The Effects of Self-Guided Meditation and Napping on Memory Consolidation in Humans

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Sleep 💤

- A reversible behavioural state of perceptual disengagement from and unresponsiveness to the environment

- Typically accompanied by
  - Postural recumbence
  - Behavioural quiescence *
  - Closed eyes *
  - All other indicators of sleeping

Sleep 💤

- Two main stages:
  - NREM (non rapid eye movement) : a relatively inactive yet actively regulating brain in a moveable body
    - Stage 1 and 2
    - Stage 3 and 4 or Slow-Wave Sleep
  - REM : Desynchronized, muscles are atonic, dreaming is typical

Memory consolidation

Encoding during wake → transformation into stable representation → Integration into the network of pre-existing LTM

- **HOW?**
  by active re-processing (“replay” or “reactivation”) of new memories in the neural networks that were involved in the encoding process

- **WHY SLEEP?**
  ‘off-line’ nature of sleep -- less interference by incoming (“online”) sensory information

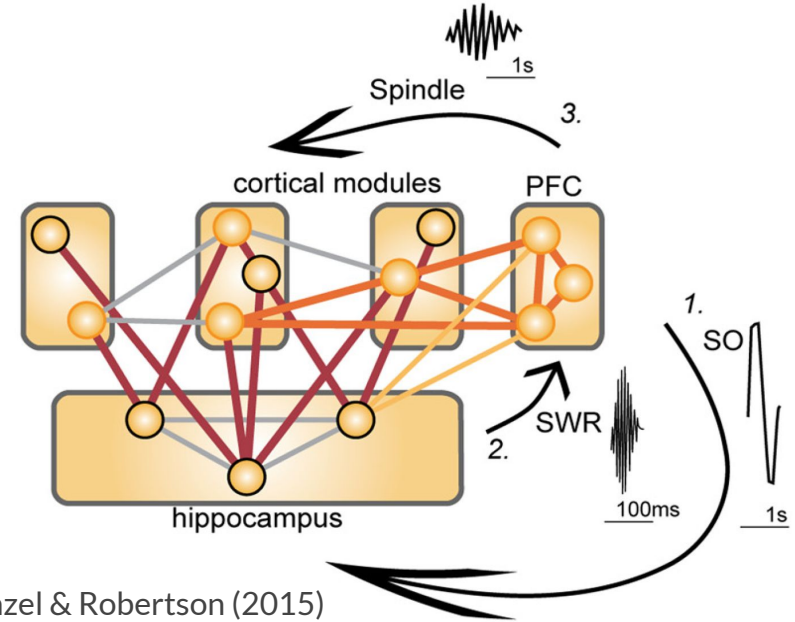
The role of sleep in consolidation

- **the active system consolidation theory**
  - Events during waking are encoded in both neocortical and hippocampal networks

