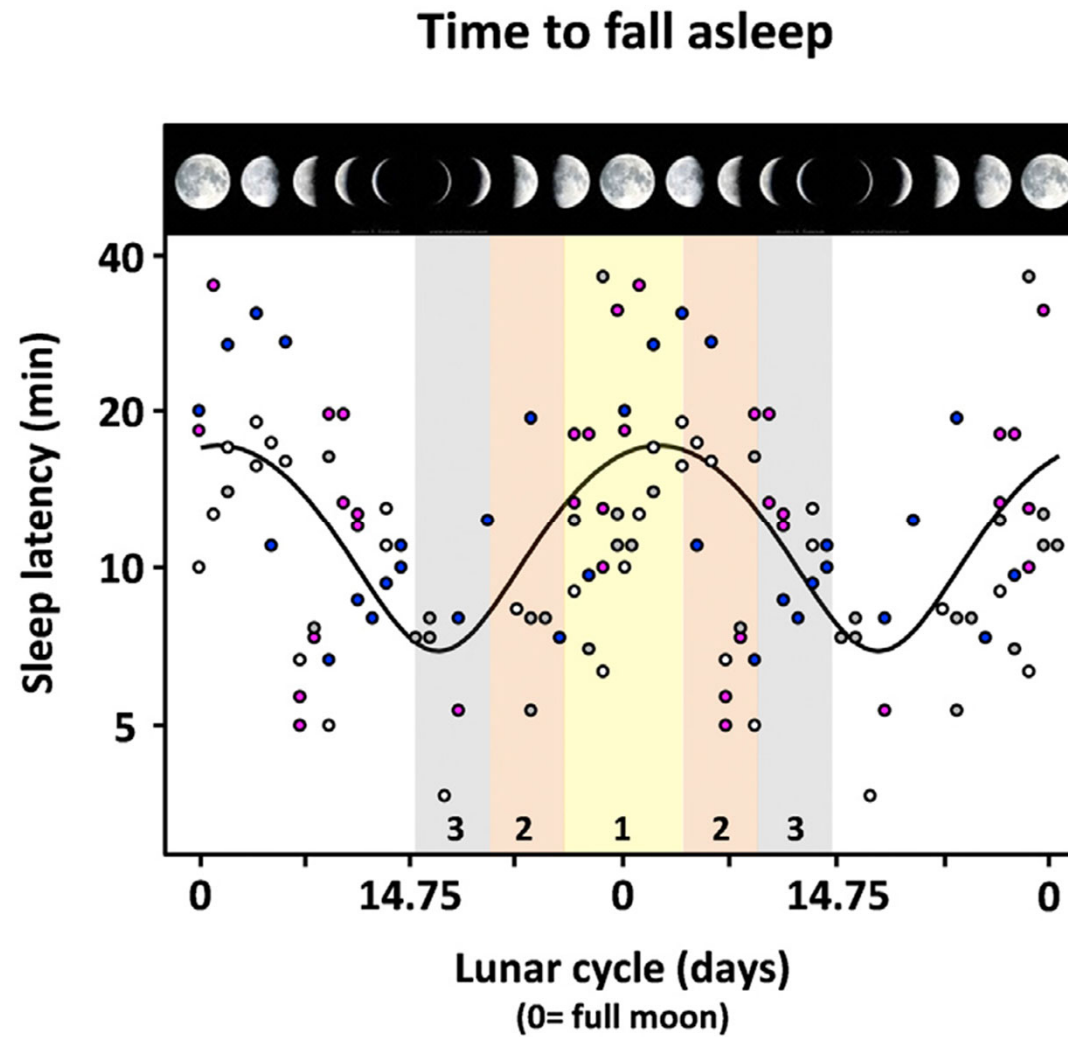
Sleep: synchronization through light



Sleep: weekly oscillations

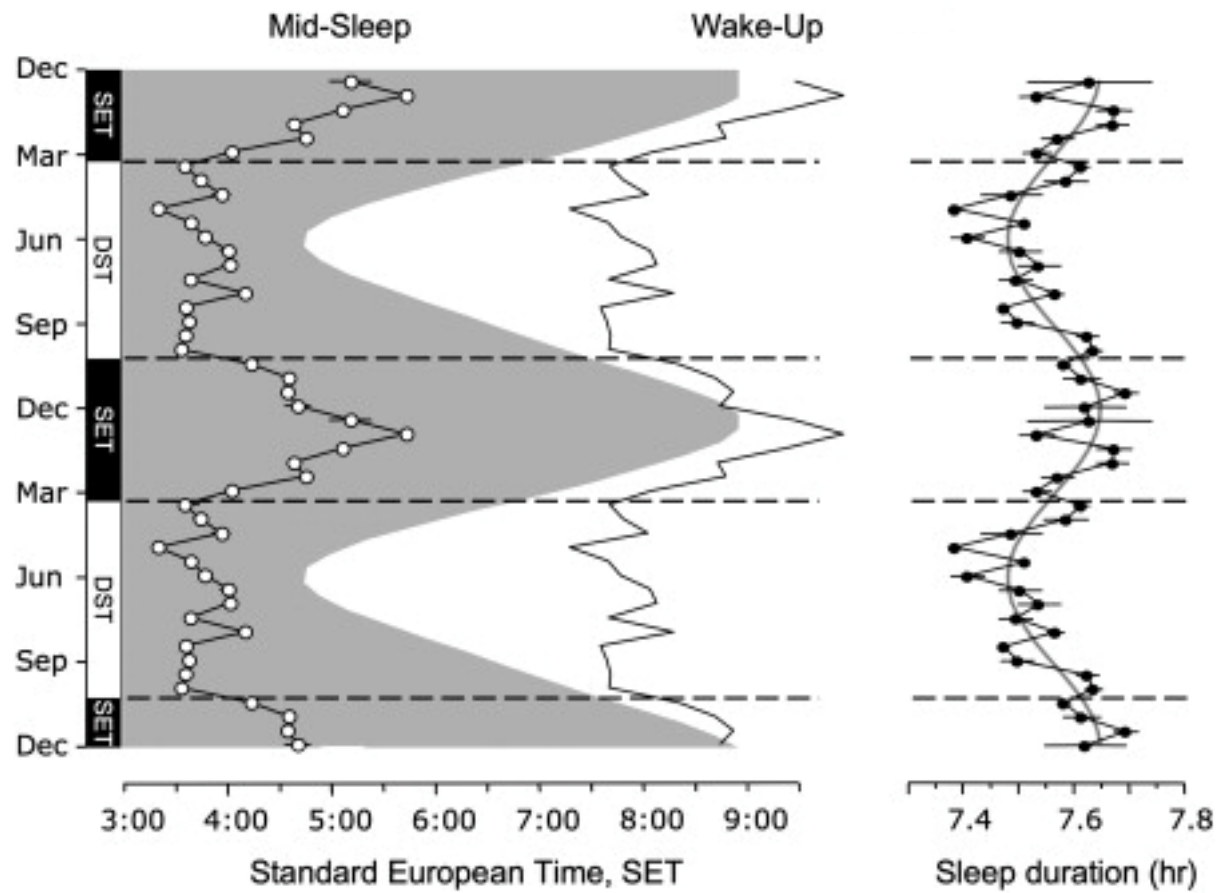


Sleep: monthly oscillations?

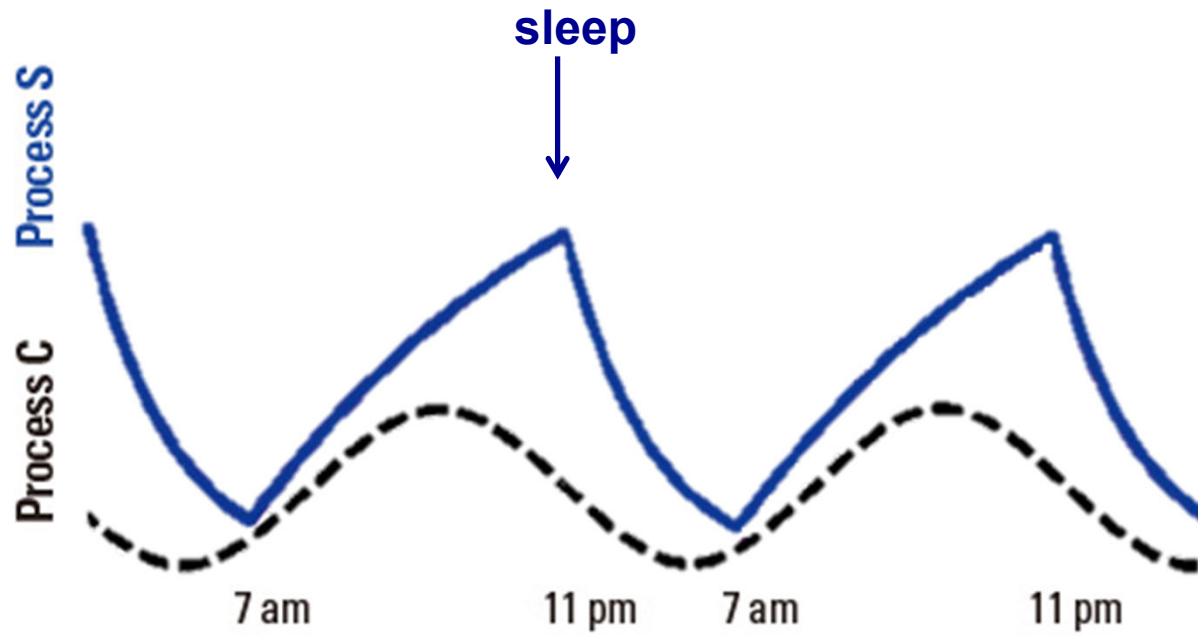


Cajochen et al., 2013
but: Cordi et al., 2014

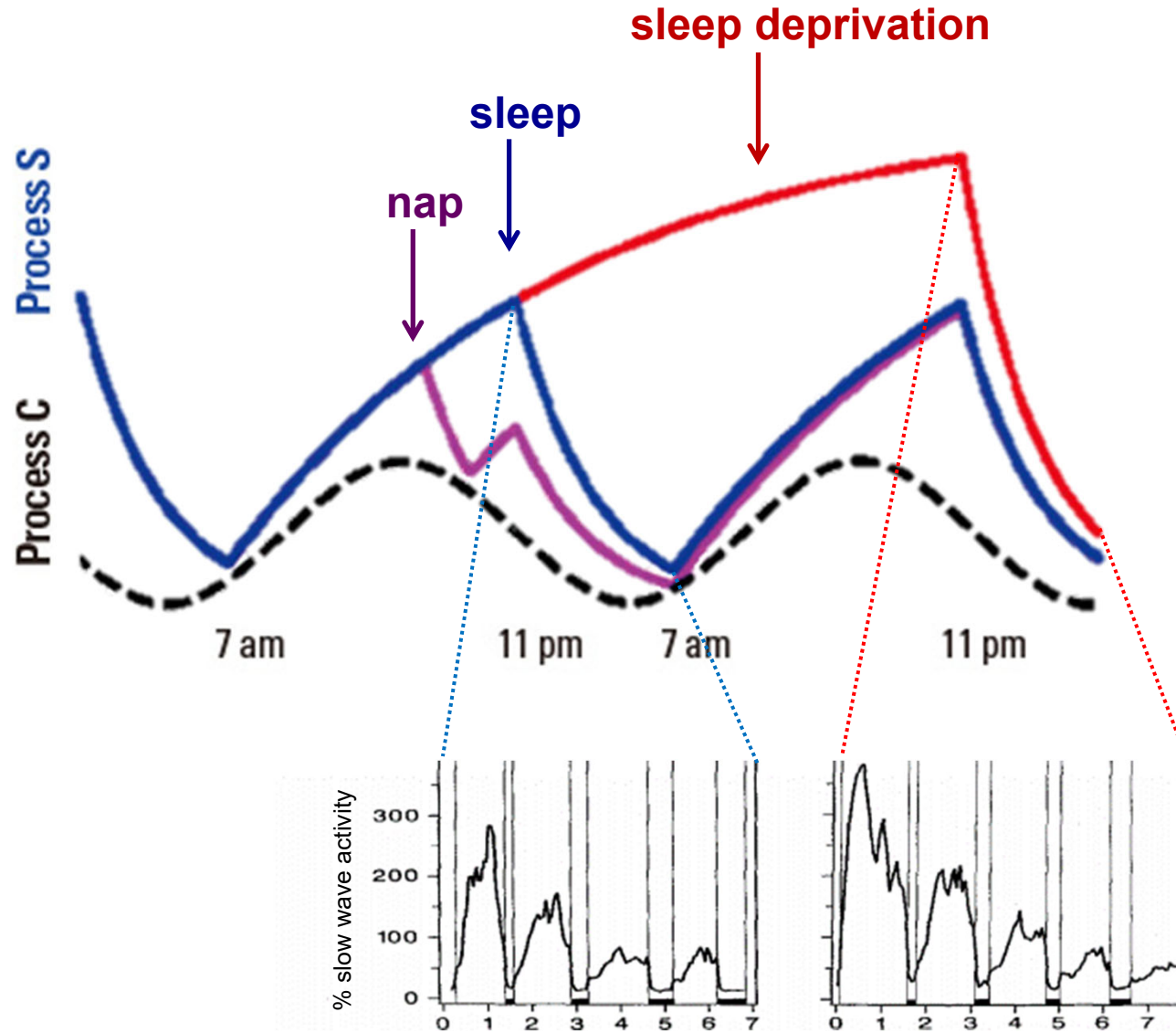
Sleep: annual oscillations



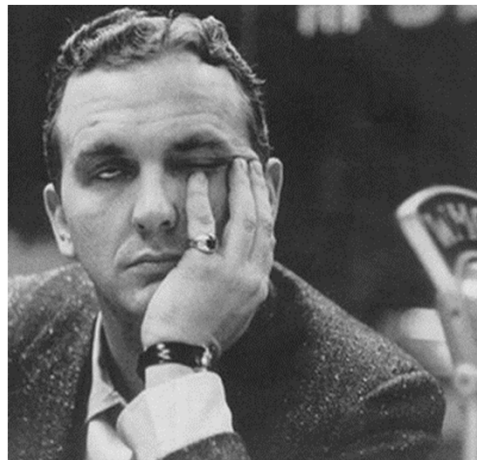
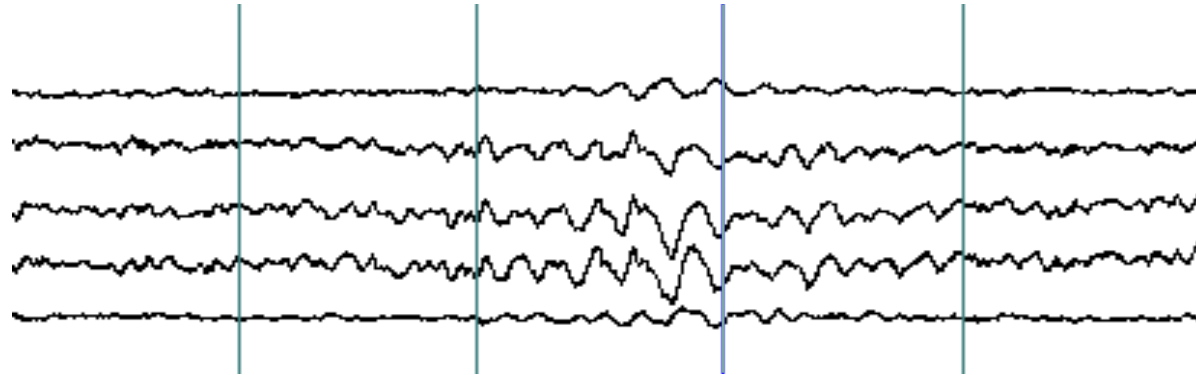
Sleep regulation: two-process model



