

from sleep to attention

the function of sleep III – learning/memory



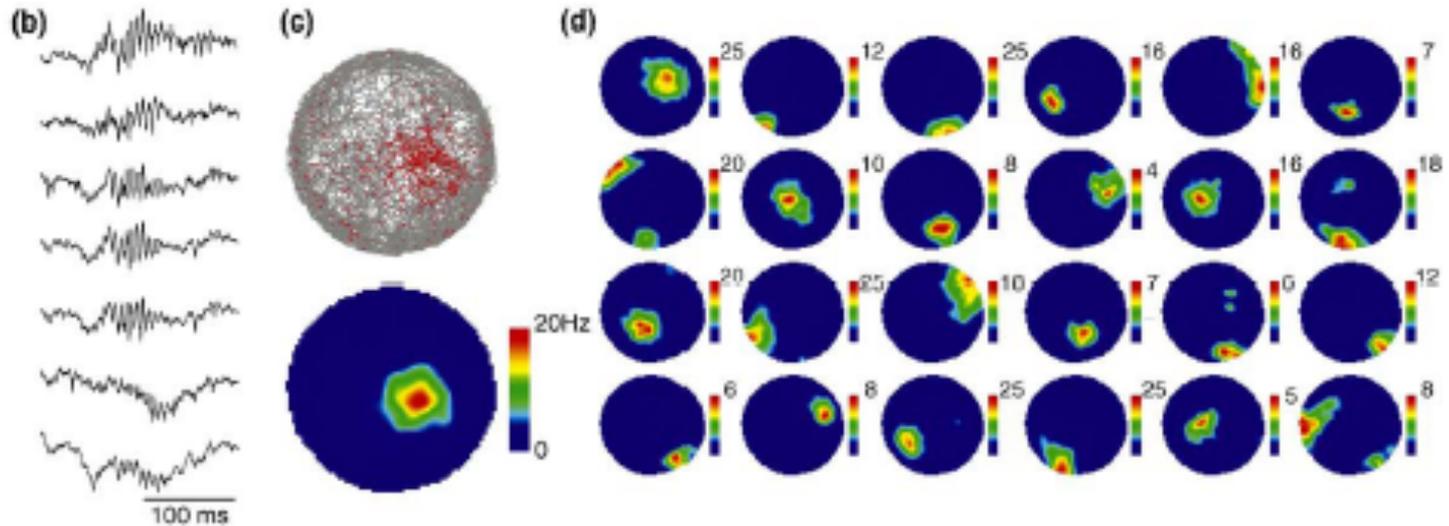
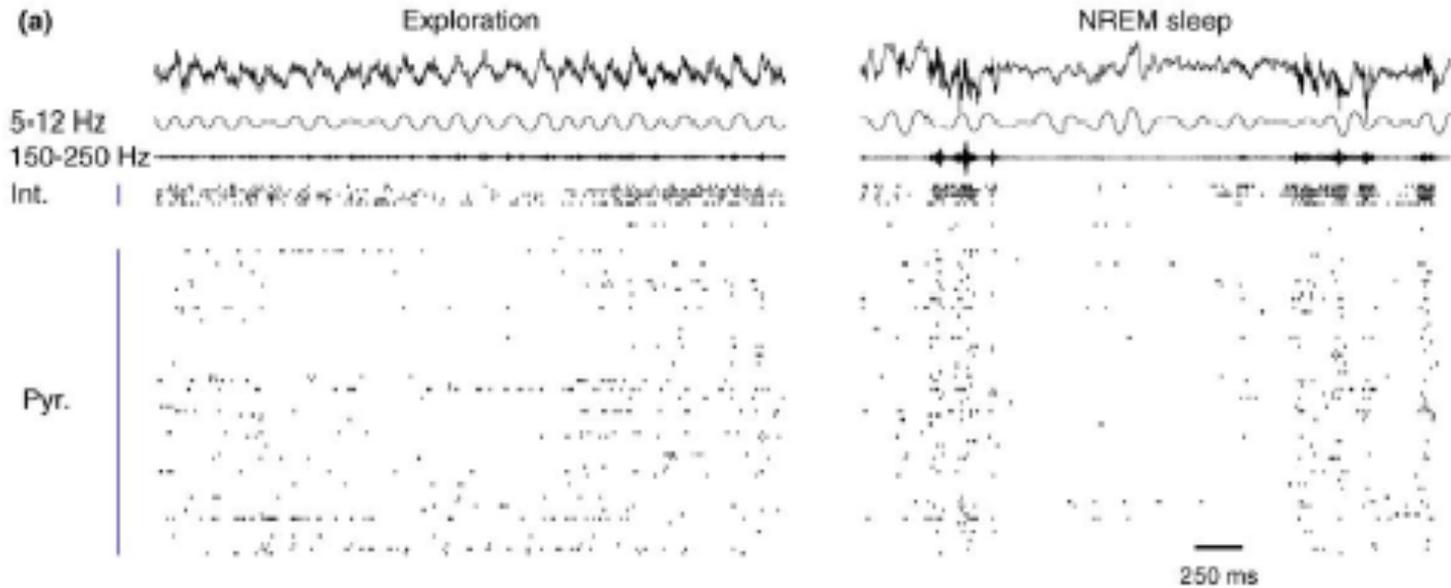
A role for sleep in learning and memory?