1. Slow oscillations initiate the replay from PFC to hippocampus

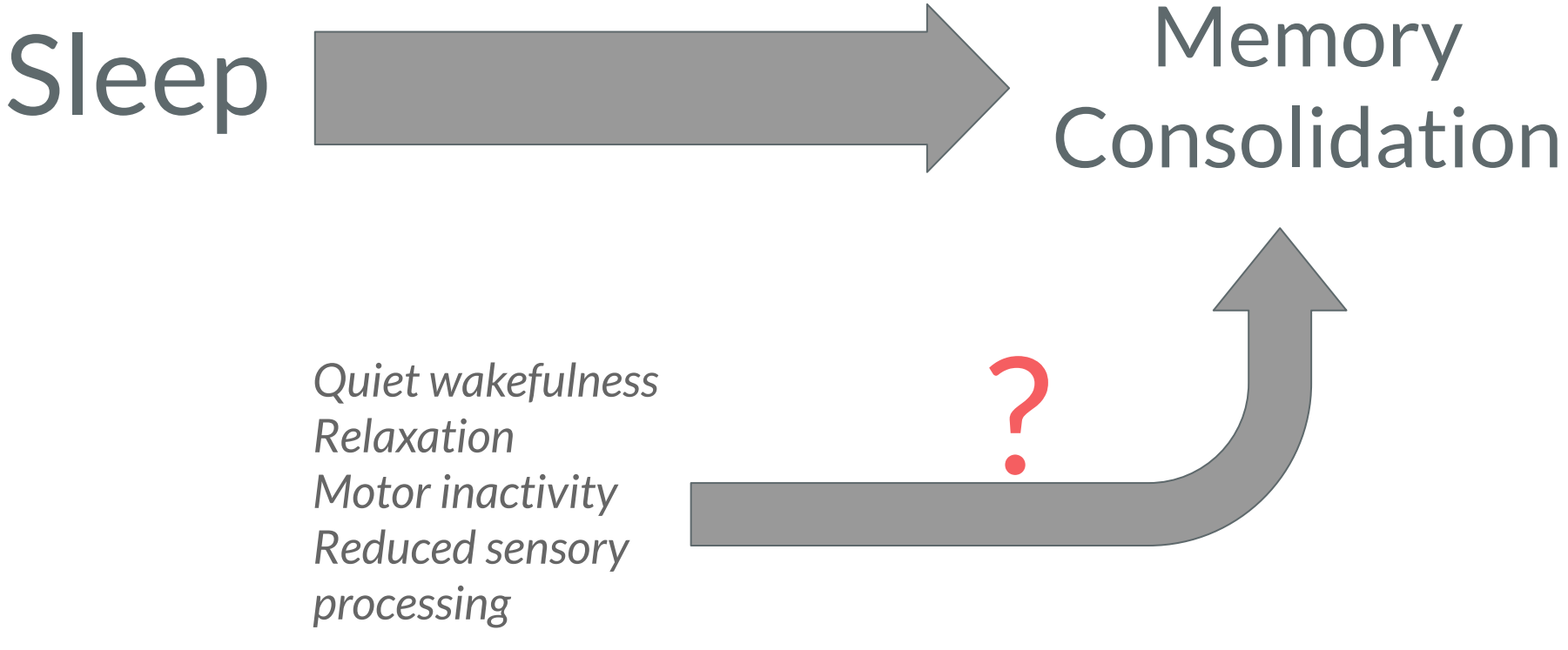
2. Sharp-wave ripple reactivates the hippocampal replay. PFC replay is initiated (light orange)

3. Sleep spindle in neocortex deafferents PFC from hippocampus and memories are transmitted to other cortical areas



Genzel & Robertson (2015)

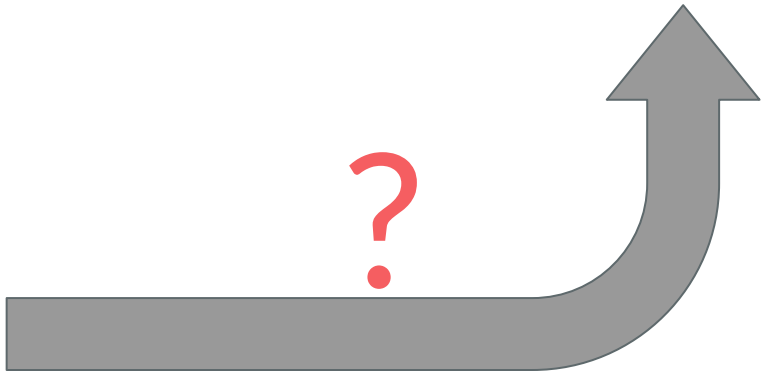
Is memory consolidation exclusive to sleep?



Sleep

Memory Consolidation

Meditation



Quiet wakefulness
Relaxation
Non-reactivity
Reduced sensory processing

Mindfulness meditation - Quiet waking

- a form of mental training, with the aim of improving core psychological capacities (i.e. attentional and emotional self-regulation)

- neurochemical and electrophysiological similarities to sleep
  - Decrease in beta and gamma activity
  - Increase in alpha and theta activity

- Enhances the quality of attention, which improves the quality of encoding

Aims of the current study

1. to examine whether sleep and some non-sleep-related behavioural states influence memory consolidation in humans

2. To examine whether some shared physiological components of sleep and waking are related to the effectiveness memory consolidation

Hypothesis:

participants in the NAP and MED conditions will outperform WAKE condition

Methods

- Participants
  - Between 18-65, healthy individuals
  - Inclusion criteria
    - Nappers: 3 times/week over the last 3 weeks
    - Meditators: at least 3 times/week