Sleep regulation: two-process model



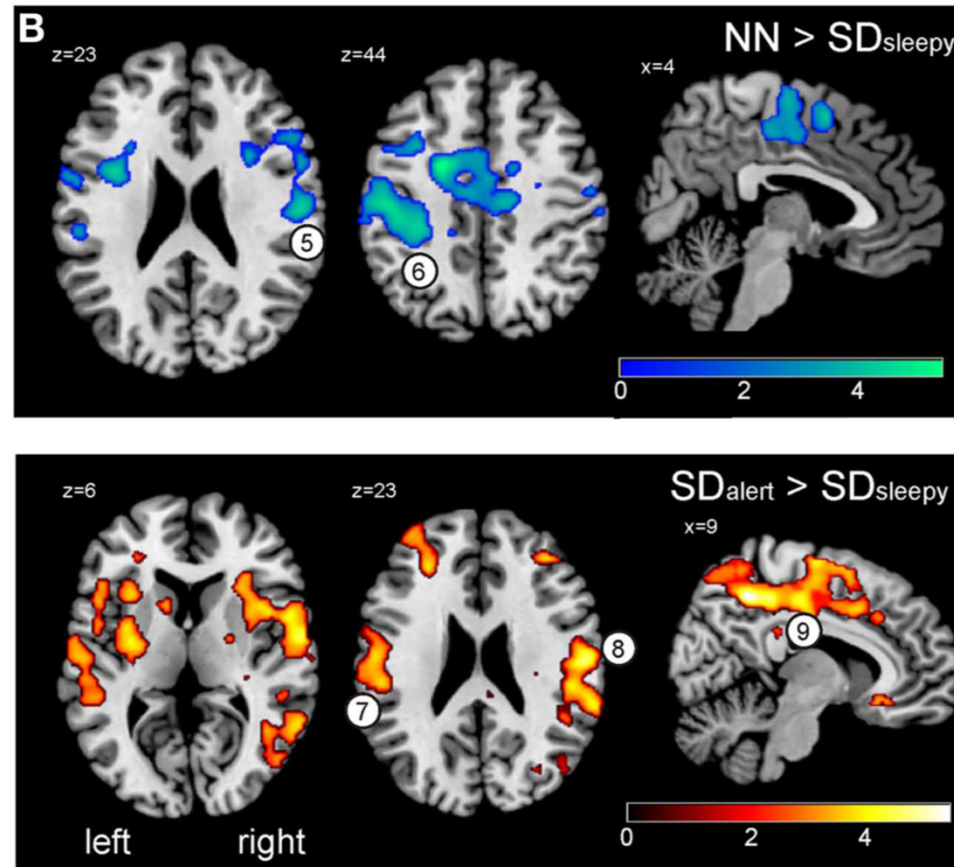
Sleep pressure



– microsleep

– local sleep

Combined EEG/fMRI: vigilance measurement



Spontaneous EEG and Sleep



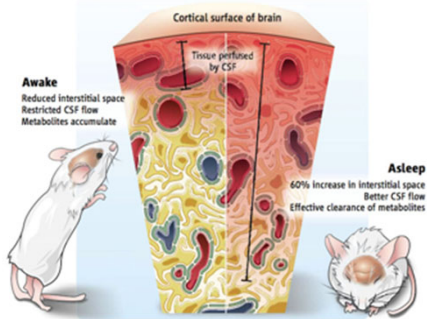
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Sleep: more than a substitute for coffee!



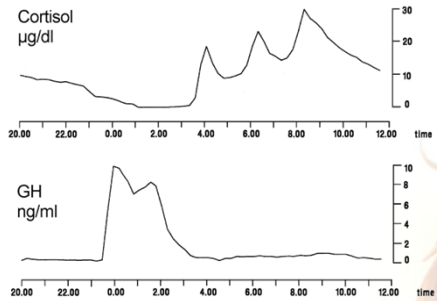
brain clearance



memory



hormones



emotions



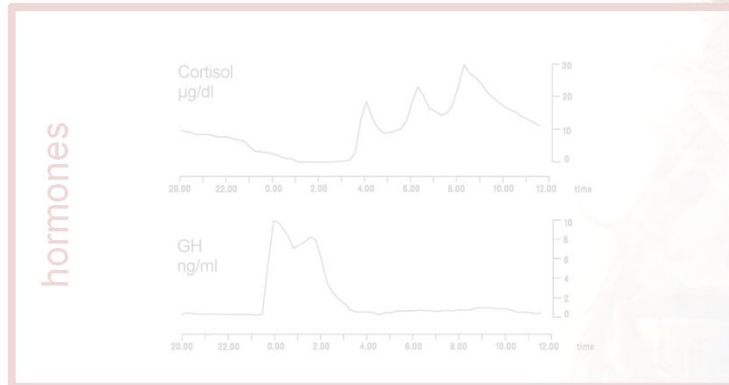
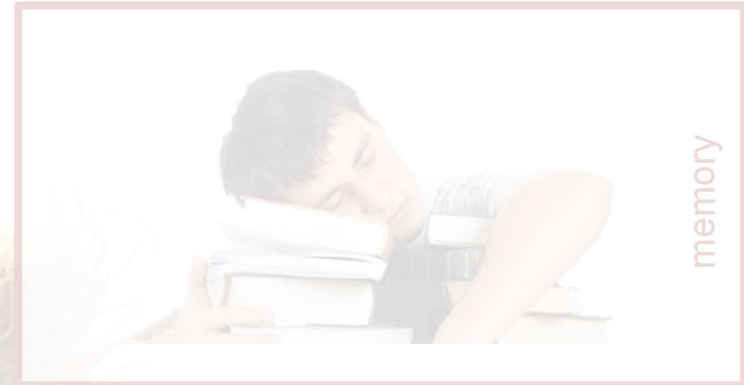
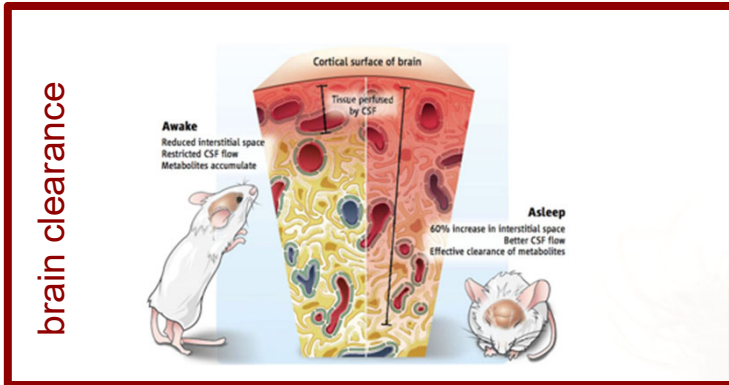
immune system



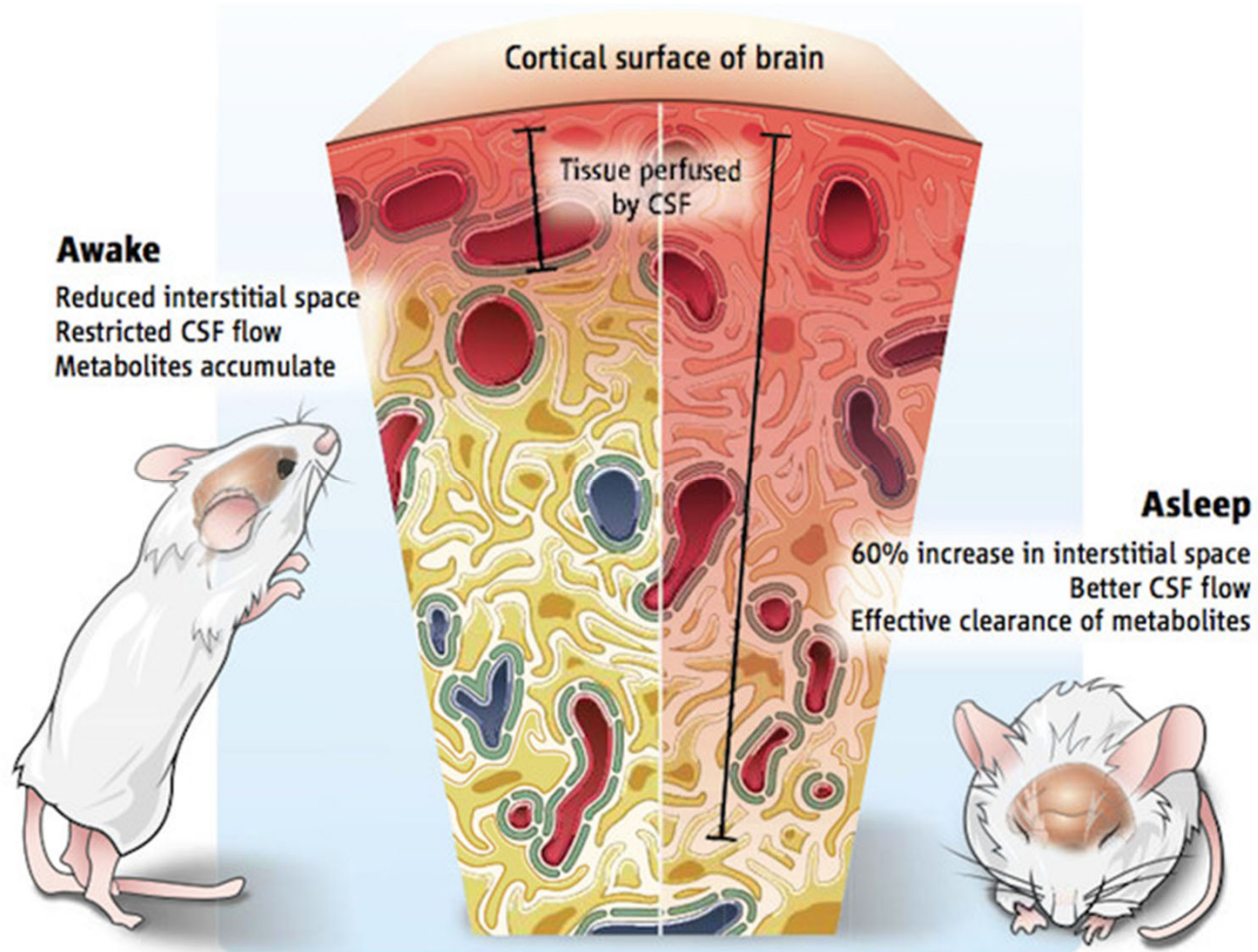
simulation



Sleep: more than a substitute for coffee!