- 1. Do REM sleep amounts correlate with intelligence?- arguments from comparison within or across species**
- 2. Does sleep deprivation impact recall of learned material?**
- 3. Does the idea make sense neurobiologically? – is material learned during waking recalled in sleep and does the neurobiology of sleep support synaptic modification (the presumed basis for learning).**
- 4. non-REM vs. REM sleep**
- 5. procedural vs. declarative memory**
- 6. consolidation vs. transfer vs. generalization**

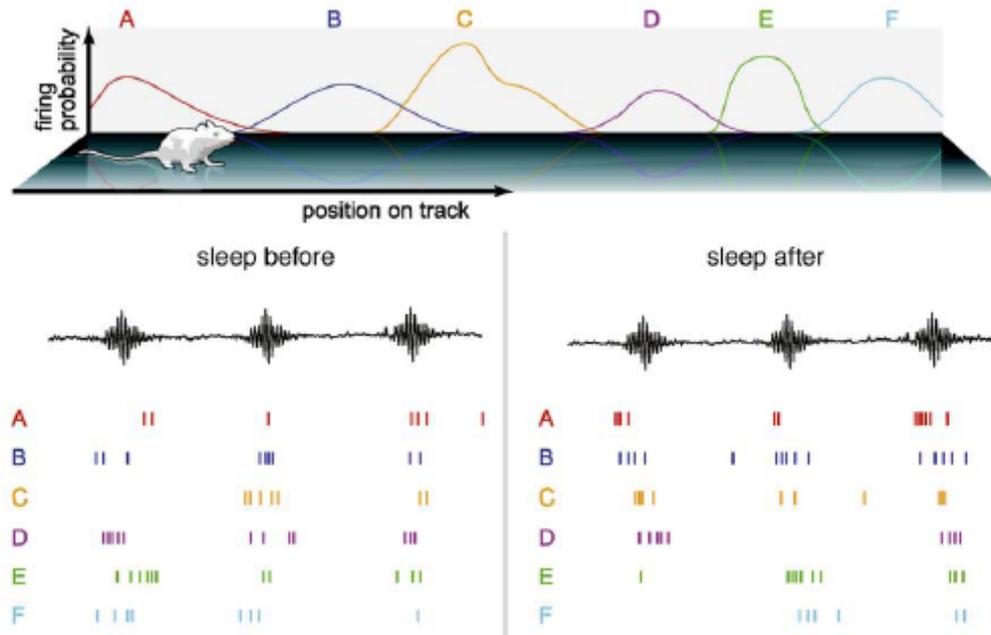
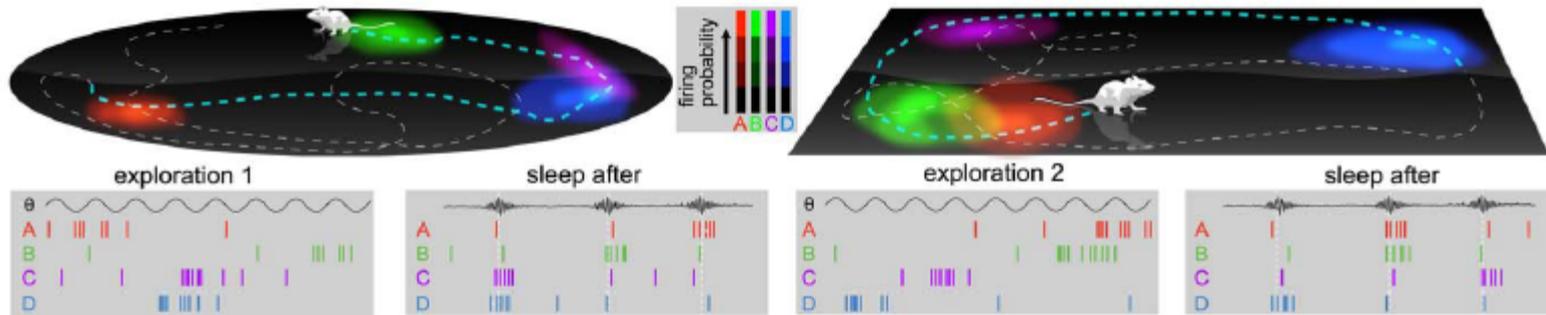
REM sleep amounts are not related to intelligence either within or across species