Declarative memory task

Paired associate task

Pre: 60 pairs of randomly generated words with 5s of ISI
Post: 20 identical, 20 novel combination, 20 completely new word pairs

	Answered Class	
Actual Class	Positive	Negative
Positive	TP	FN
Negative	FP	TN

$$TPR = \frac{TP}{TP + FN} \qquad TNR = \frac{TN}{TN + FP}$$

$$\text{Geometric Mean} = \sqrt{TPR \times TNR}$$

Nondeclarative memory task

Marble Maze visuo-motor task

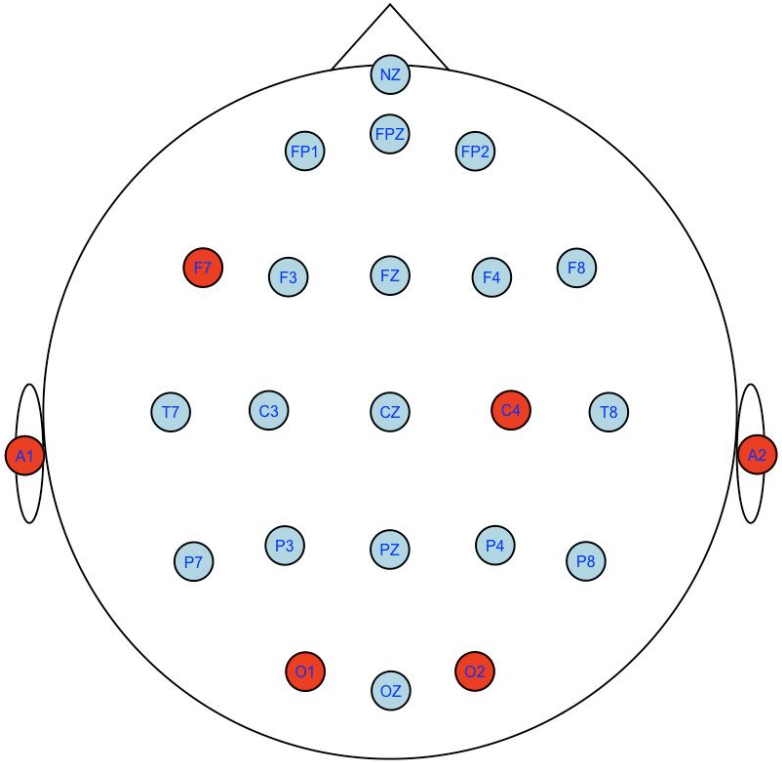
Passing the marble along the lined path using two knobs
Ability to score higher is important, not the path itself.

Training session :100 trials
Test session : 50 trials

Difference of medians = [trials 1-10 of test session] - [trials 91-100 of training session]

Electrophysiological recordings

- EEG
  - O1-F7, O2-C4, according to the 10-20 system
  - bilateral mastoid references
- EOG
  - Right and left outer canthus
  - the bridge of the nose as reference
- EMG
  - At the chin for assessing jaw muscle tone