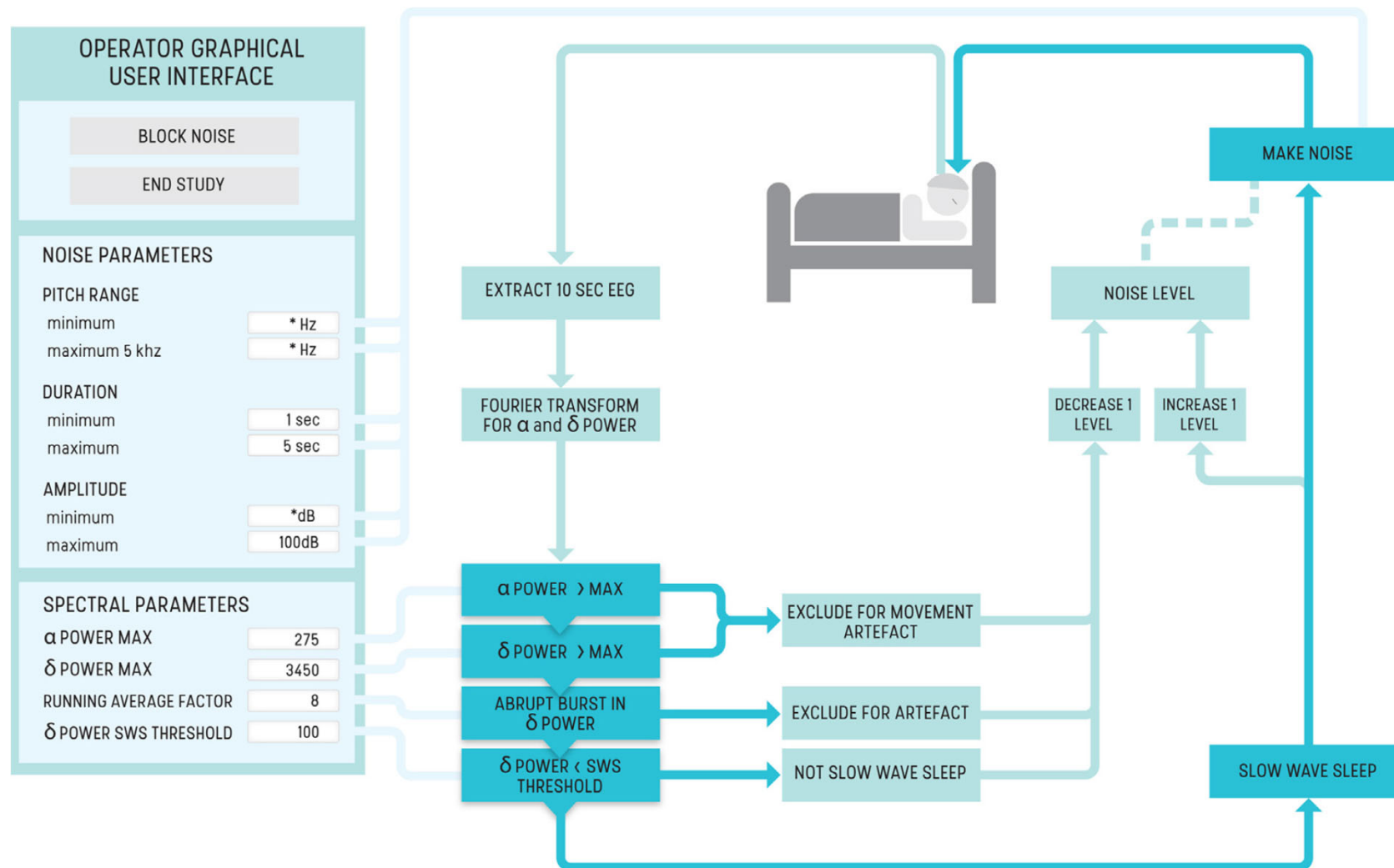


Brain clearance function of sleep



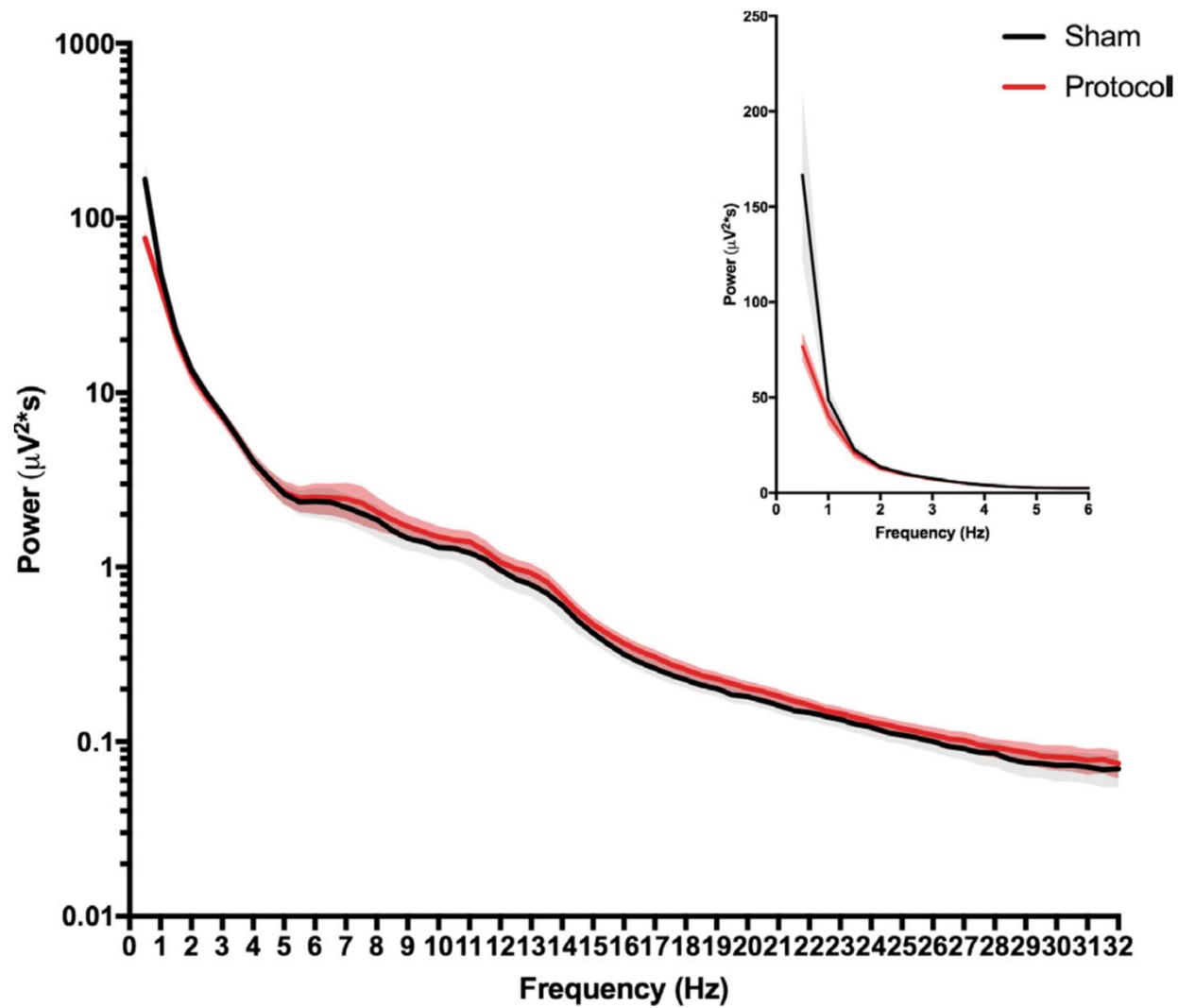
Xie et al., 2013

Brain clearance function of sleep



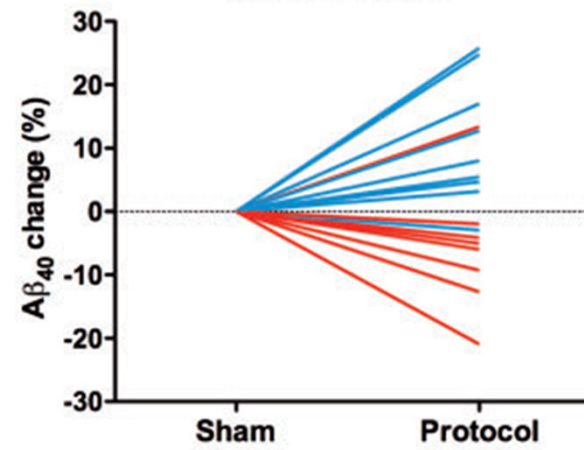
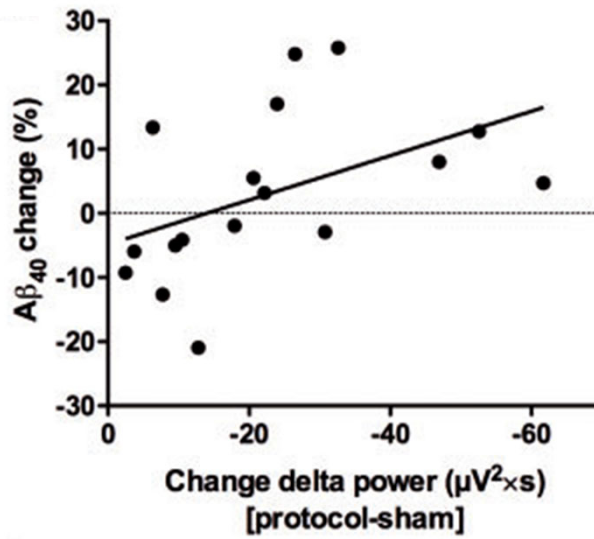
Ooms et al., 2017

Brain clearance function of sleep

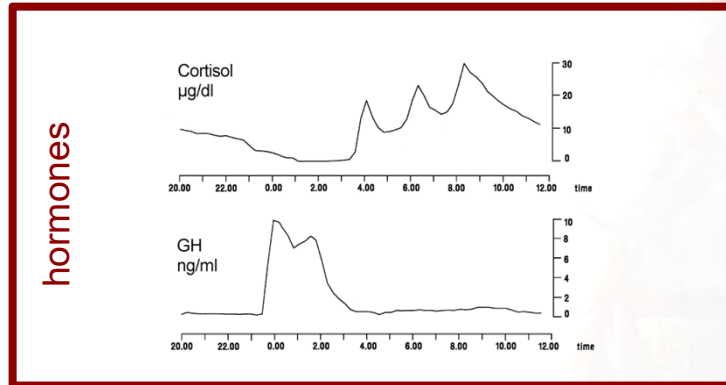
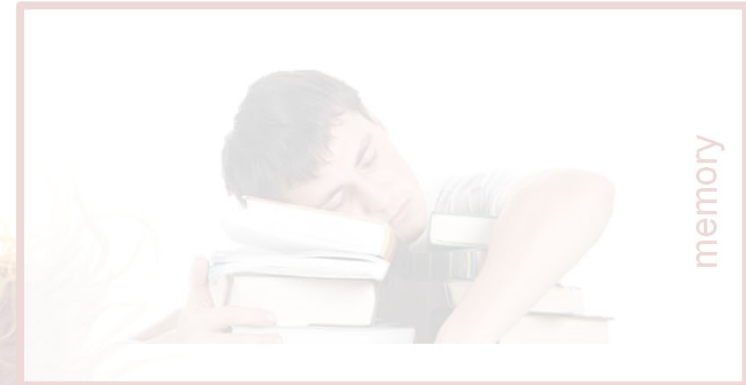
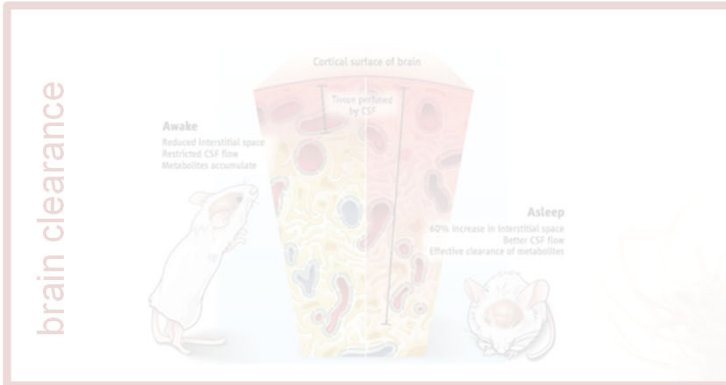


Ooms et al., 2017

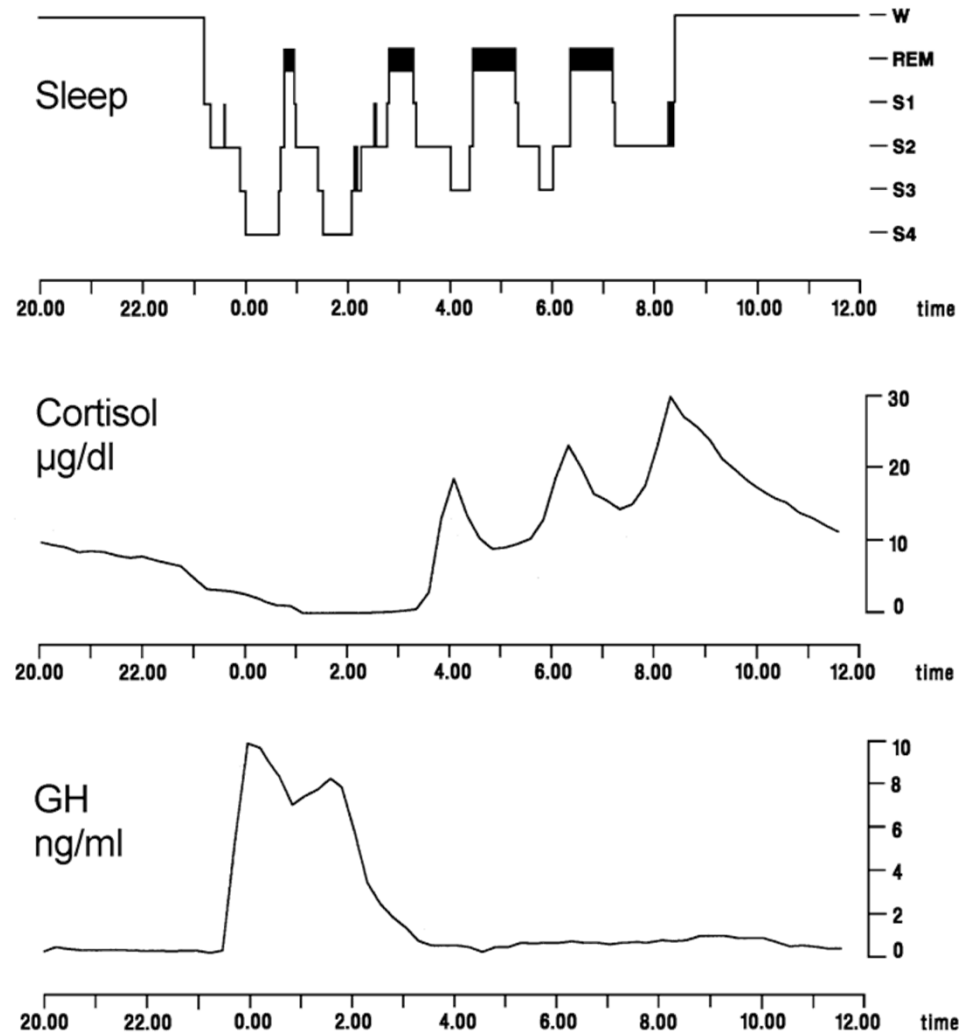
Brain clearance function of sleep



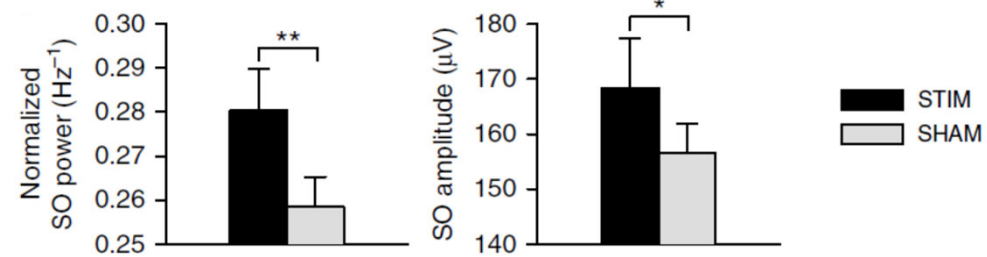
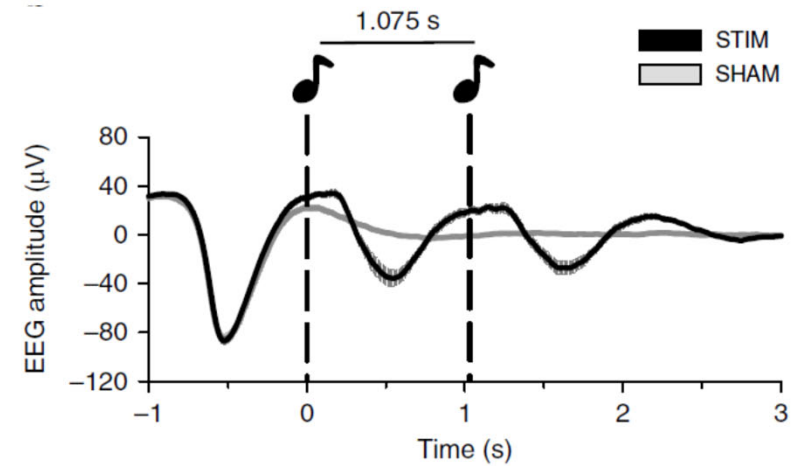
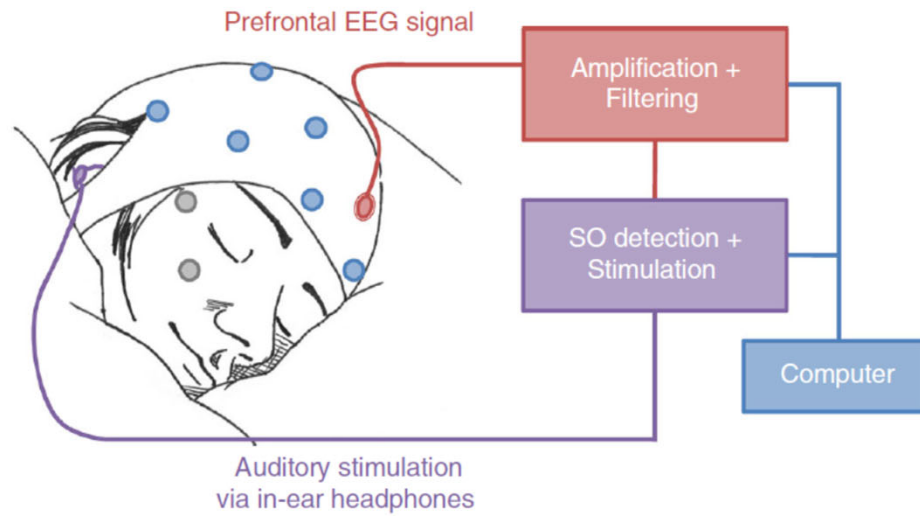
Sleep: more than a substitute for coffee!



