DIFFERENTIAL ROLE OF SLOW WAVE AND RAPID EYE MOVEMENT SLEEP ON MEMORY FORMATION: PRELIMINARY RESULTS

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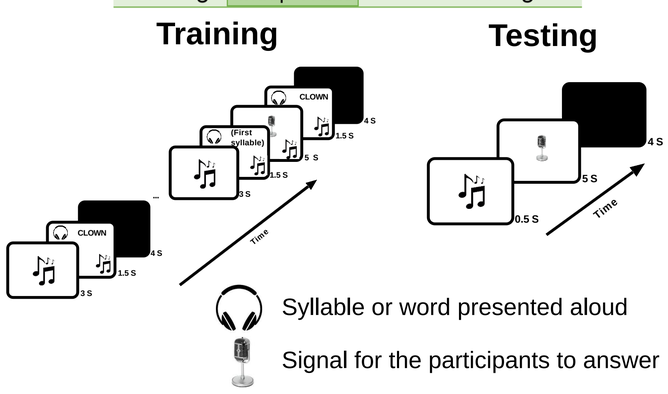
INTRODUCTION

Sleep promotes offline consolidation and enhancement of recent memories[1]. During Non-Rapid Eye Movement sleep (Non-REM), recently acquired memories are reactivated in the hippocampus and transferred and redistributed in the neocortex[1]. This hippocampal-cortical 'dialogue' is mediated by temporal synchronization between cortical slow waves (0.5-4 Hz), thalamic spindles (12-15 Hz), and hippocampal sharp waves and ripples (80 Hz). Furthermore, Non-REM sleep favors memory consolidation, while it has been proposed that REM sleep promotes memory generalization and integration into existing networks[2,3]. To test this, we performed a two-day experiment. Participants were trained at midday (day 1) using a sound-word paradigm and immediately after they were allowed to sleep for 40 min, 90 min or to remain awake. One week later (day 8) they were evaluated.

METHODS

Experimental Protocol

Day 1		Day 8
Training	Sleep/Wake	Testing



Memory Change = nº Correct responses Testing – nº Correct responses Training

Normalized Memory Change = (nº Correct responses Testing – nº Correct responses Training) / nº correct responses Training x 100

Polysomnographic recordings

Sleep was recorded by standard polysomnography including electroencephalographic (EEG), electromyographic (EMG), and electrooculographic (EOG)) recordings with BrainAmp amplifiers (Brain Products). Data were recorded at a sampling rate of 250 Hz.

- **EEG data processing**

Data were bandpass-filtered between 0.16 and 35 Hz. Recordings were scored according to standard criteria[4]

- **Power spectral analysis**

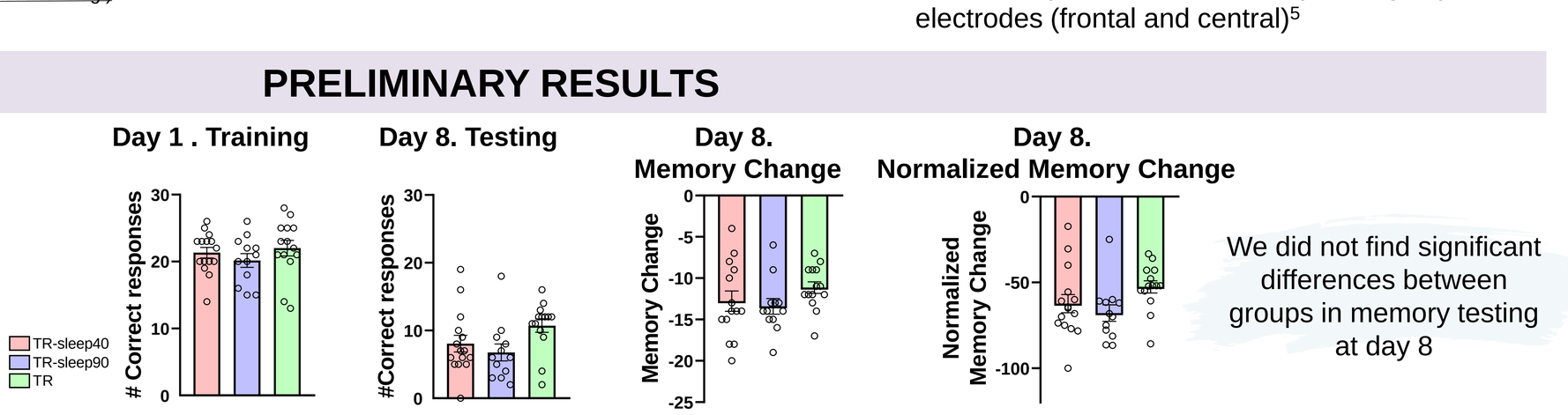
Power density was calculated for Non-REM sleep. Artifact-free Non-REM epochs were divided into consecutive 10 s blocks that overlapped 5 s in time. Each block was tapered by a Hanning window of 50% before applying Fast Fourier Transformation. Individual mean power density was averaged across central electrodes in the following frequency bands: slow oscillations (0.5–1 Hz), delta (1–4 Hz), slow spindle (9–12 Hz), fast spindle (12–15 Hz).