Results

- 64 Participants
  - 23 ±7 years old
  - 76 % female

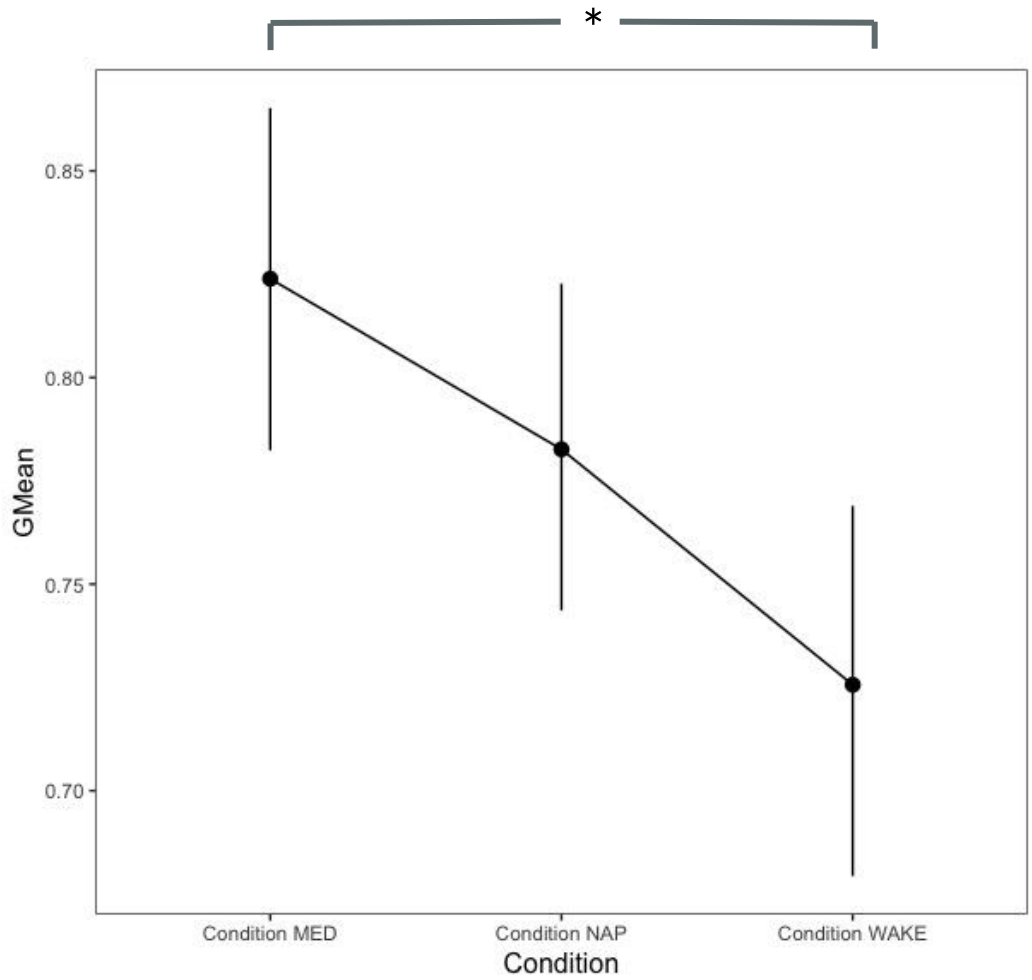
- 21 Nappers
  - 10 went to SWS
- 25 Quiet waking (meditation)
- 18 Active waking (watching documentary)

Declarative memory

Overall performance of all participants across conditions using Bayesian GLM

Meditators outperformed participants in the Wake condition (MPE =97.42%)

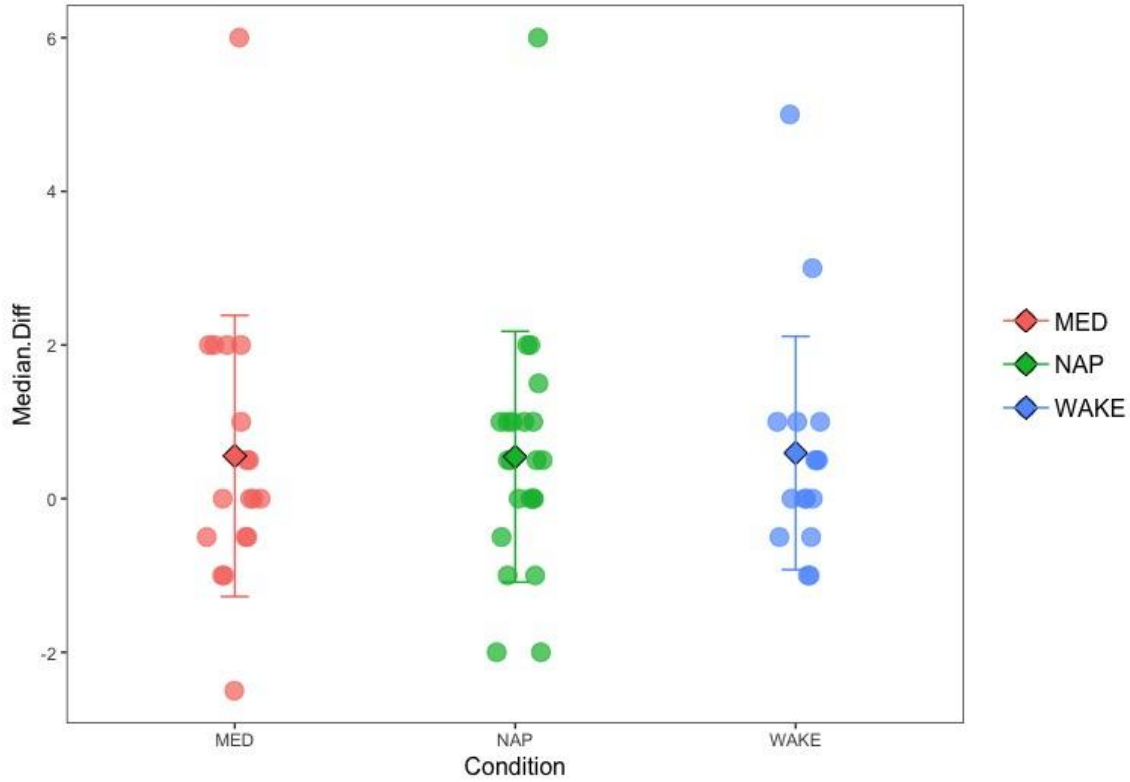
(error bars reflect 90% C.I.)

