LONG TERM EFFECTS OF PROCEDURAL MEMORY CUEING DURING SLEEP

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INTRODUCTION

- Sleep benefits procedural memory consolidation[1]
- Memory reactivation during sleep is thought to underpin this process[2]
- Targeted memory reactivation (TMR) involves re-presenting learning-associated cues during sleep[3] in order to trigger reactivation
- Although the technique is developing rapidly, only a few studies have examined how the effects of TMR develop over time [4, 5]
- Our prior work has suggested that dominant and nondominant hands benefit differentially from TMR over one night, so we decided to examine this over a longer period

Qs & HYPOTHESIS

How do the TMR effects develop over time?

> Following cue presentation, synapses relevant for the reactivated memory are 'tagged' for plastic changes during subsequent sleep, thus allowing TMRed memories to persist for longer than non-TMRed ones[4]

Does TMR of a procedural task affect both hands equally?

> Weaker memory representations, with lots of room for improvement, are more responsive to TMR than strongly-remembered ones [6,7]

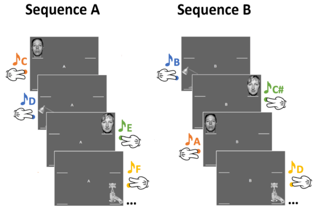
METHODS

23 RIGHT-HANDED HEALTHY PARTICIPANTS

WITHIN-SUBJECTS DESIGN

SERIAL REACTION TIME TASK

Sequence A Sequence B



TMR IN SWS & N2

sequence counterbalanced

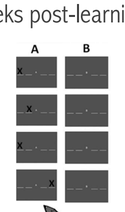
PERFORMANCE TESTED

- S1: pre-sleep (=learning)

------------ S L E E E P ------------

- S2: 24h post-learning
- S3: 10 days post-learning
- S4: 6 weeks post-learning*

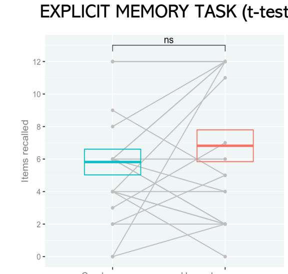
*EXPLICIT MEMORY TASK (S4)



RAW DATA

ANALYSIS & RESULTS

EXPLICIT MEMORY TASK (t-test)



> No effect of TMR on seq explicit knowledge 6 weeks post-encoding

SRTT (LME analysis)

Dependent variable?

> Late sequence-specific skill (late SSS) = mean (random blocks) – mean (last 4 blocks)

Why LME analysis?

> To account for the non-independence of multiple responses collected over time

> To avoid listwise deletion due to dropout on S4

LME model for S2-4? > lmer(SSS ~ Session + TMR + (1|Participant))

How the p-values were obtained?

> Likelihood ratio tests (LRT) between the full model and the model without the effect of interest

Post-hoc comparisons? > Tukey adjusted

Likelihood ratio tests results

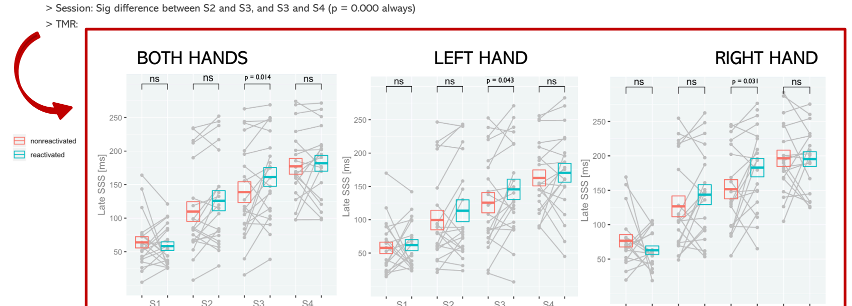
> Sig effect for session (p = 0.000 for both hands, left hand and right hand)

> Sig effect of TMR (both hands: p = 0.006; left hand: p = 0.013; right hand: p = 0.033)

Post-hoc comparisons

> Session: Sig difference between S2 and S3, and S3 and S4 (p = 0.000 always)

> TMR:



> Participants continued to improve over time

> Sequence specific skill was greater for the cued than un-cued sequence 10 days after encoding

RESULTS

Dependent variable? > Late SSS on cued sequence – late SSS on uncued sequence

LME model for S2-4? > lmer(CuedUncued ~ Session + (1|Participant))

Likelihood ratio tests results

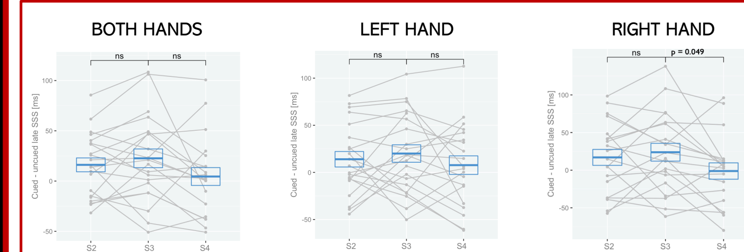
Effect for session:

> both hands p= 0.093

> left hand p = 0.432

> right hand p = 0.061

Post-hoc comparisons



DISCUSSION

- We observed no effect of TMR on the day after stimulation. This may be because S2 was scheduled in the evening rather than in the morning immediately after sleep, as in prior studies.
- We then found a significant effect of TMR on both left and right hand, 10 days after stimulation, suggesting that TMR starts a process which unfolds for several days after stimulation.
- Interestingly, the TMR effect had disappeared 5 weeks later.
- This observation, together with a marginally significant reduction in the right hand TMR effect between S3 & S4, suggests that TMR related plasticity does not last beyond 6 weeks.
- The absence of any TMR benefit to explicit knowledge at 6 weeks is in keeping with the idea that all TMR benefits fade by this time.

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