- **Slow Wave detection analysis**

Count and density of slow waves in stage 2, Slow Wave Sleep and non-REM sleep through specific electrodes (frontal and central)[5]

PRELIMINARY RESULTS

Group	Day 1		Day 8
TR-sleep40	Training	Sleep 40 min	Testing
TR-sleep90	Training	Sleep 90 min	Testing
TR	Training		Testing



We did not find significant differences between groups in memory testing at day 8

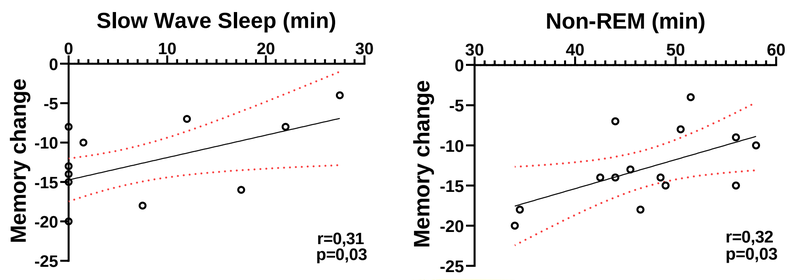
Preliminary sleep analysis

Sleep stage analysis

Sleep stage (min)	TR-sleep40	TR-sleep90
Wake	1,77± 0,92	2,58 ± 1,14
S1	13,10 ± 2,25	16,54 ± 3,07
S2	28,33 ± 2,33	50,00 ± 3,98
SWS	5,77 ± 2,44	11,42 ± 4,13
REM	-	9,58 ± 1,17
Non-REM	47,30 ± 1,82	77,96 ± 3,61

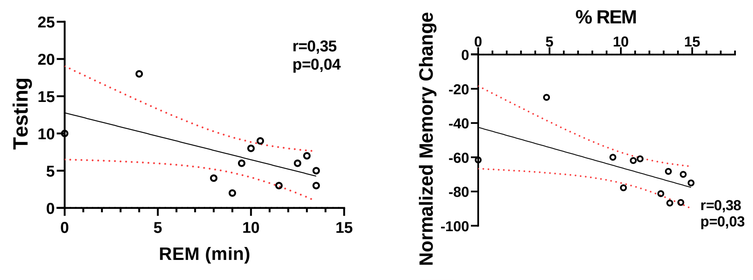
Sleep stage (%)	TR-sleep40	TR-sleep90
Wake	3,55 ± 1,87	3,02 ± 1,34
S1	28,28 ± 4,27	19,18 ± 3,17
S2	58,77 ± 4,29	57,46 ± 4,35
SWS	12,11 ± 4,88	12,14 ± 4,38
REM	-	10,81 ± 1,27
Non-REM	97,81 ± 1,44	86,14 ± 1,49

- **TR-sleep40**



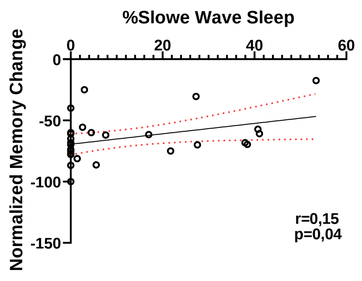
The higher the time in Non-REM sleep and SWS, the smaller the memory decay at day 8.

- **TR-sleep90**



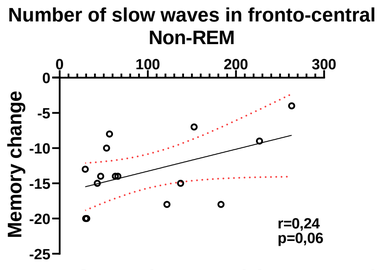
The higher the time in REM sleep, the higher memory decay at day 8.

- **TR-sleep40 and TR-sleep90 groups pooled**



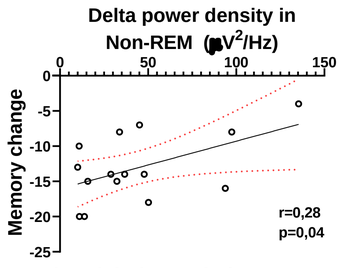
The higher the percentage of SWS, the smaller the memory decay on day 8 for both nap groups pooled.

Slow Wave detection analysis — TR-sleep40

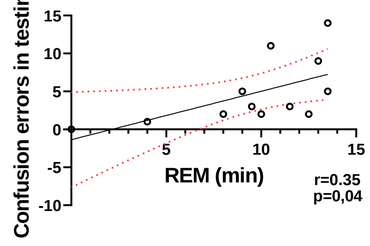


We found a positive trend between the number of slow waves and memory performance on day 8.

Power spectral analysis — TR-sleep40



The higher delta power density in Non-REM sleep, the smaller memory decay on day 8.



The higher the time in REM sleep, the higher the confusion errors in testing on day 8.

CONCLUSIONS

These preliminary findings suggest that Non-REM sleep favors memory consolidation of specific items while REM sleep increases confounding errors with the passage of time evidencing integration and generalization processes that could take place during this sleep stage.

REFERENCES

[1]Rasch B, Born, J. (2013) Physiol Rev, 93(2):681-766.[2]Sterpenich V.et al.,. (2014). Sleep, 37(6), 1061-1075, 1075A-1075B. [3] Payne JD (2014). Sleep, 37(6): 1029–1030. [4]Rechtschaffen A, Kales A. (1968). Brain Information Service, Brain Information Institute, UCLA: Los Angeles, CA, USA. [5]Frederik D. Weber (2013) SpiSOP tool(box) https://www.spisop.org

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