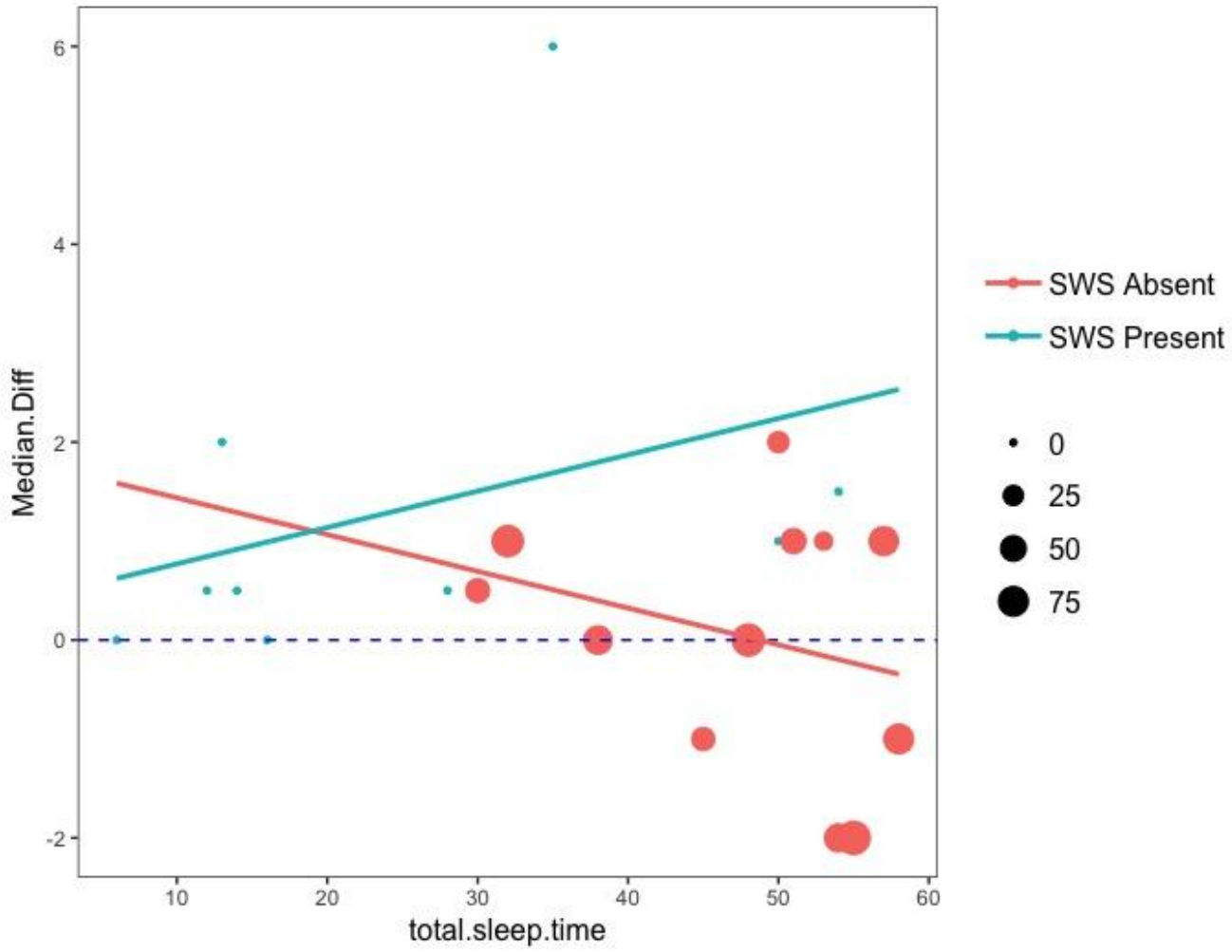


Non-declarative memory

Overall distribution of performance

(error bars reflect SEM)



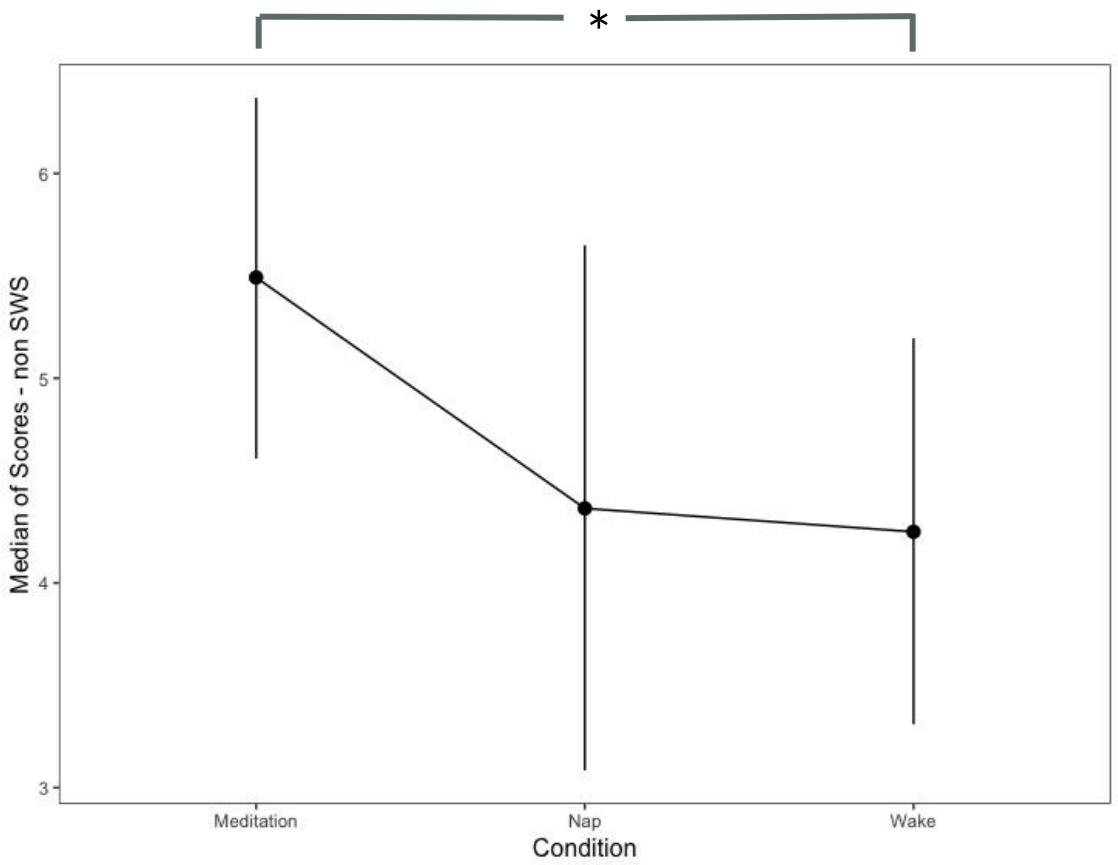

6
4
2
0
-2
Median.Diff
10
20
30
40
50
60
total.sleep.time
SWS Absent
SWS Present
0
25
50
75

Non-declarative memory

Overall performance of nappers <u>without SWS</u> across conditions. Repeated-measures Bayesian GLM

Meditators outperformed participants in the Wake condition (MPE =94.77%)

(error bars reflect 90% C.I)