High REM Sleep ≥ 3 hours of REM sleep/day	Human <i>Homo sapiens</i>	Low REM Sleep ≤ 1 hour of REM sleep/day		
Platypus <i>Ornithorhynchus anatinus</i>  8 REM, 14 Total		Guinea Pig <i>Cavia porcellus</i>  1 REM, 9.5 Total	Guinea Baboon <i>Papio papio</i>  1 REM, 9.5 Total	
Thick-tailed Opossum <i>Lutreolina crassicaudata</i>  6.6 REM, 18 Total		Ferret <i>Mustela nigripes</i>  6 REM, 14.5 Total	Sheep <i>Ovis aries</i>  0.6 REM, 5.9 Total	Horse <i>Equus caballus</i>  0.5 REM, 3 Total
Big Brown Bat <i>Eptesicus fuscus</i>  3.9 REM, 19.7 Total			Giraffe <i>Giraffa camelopardalis</i>  0.5 REM, 4.5 Total	Bottlenose Dolphin <i>Tursiops truncatus</i>  <0.2 REM, 10 Total
European Hedgehog <i>Erinaceus europaeus</i>  3.5 REM, 10.1 Total				
Armadillo <i>Dasypus novemcinctus</i>  3 REM, 17 Total				

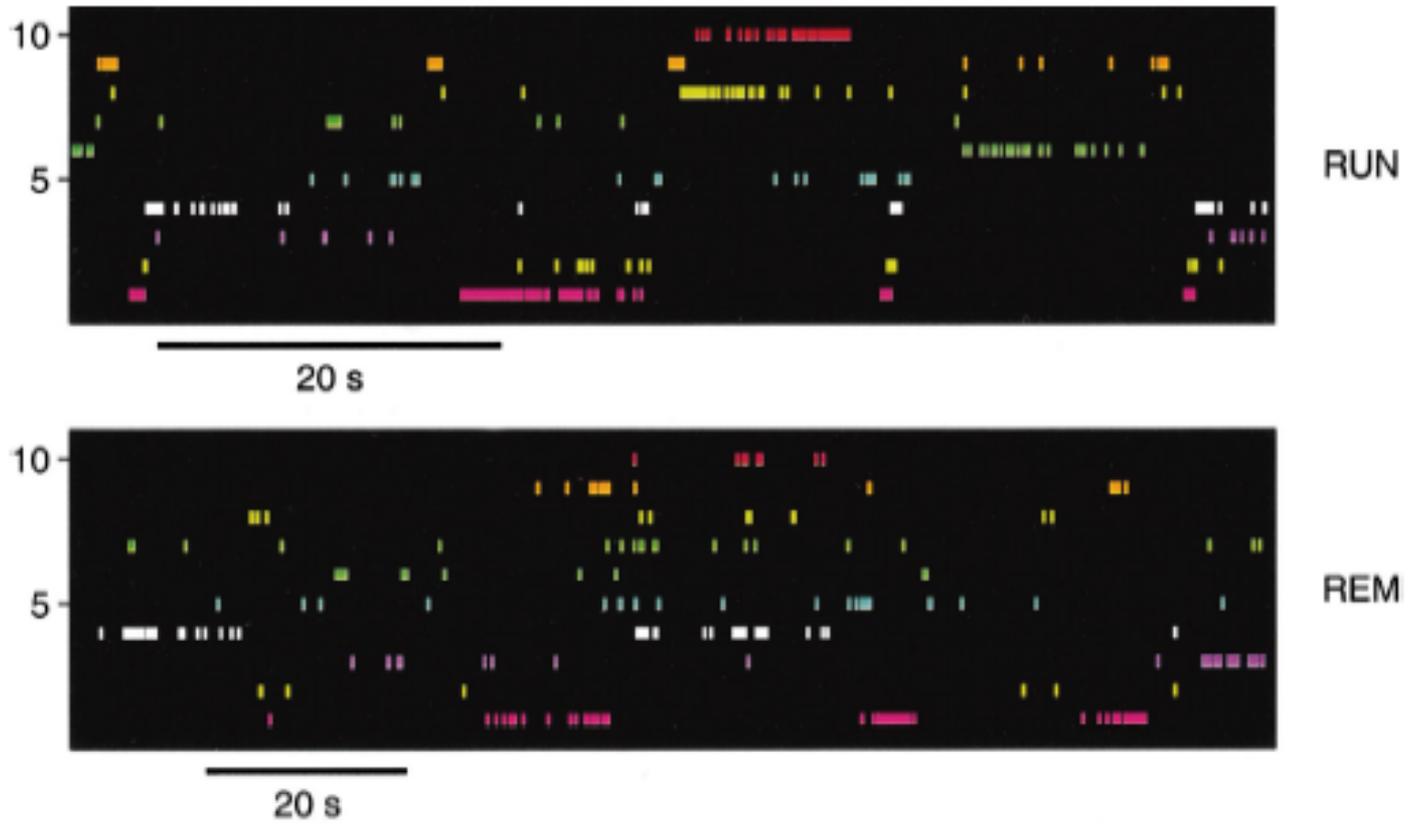
wake vs. non-REM LFPs in hippocampus



'attention' within sleep - sequences of hippocampal activity realized in waking are 'reactivated' during subsequent non-REM sleep



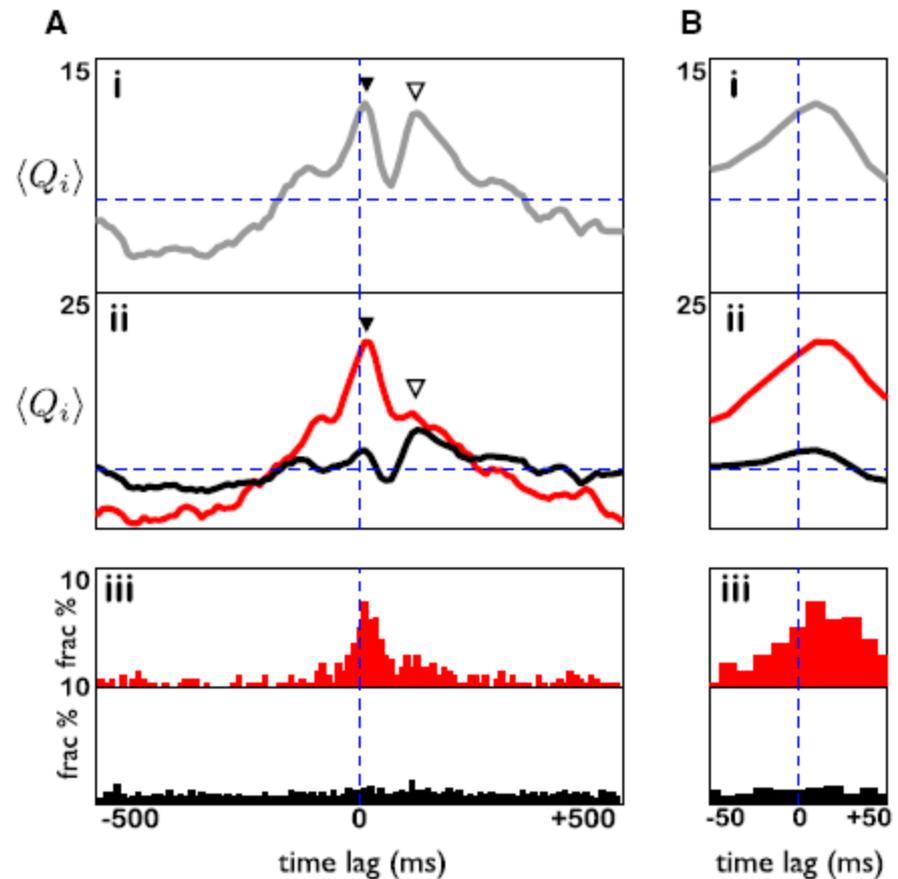
incomplete evidence for sequence replay during REM sleep