Endocrinological function of sleep

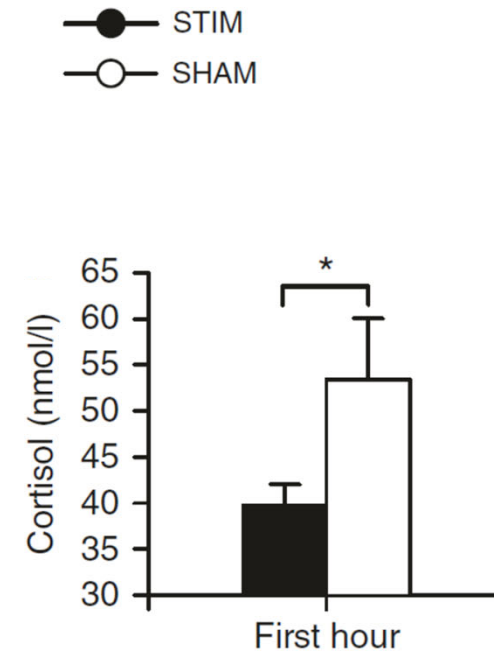
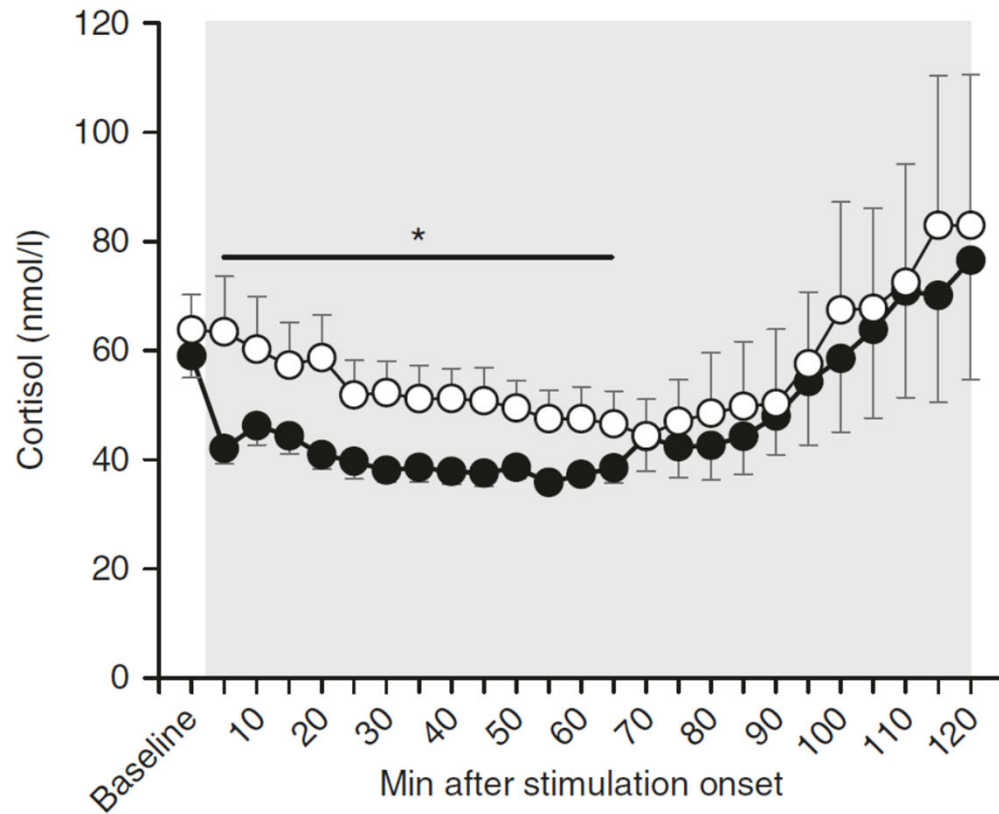


Endocrinological function of sleep



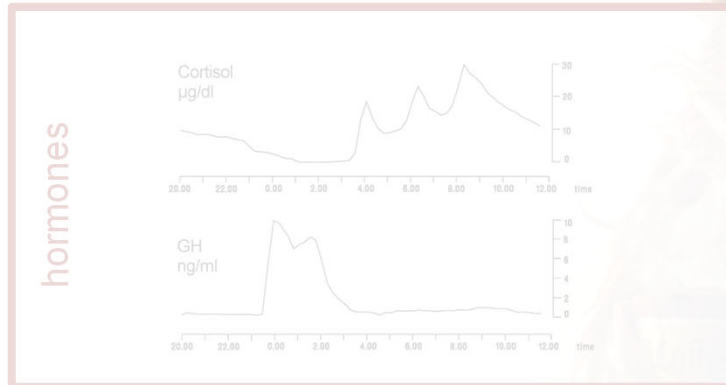
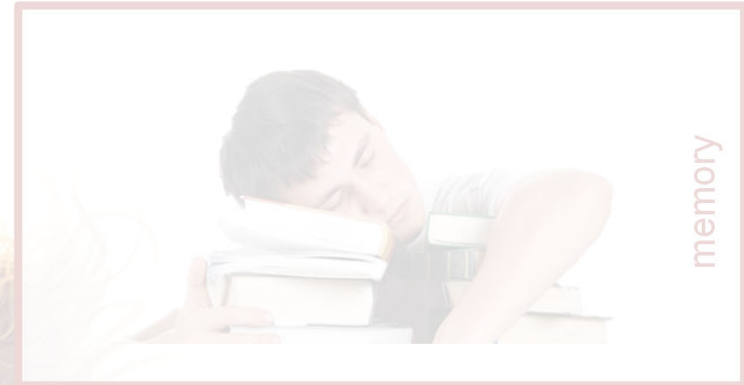
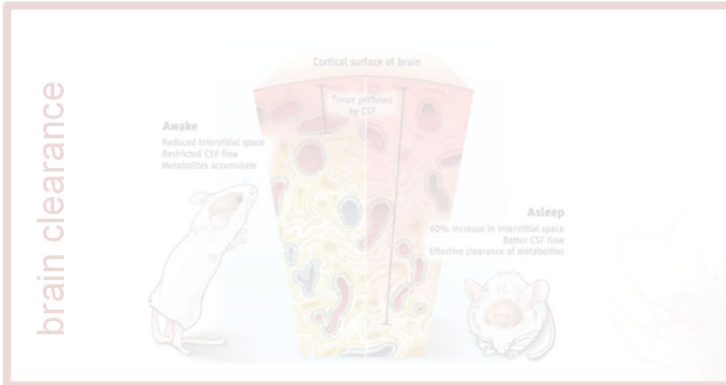
Besedovsky et al., 2017

Endocrinological function of sleep

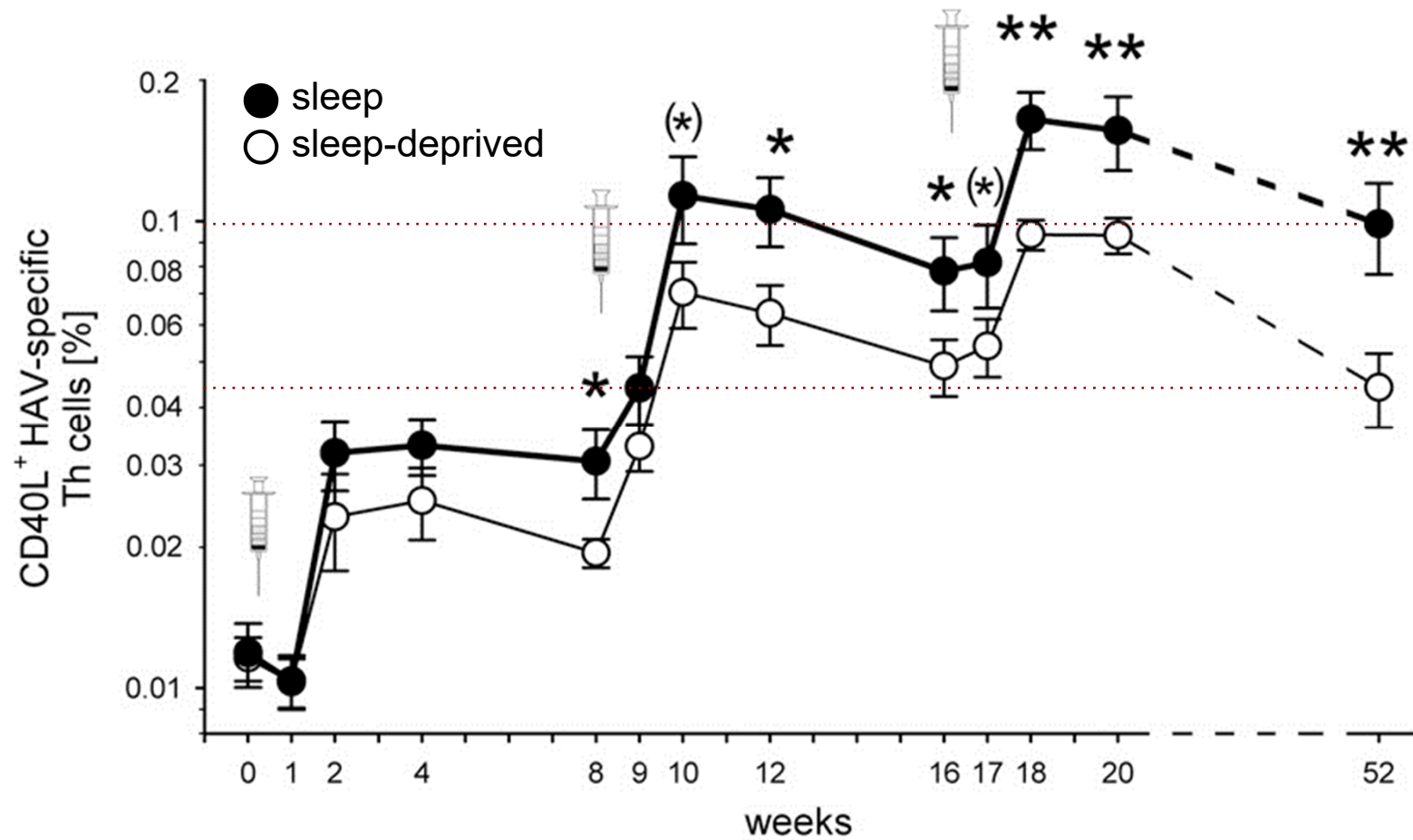


Besedovsky et al., 2017

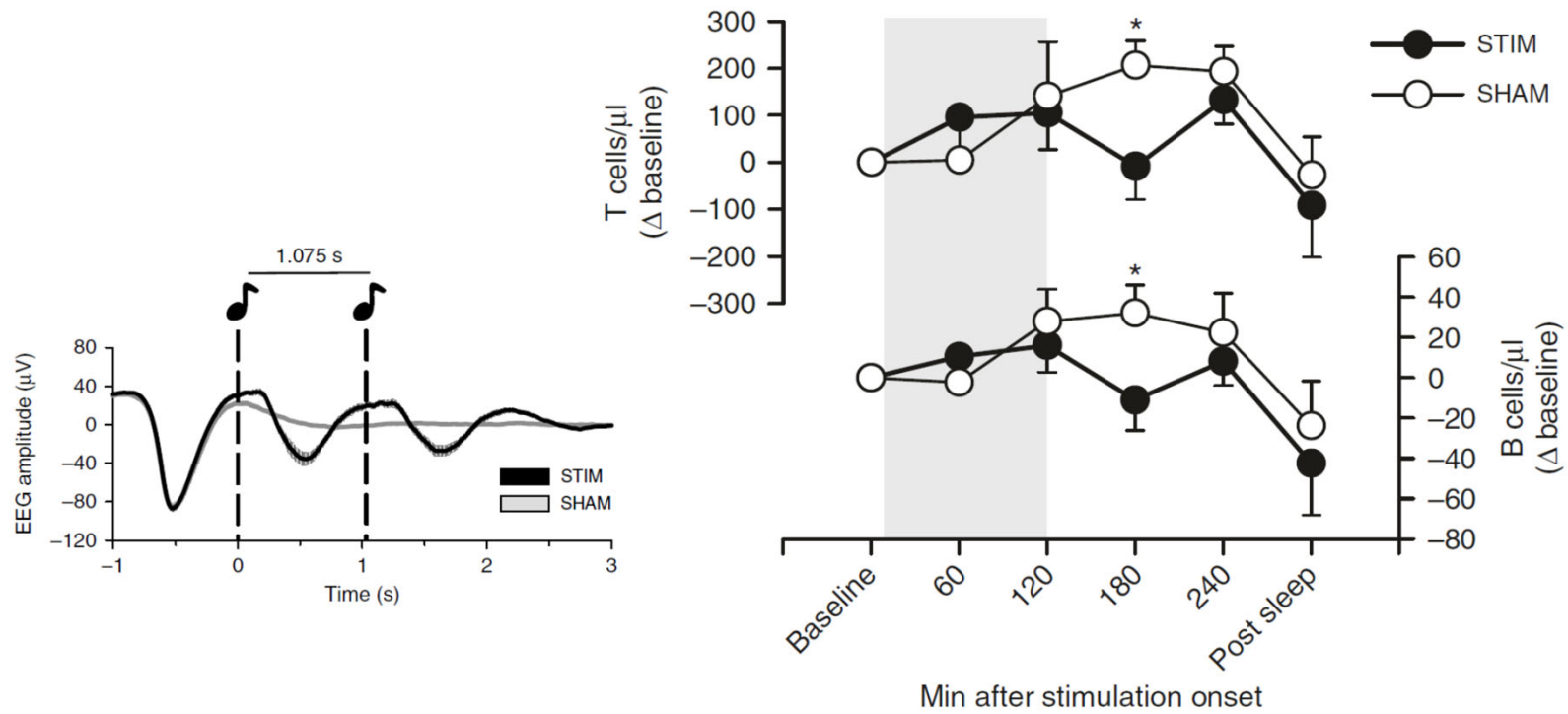
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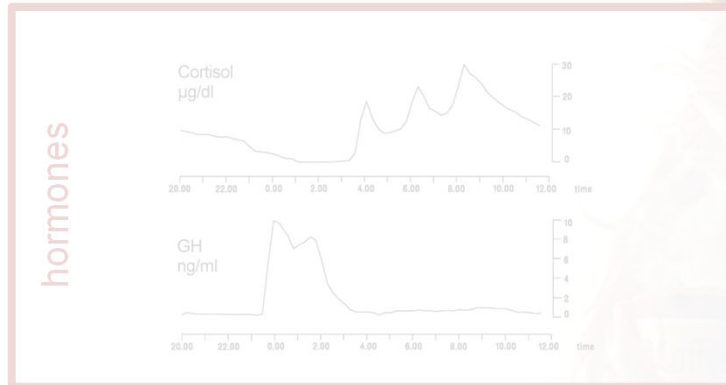
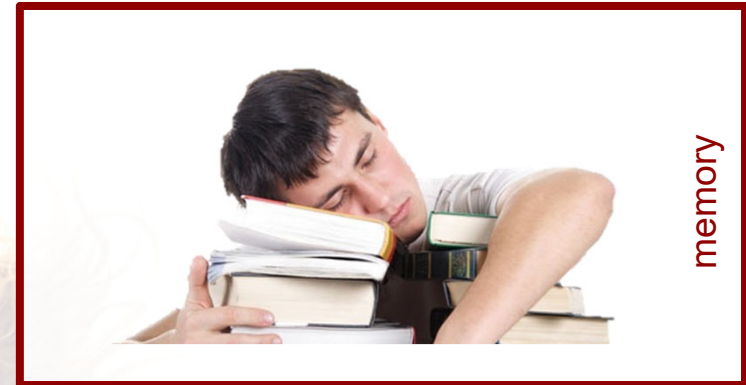
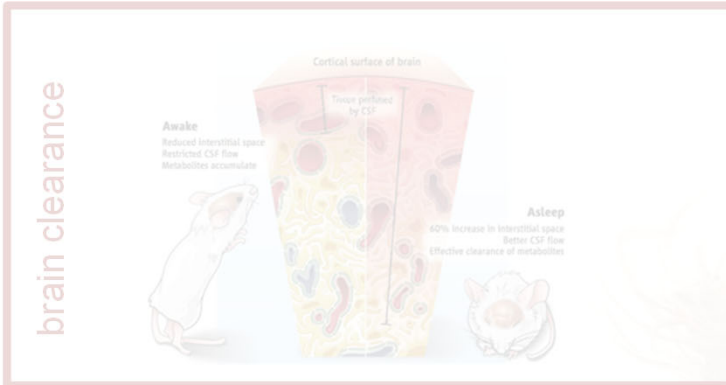
Immunological function of sleep