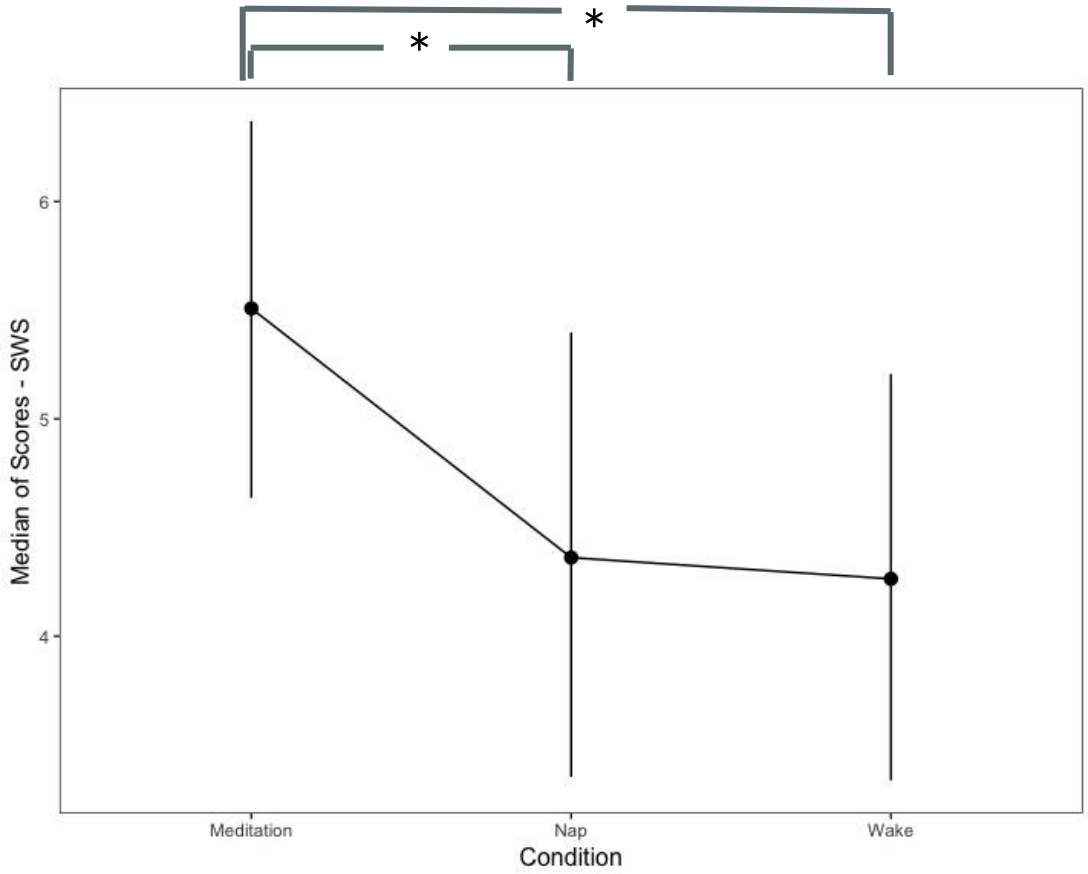


Non-declarative memory

Overall performance of nappers <u>with SWS</u> across conditions. Repeated-measures Bayesian GLM

Meditators (MPE= 95.67%) and nappers (MPE=93.12%) outperformed participants in the Wake condition

(error bars reflect 90% C.I)



Summary

Declarative Memory

- Better performance after self-guided meditation and napping, compared to active waking

Non-declarative Memory

- Better performance after self-guided meditation and non-SWS napping, compared to SWS napping and active waking

Some forms of quiet waking can bring beneficial effects of memory consolidation that are similar to those seen with sleep

Thank you!

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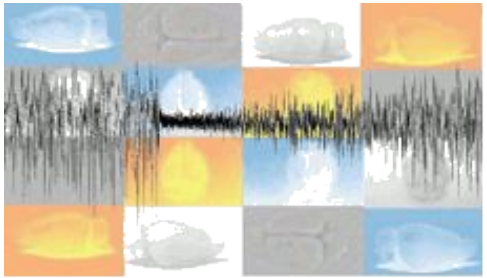
  - Katie McGuire (my volunteer)

Neuroplasticity Lab



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