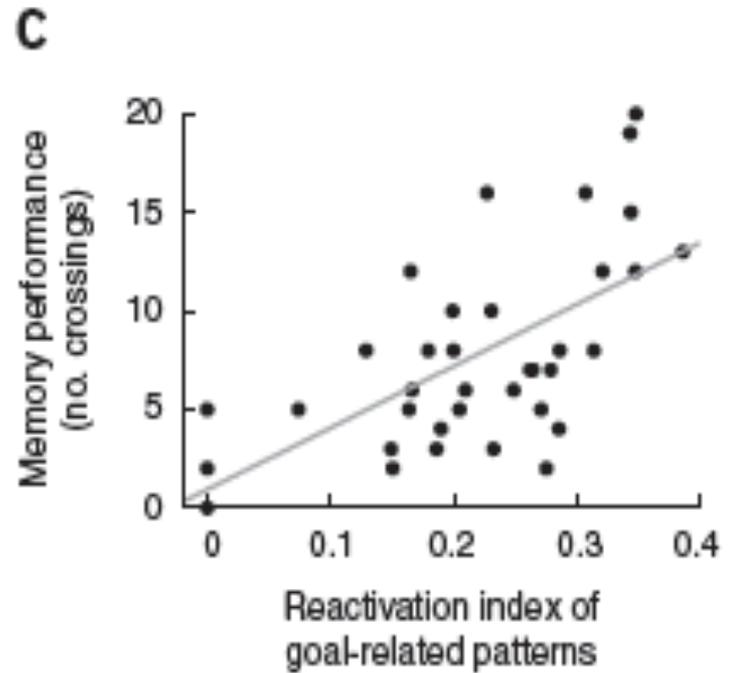
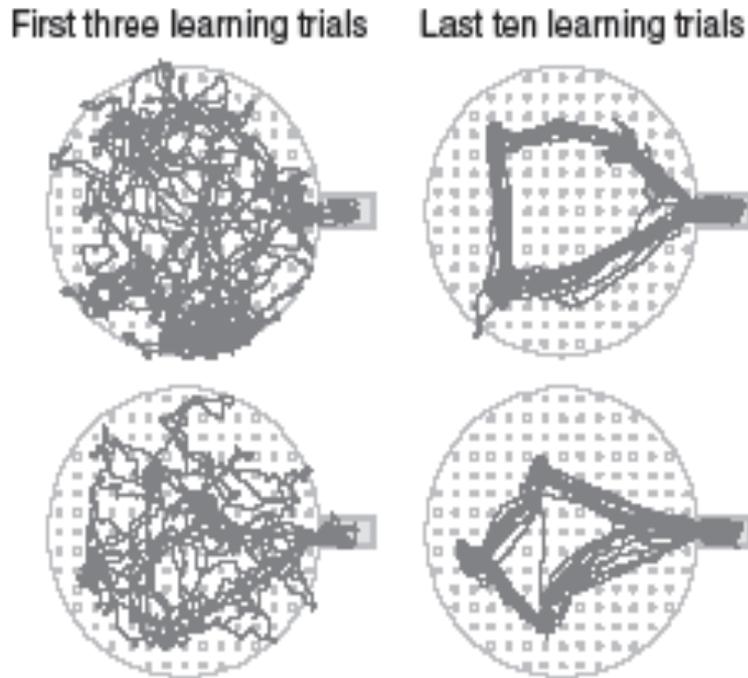
reactivation in the hippocampus is associated 100ms later by a burst of activity in the prefrontal cortex – this supports the idea that hippocampal memories are transferred to cortex during sleep