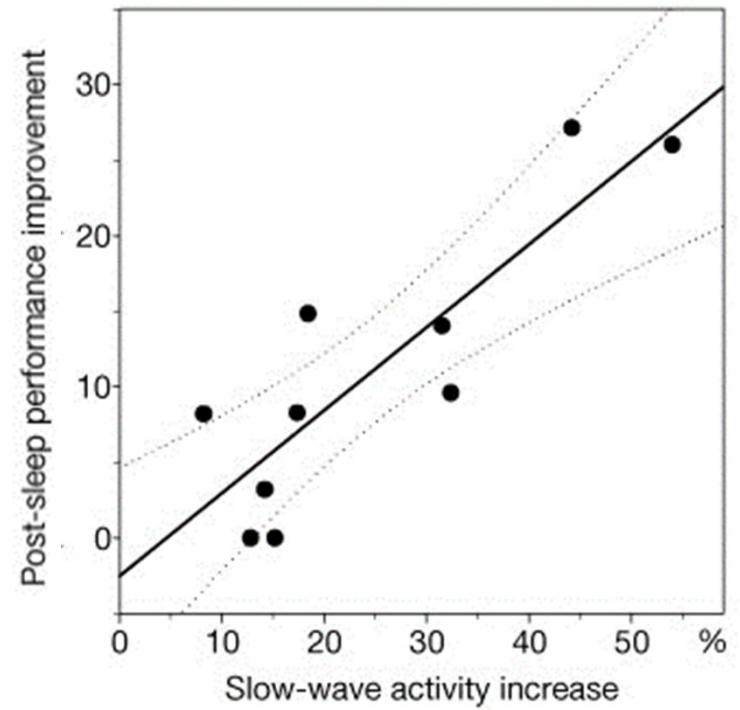
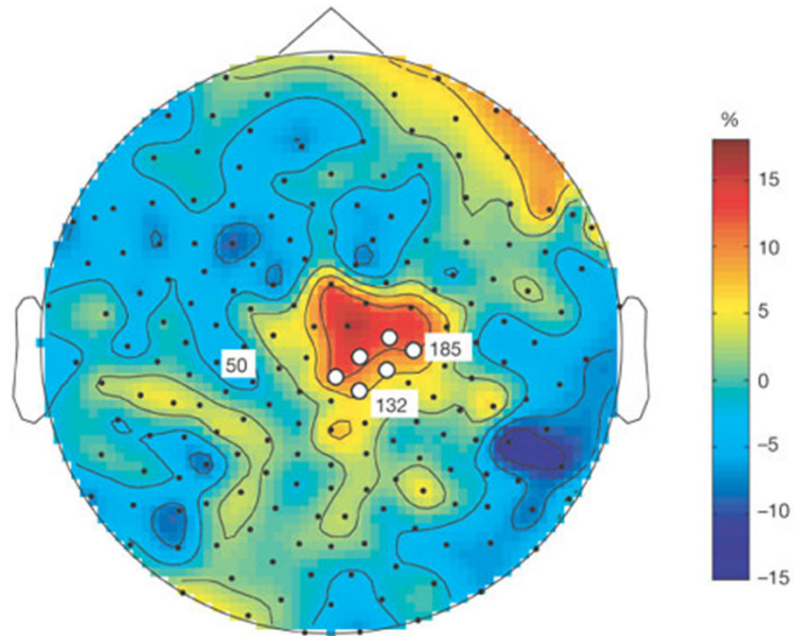
Immunological function of sleep

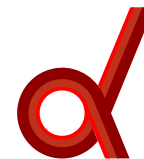


Sleep: more than a substitute for coffee!

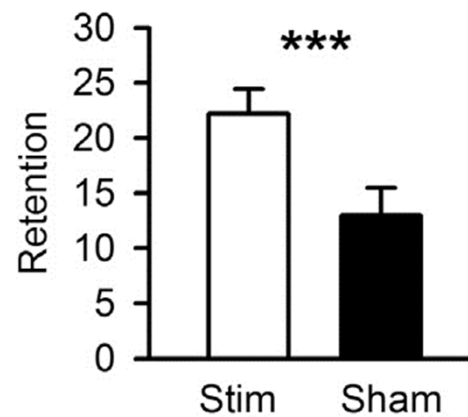
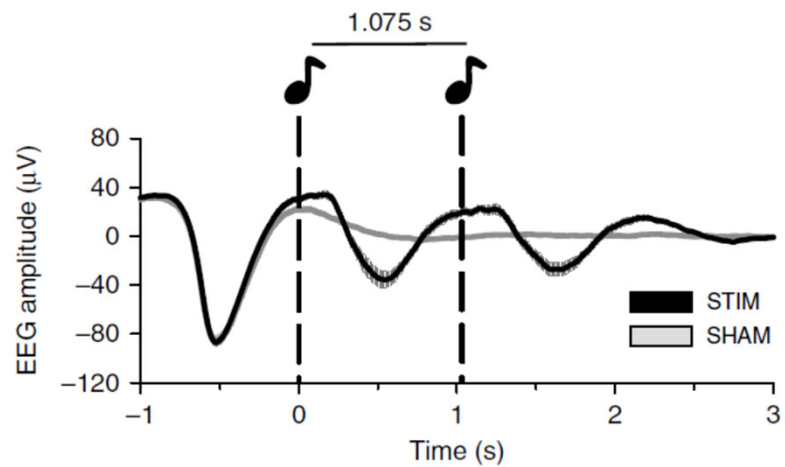


Slow wave activity

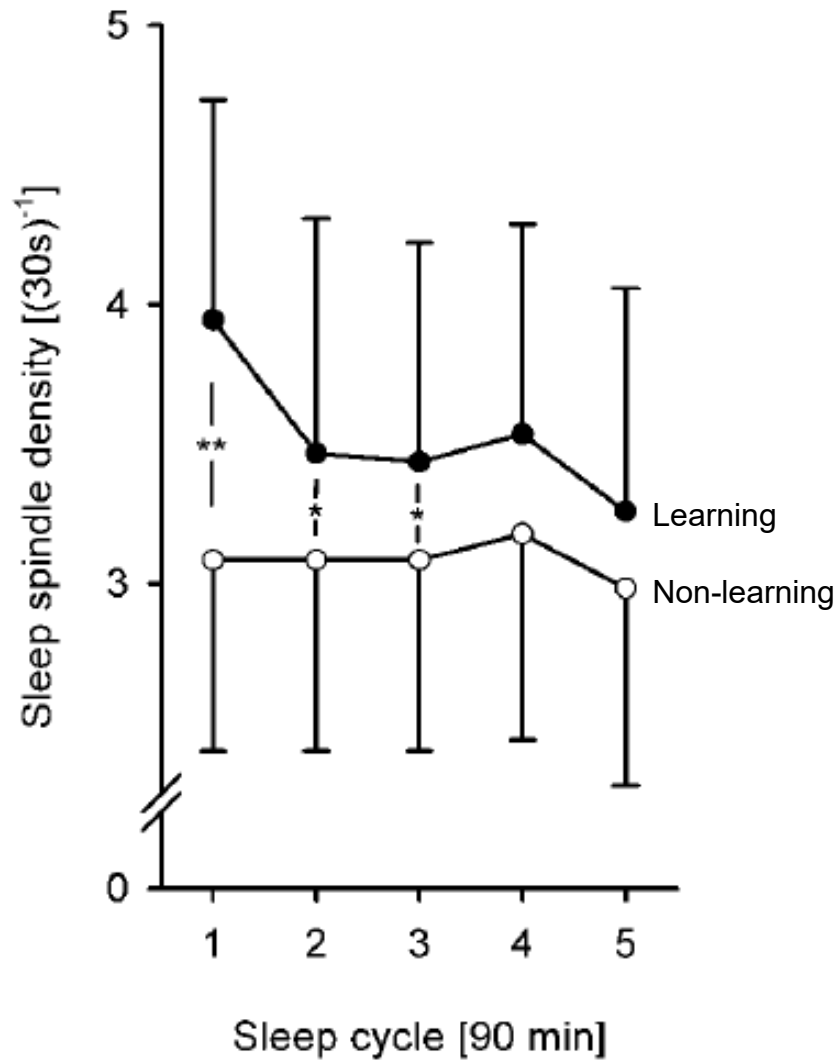




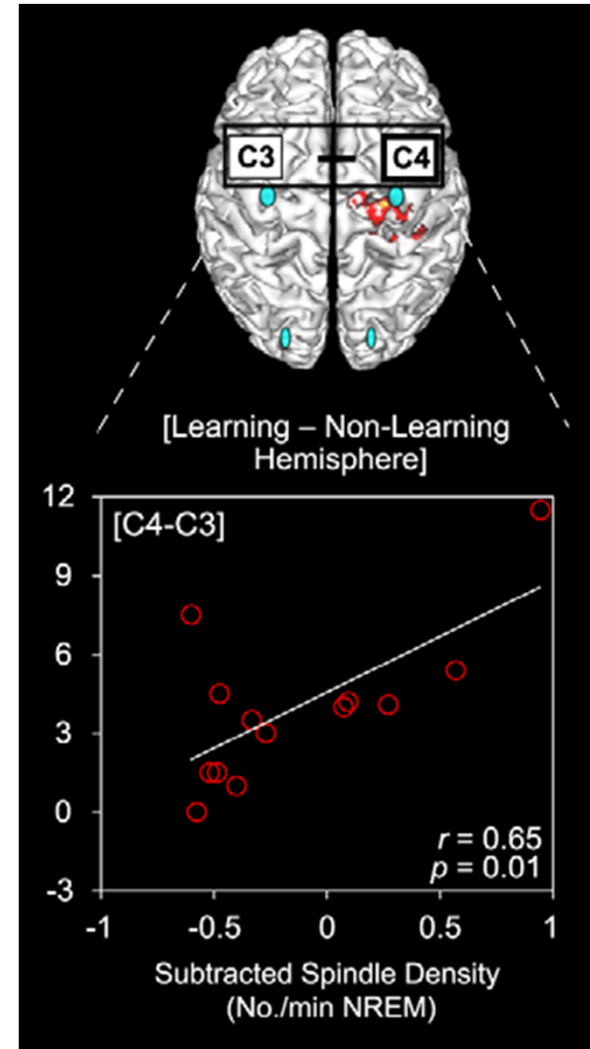
Slow wave activity



Sleep spindles

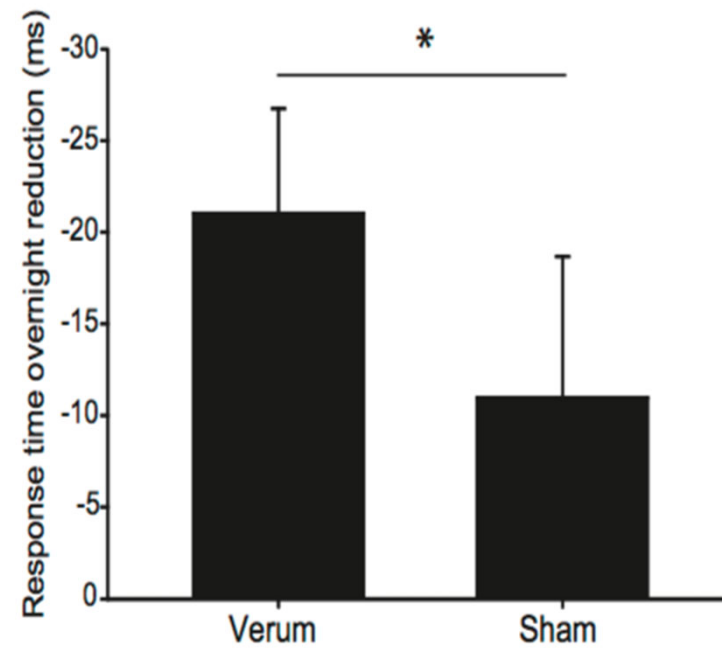
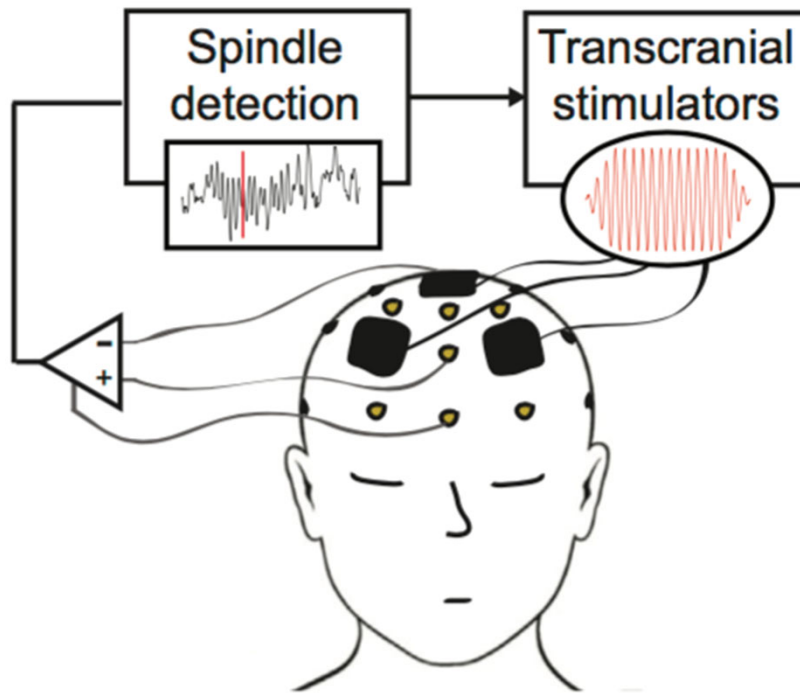


Gais et al., 2002

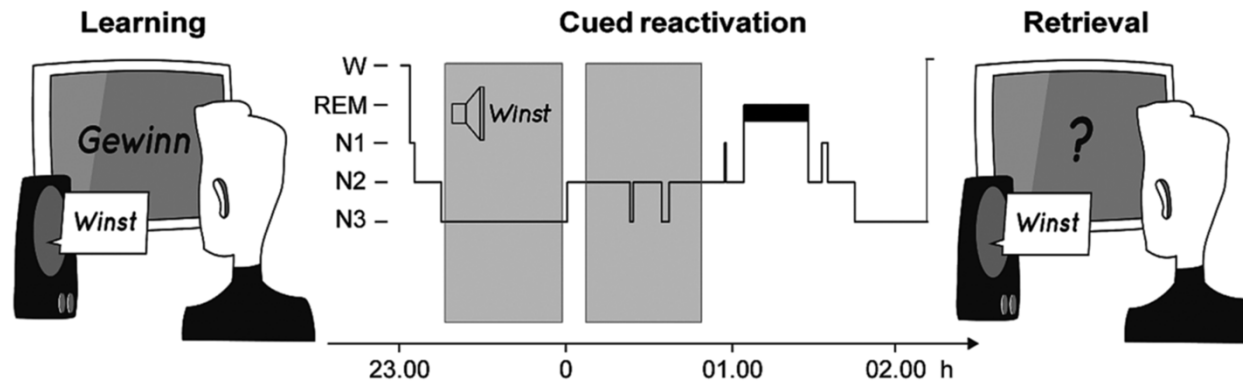


Nishida & Walker, 2007

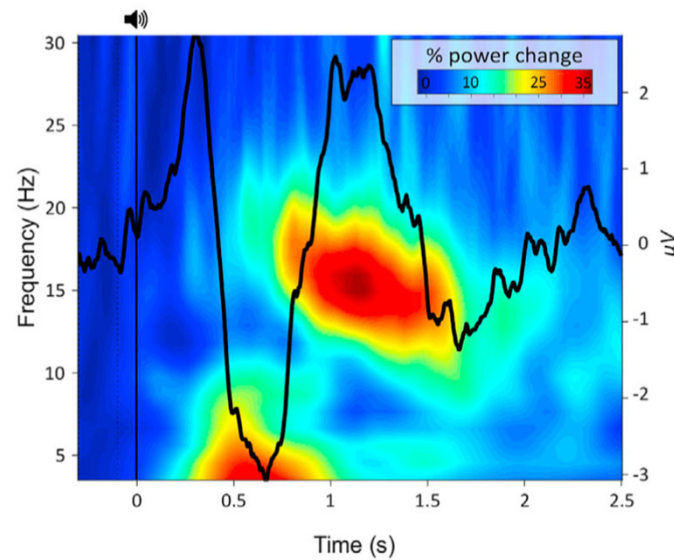
Sleep spindles



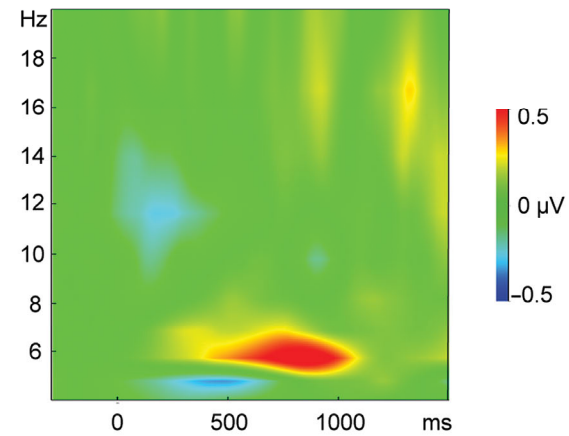
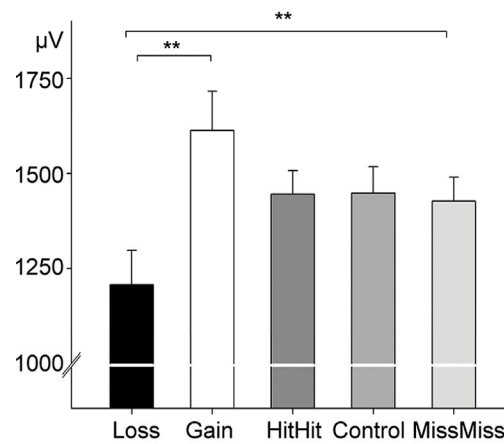
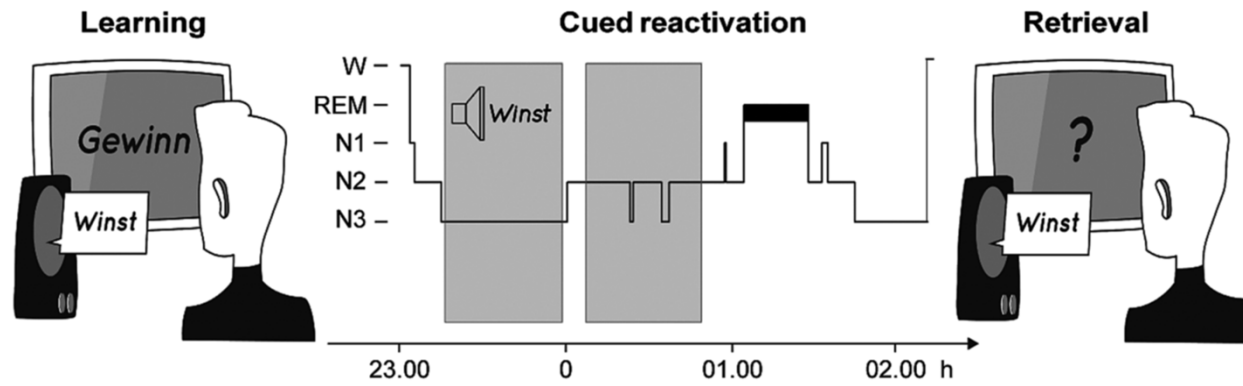
Cued memory reactivation



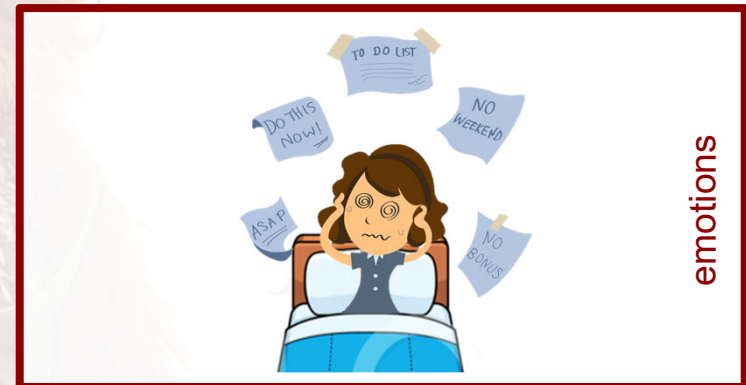
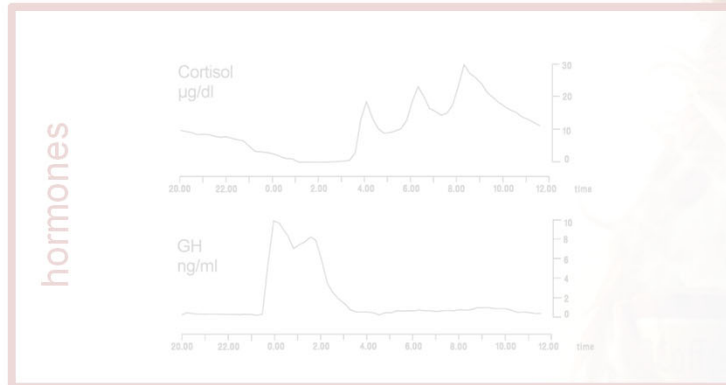
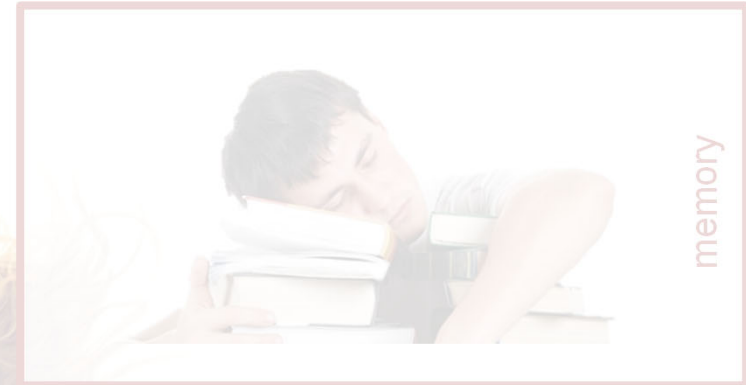
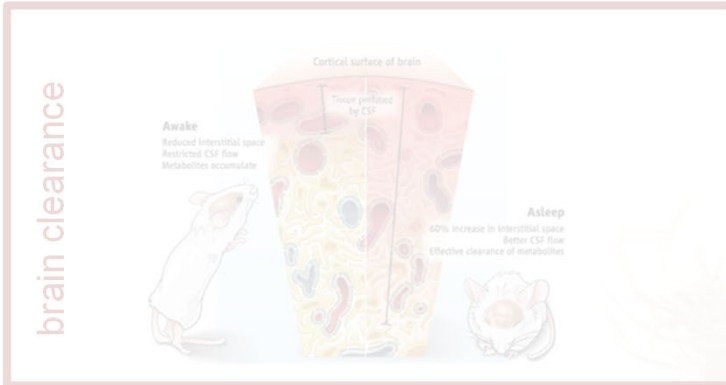
memory-cue evoked EEG response



Cued memory reactivation



Sleep: more than a substitute for coffee!