X-axis = time since burst of activity in hippocampus during non-REM sleep

Y-axis = firing rate of all prefrontal cortex neurons (grey), rate of prefrontal cortex neurons with activity related to hippocampal activity during waking (red), and rate of prefrontal cortex neurons without activity related to hippocampal activity during waking (black)

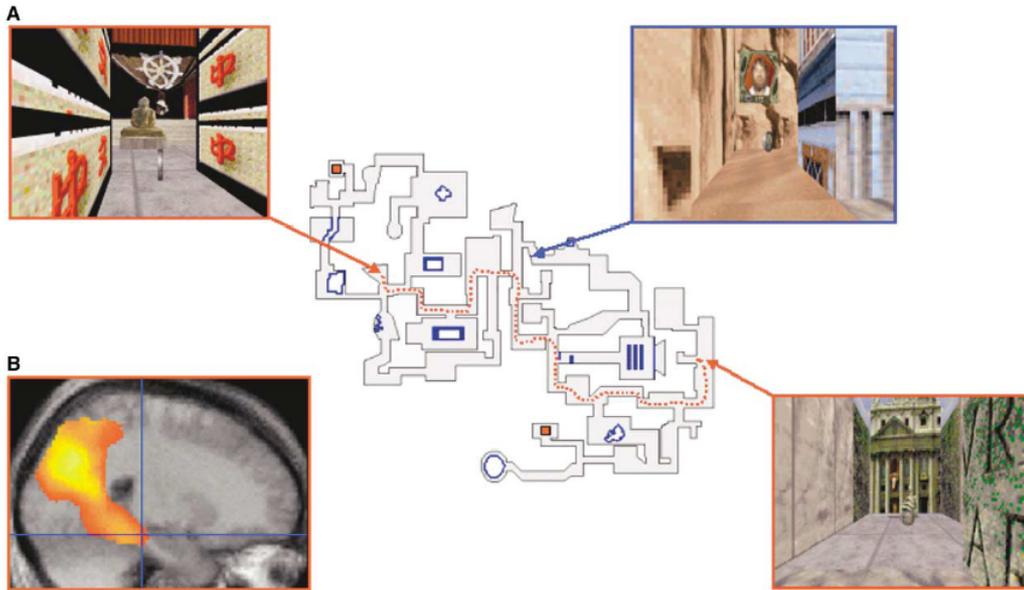


the first decent evidence that sleep reactivation matters



Dupret et al., Nature Neuroscience, 2010

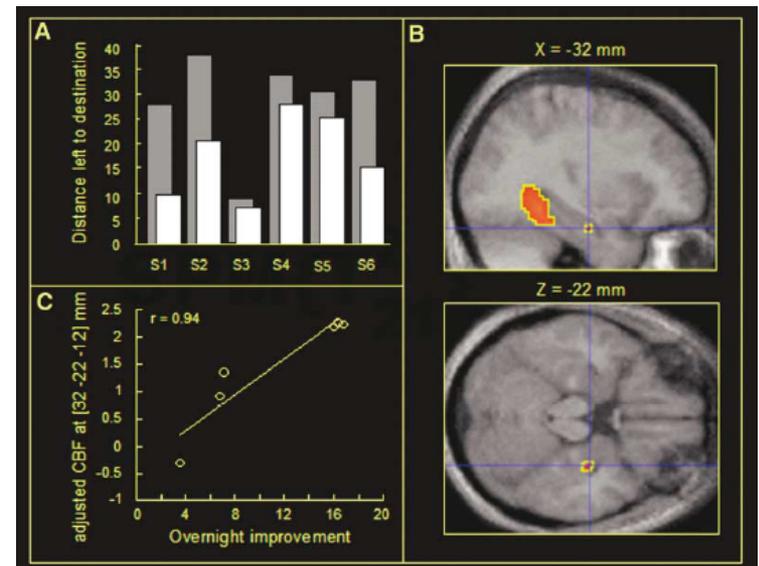
reactivation in humans



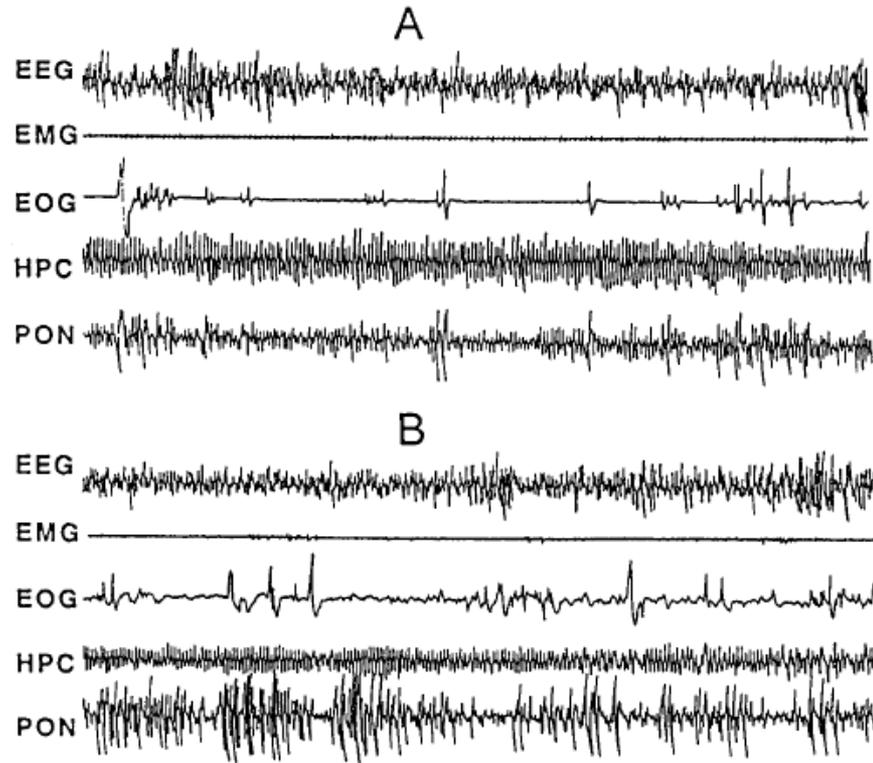
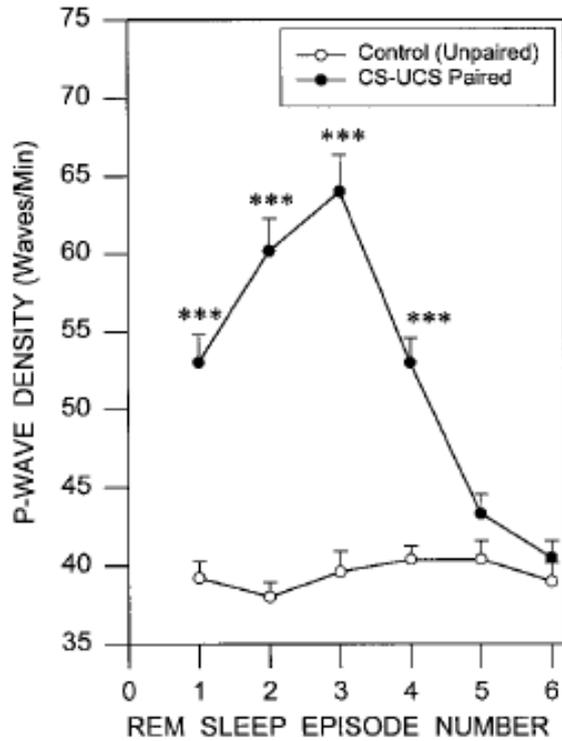
virtual navigation activates hippocampus and parietal cortex

Peigneux et al., 2004 Neuron

post-sleep improvements in navigation correlate with hippocampal activation in sleep

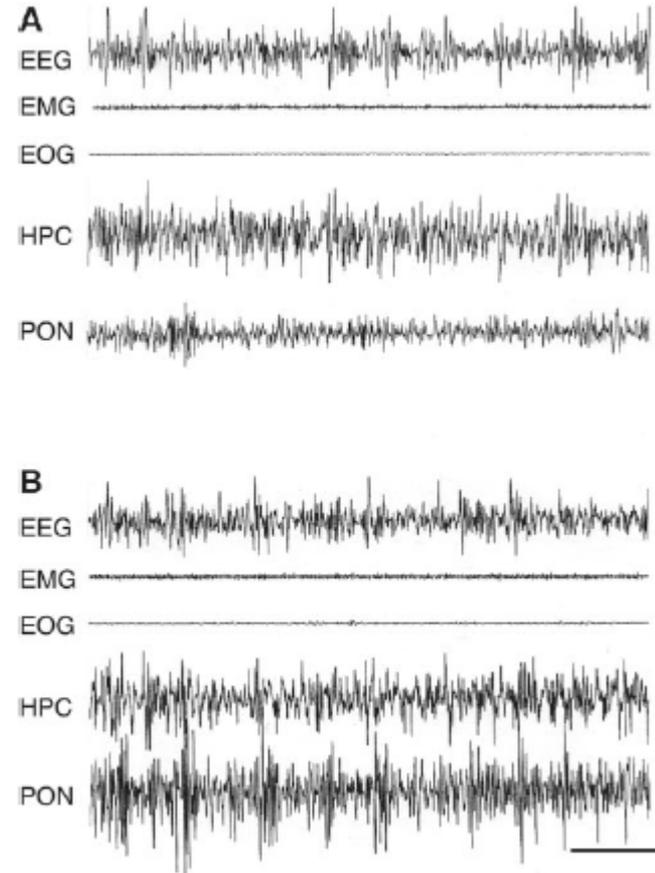
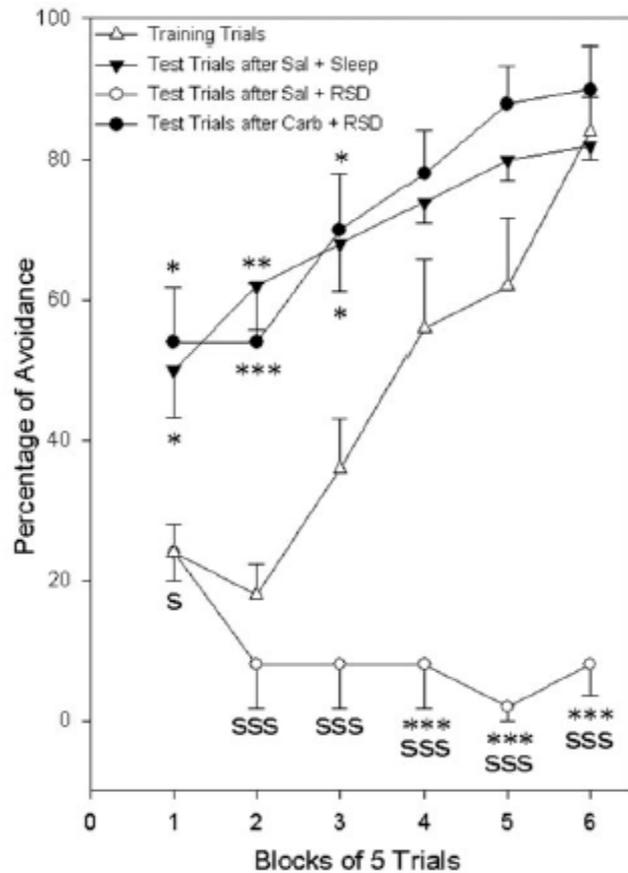


shock avoidance training increases PGO spike density in subsequent sleep



Datta, 2000 J. Neuroscience

REM sleep deprivation impairs two-way avoidance learning, but not if PGOs are induced within non-REM sleep



Datta, 2004 J. Neuroscience