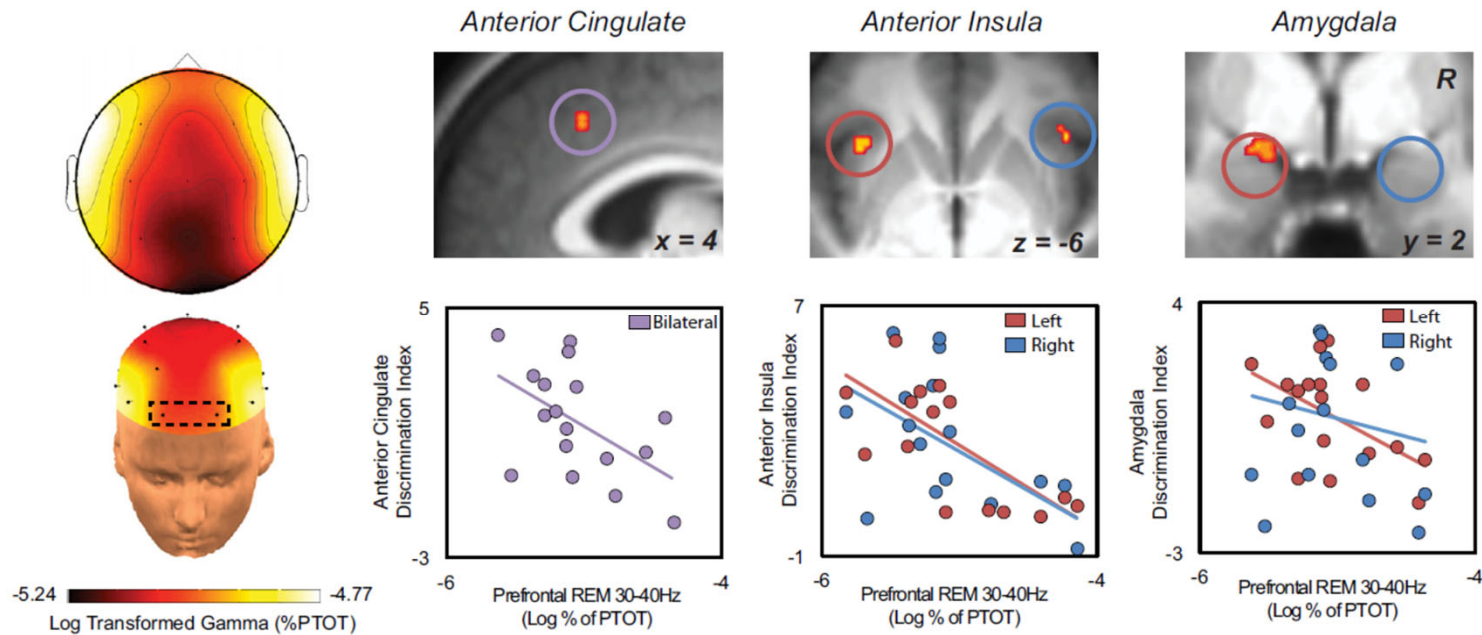


Emotional function of sleep

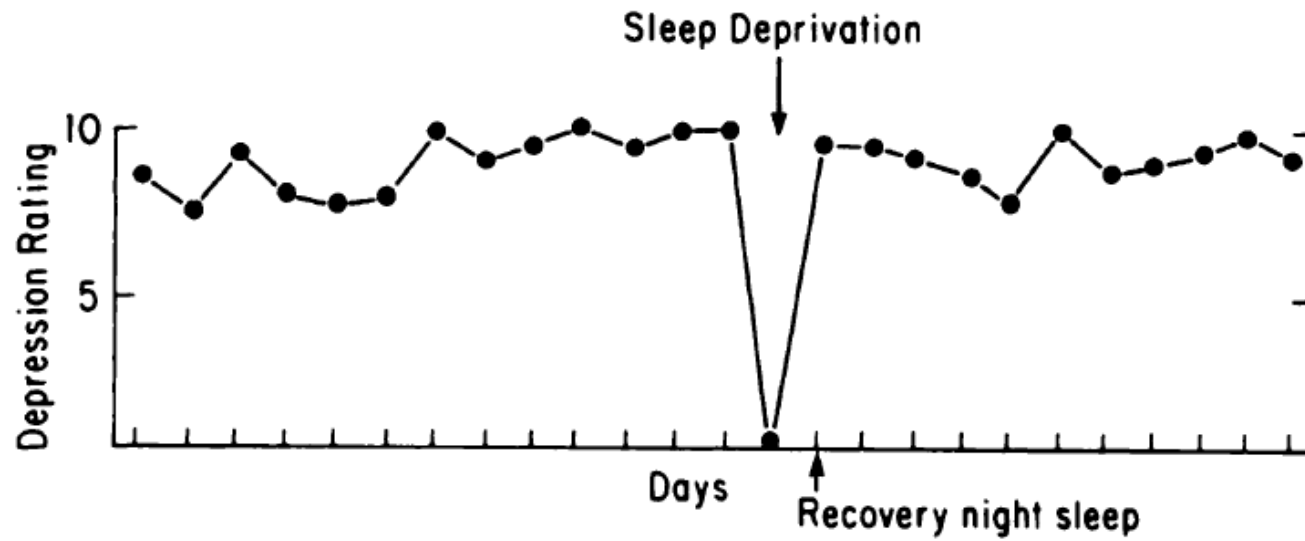


Not Threatening

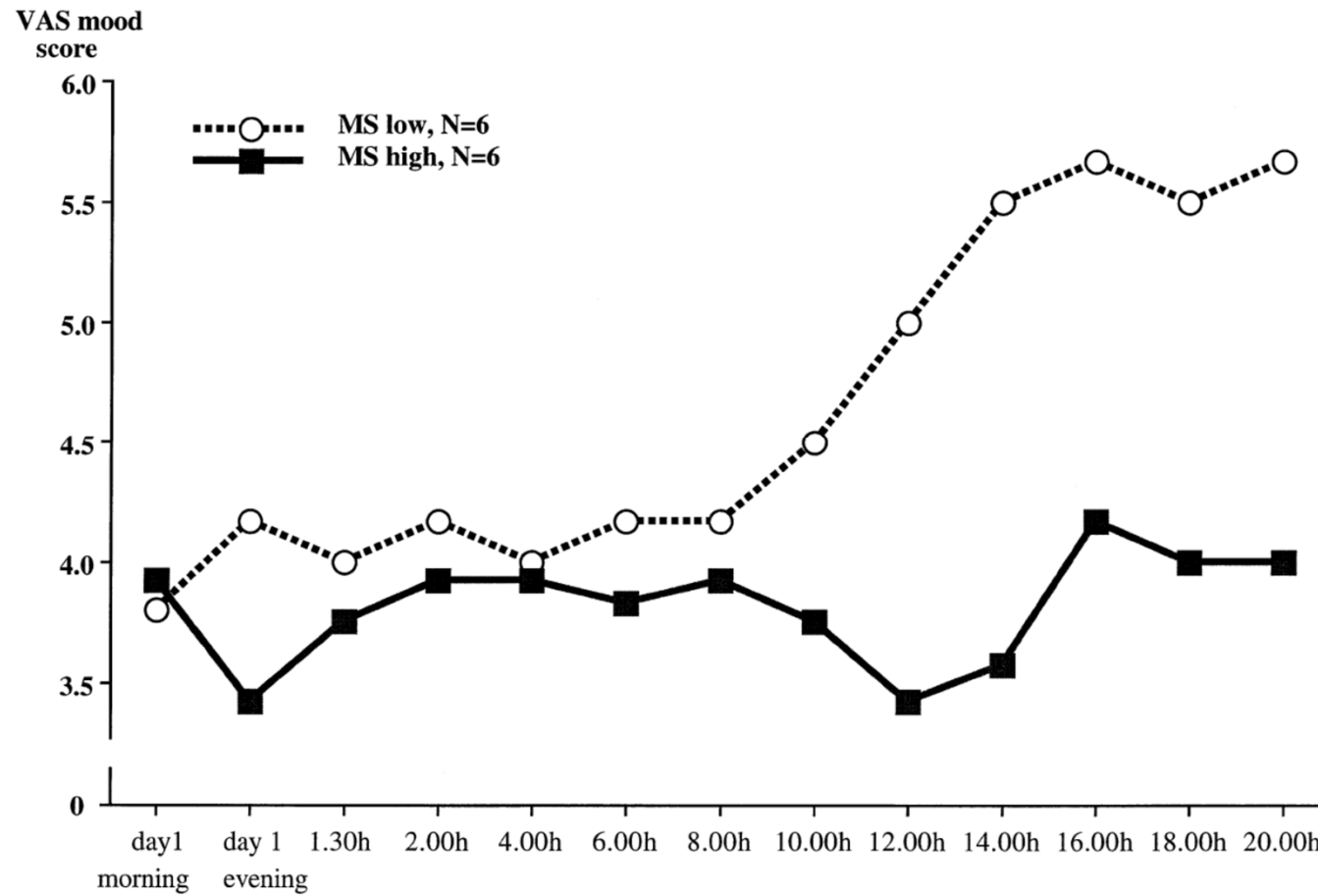
Threatening



Depression and sleep deprivation

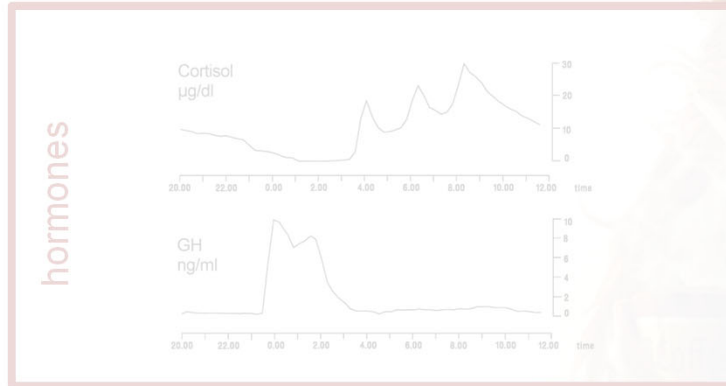
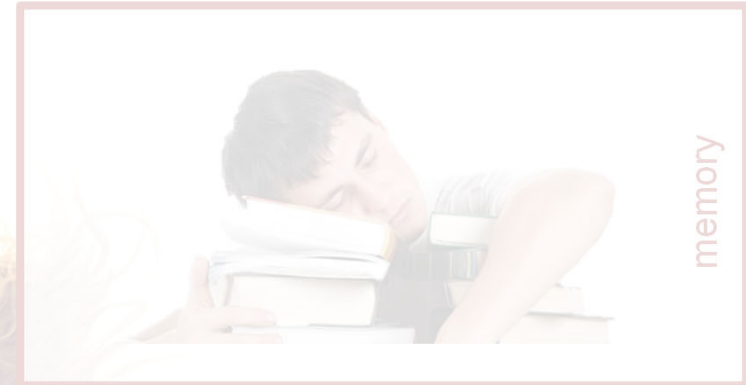
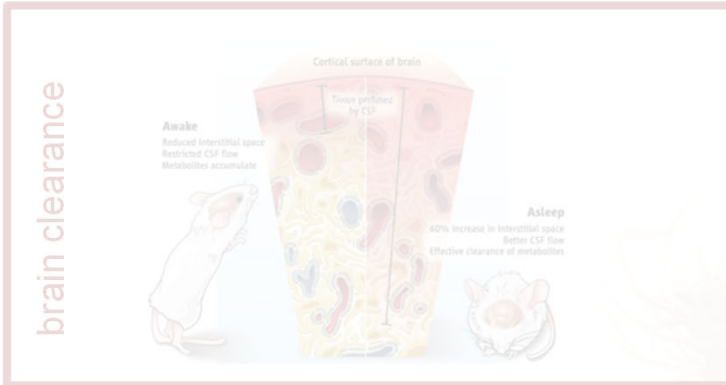


Depression and sleep deprivation



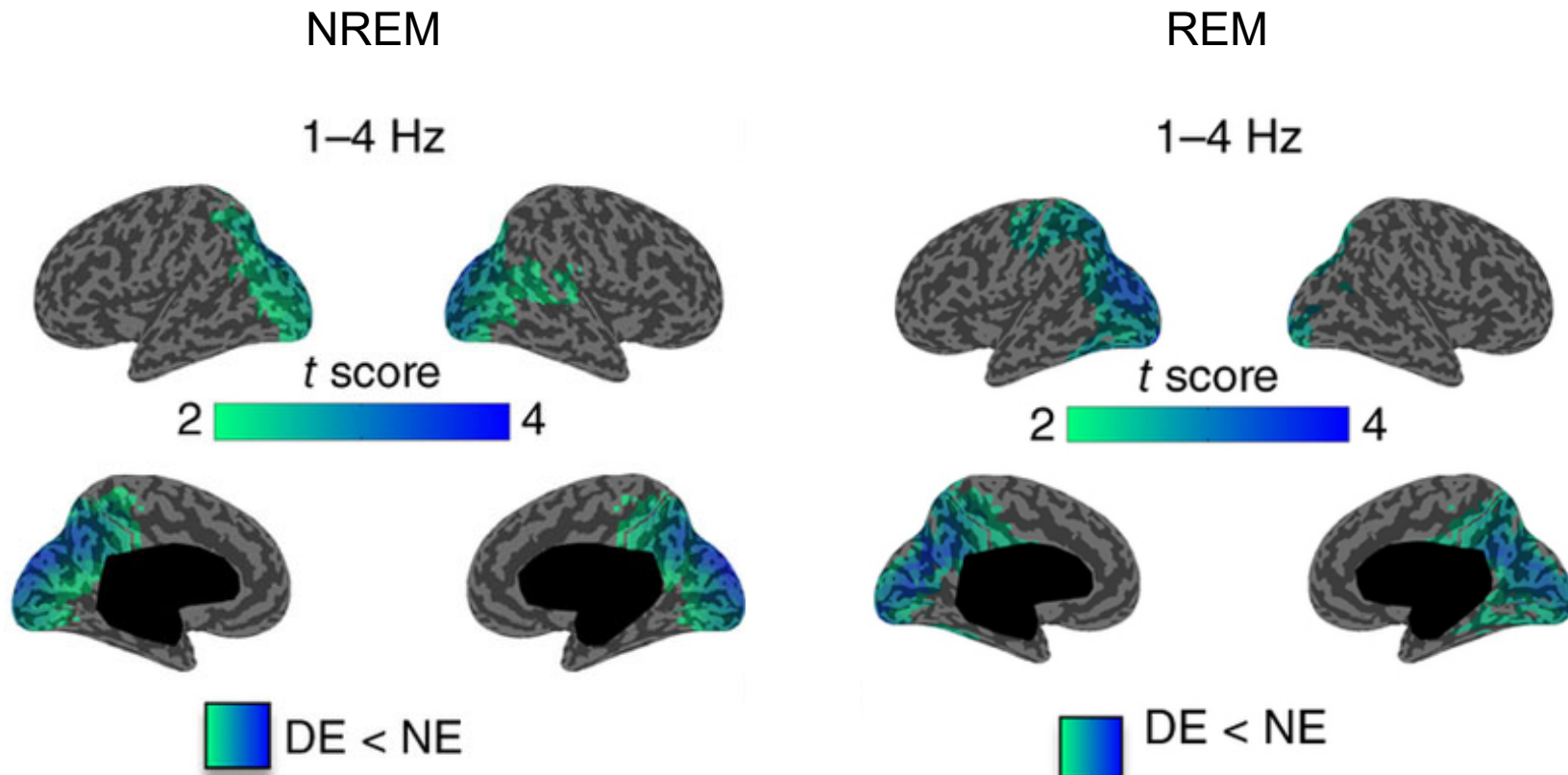
Hemmeter et al., 1998

Sleep: more than a substitute for coffee!

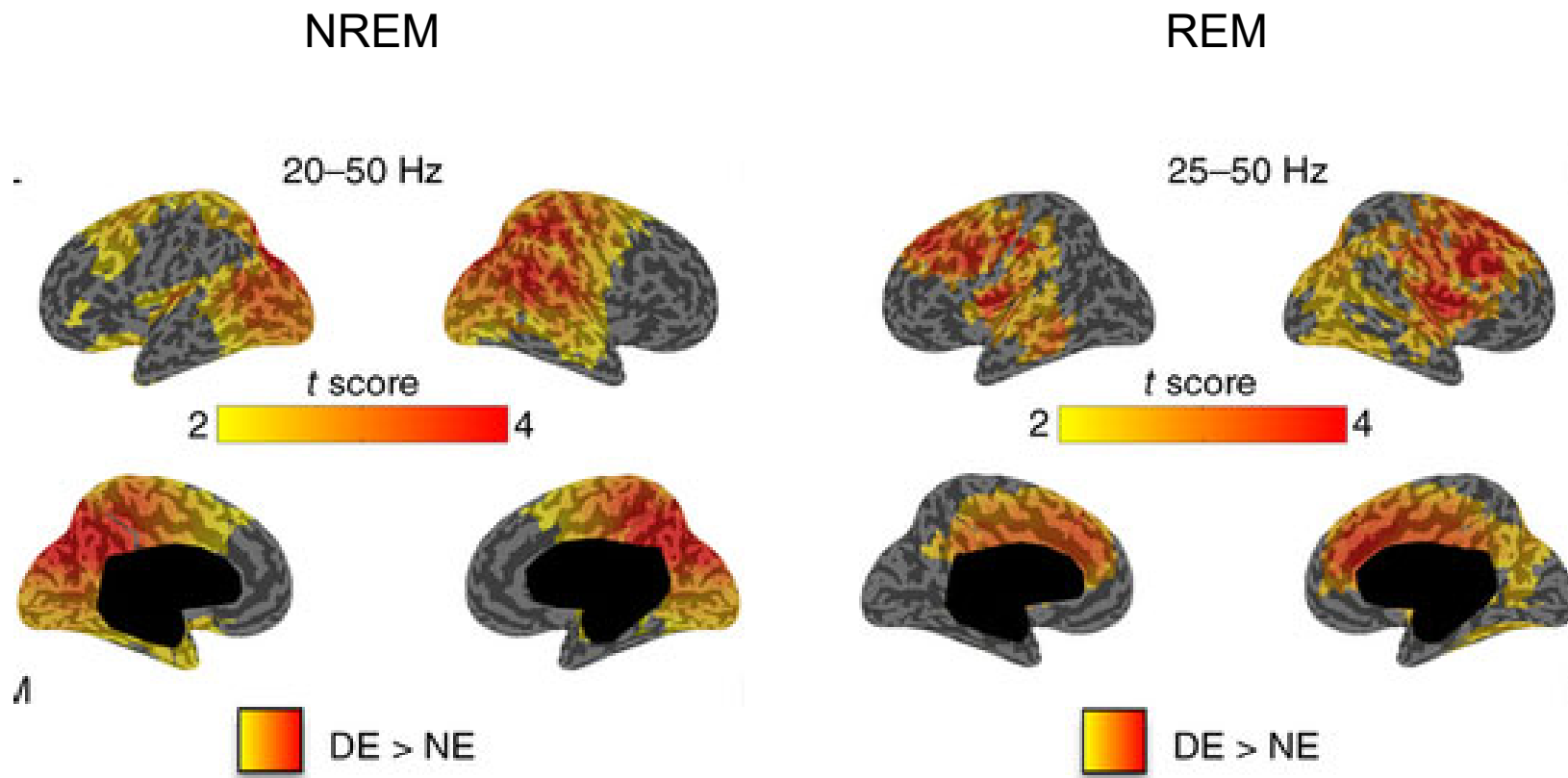




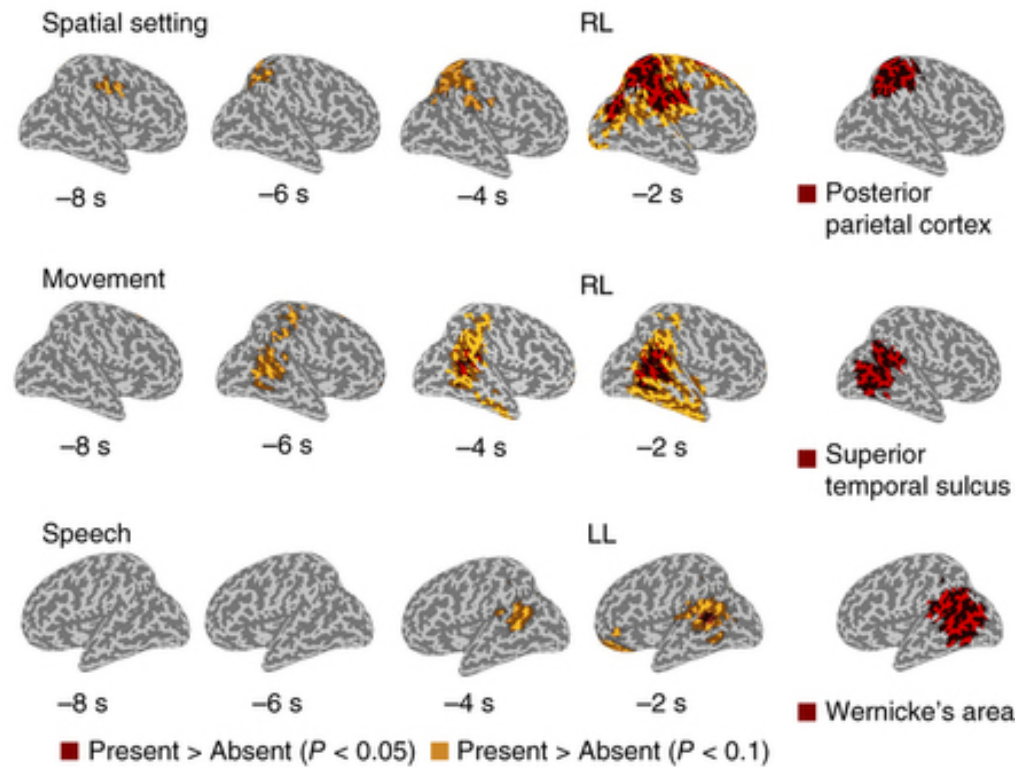
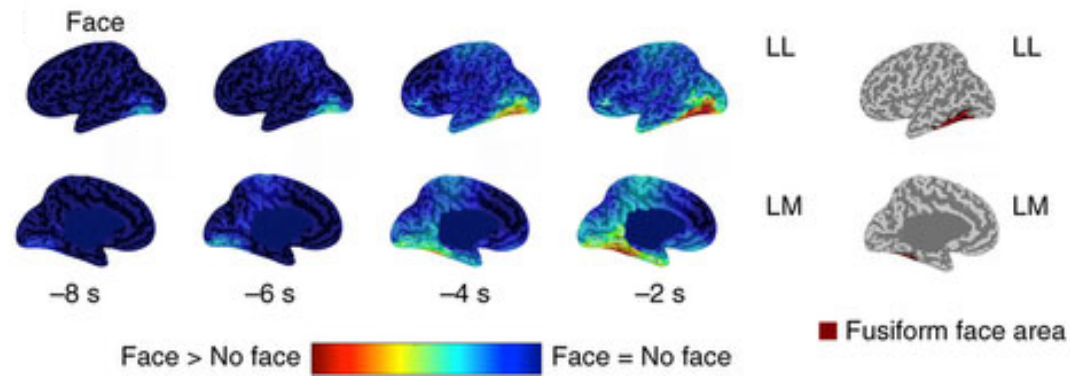
Dream experience vs. no experience



Dream experience vs. no experience



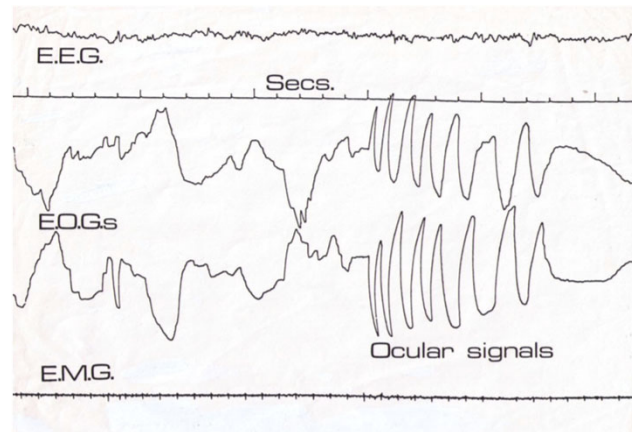
Dream content



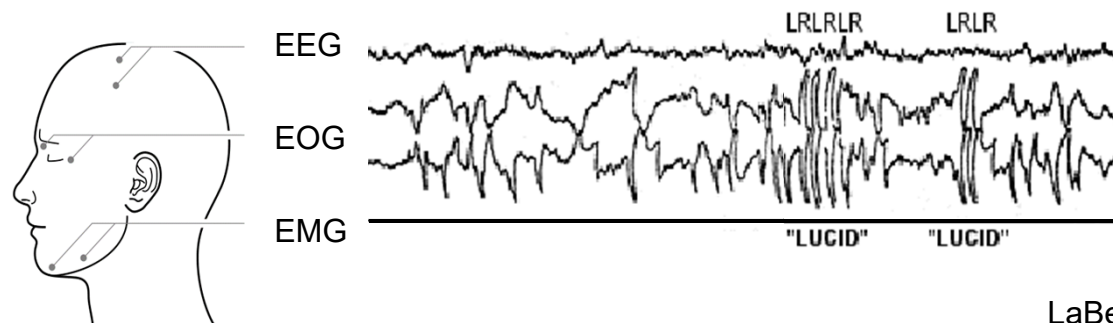
...am I
dreaming?



Lucid dreaming



Hearne, 1978

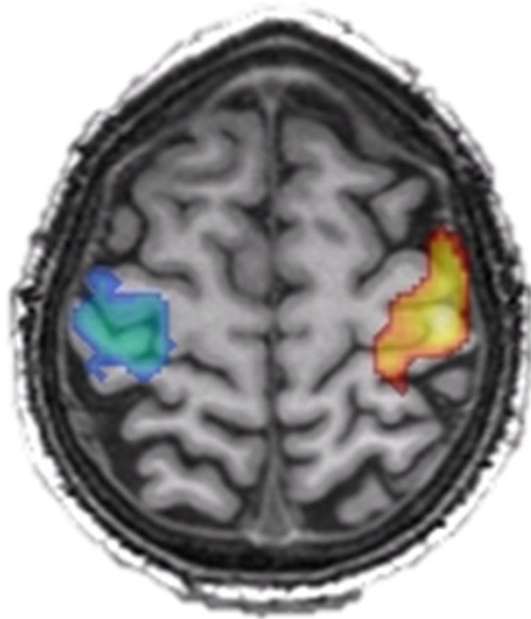


LaBerge et al., 1981

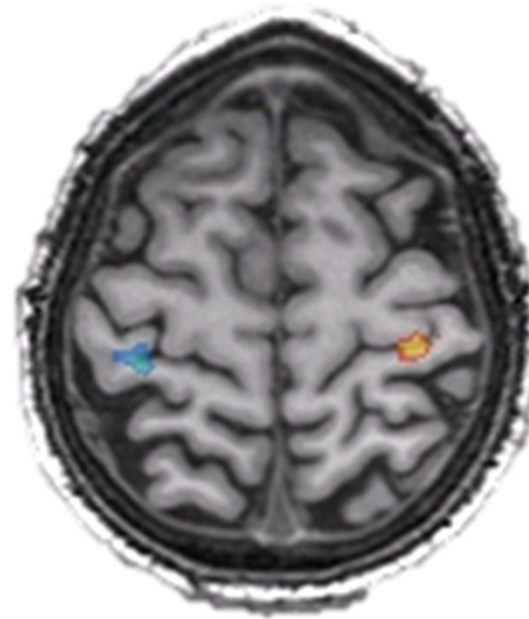
Neural correlates of dream content



real hand movement



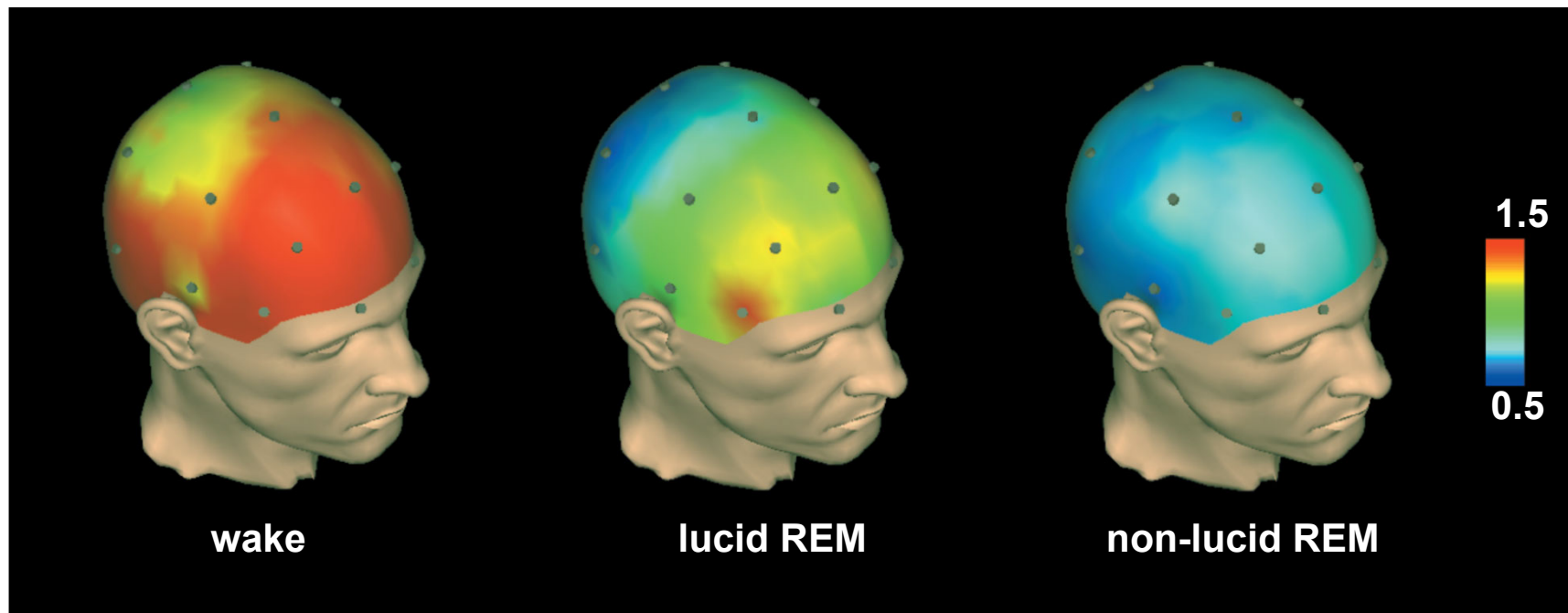
dreamed hand movement



Neural correlates of lucid dreaming



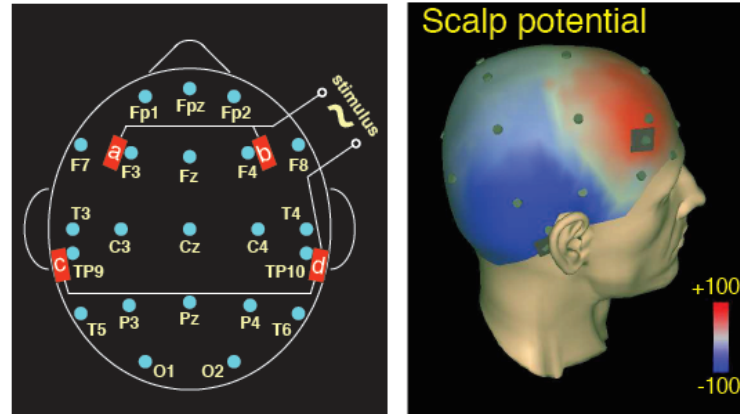
40 Hz gamma power



Neural correlates of lucid dreaming

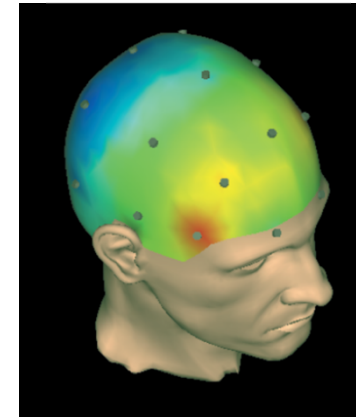


transcranial alternating current stimulation (tACS)

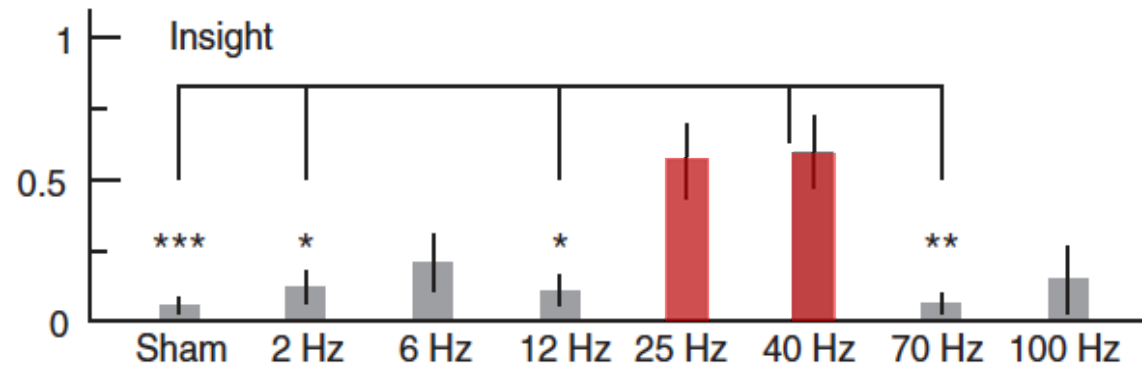


Voss et al., 2014

40 Hz: lucid REM



Voss et al., 2009



Voss et al., 2014

Conclusions



- Spontaneous EEG activity harbors important information
- In particular sleep before, during, after experiment!
- Cascade of nested oscillations
- Options to manipulate spontaneous oscillations