Decomposition of EEG reveals a diversity of beta-band responses to a single pulse of TMS

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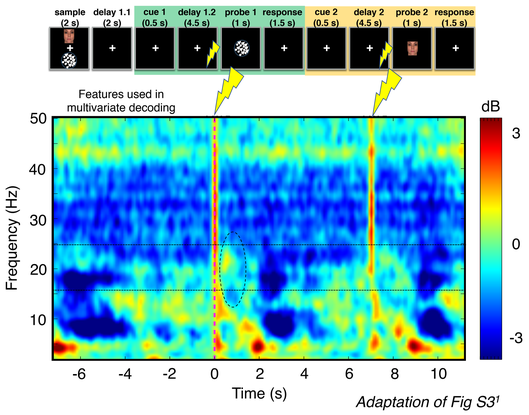
CNS 2020 #A42

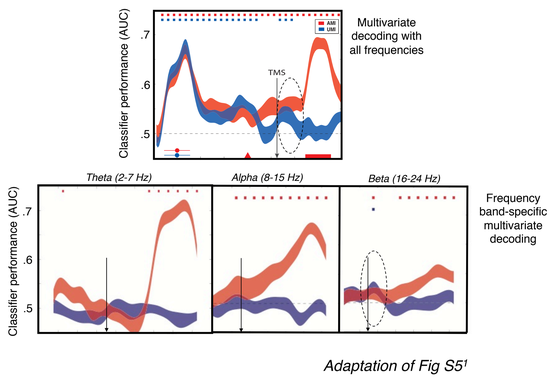
Background

Single-pulse TMS briefly reinstates multivariate decodability of an unprioritized memory item (UMI) from concurrently measured EEG, localized to the beta-frequency band[1].



Adaptation of Fig S3[1]

What are the physiological bases of TMS "reactivation" effects?



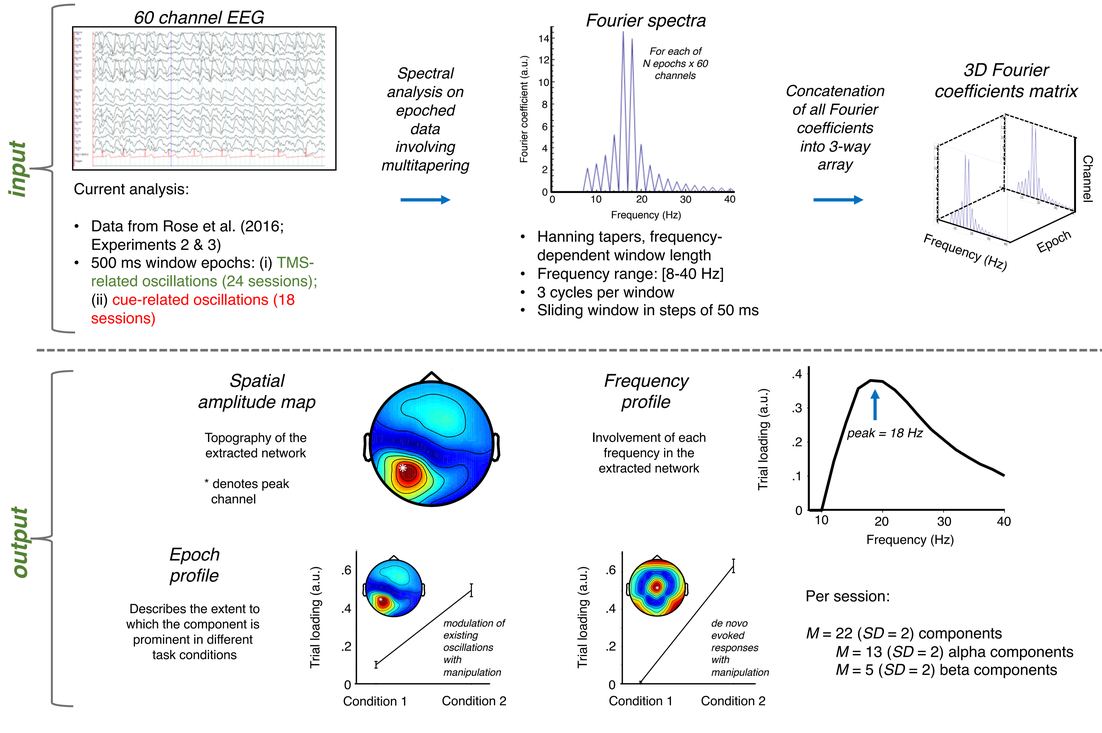
Adaptation of Fig S5[1]

Approach: SPACE-FSP

Spatially-distributed PhAse Coupling Extraction with a Frequency-Specific Phases model[2-3]

Advantages of SPACE:

- A signal decomposition application of parallel factor analysis that extracts phase-coupled oscillatory networks
- Identifies neurobiologically plausible rhythms
- Not a source localization method; separates and characterizes signal at the scalp level attributable to discrete coupled oscillators
- Is not subject to non-physiological statistical constraints (e.g., orthogonality, maximum variance, statistical independence).
- Provides the strength of the component on each trial ("trial loadings") for analysis of task modulations

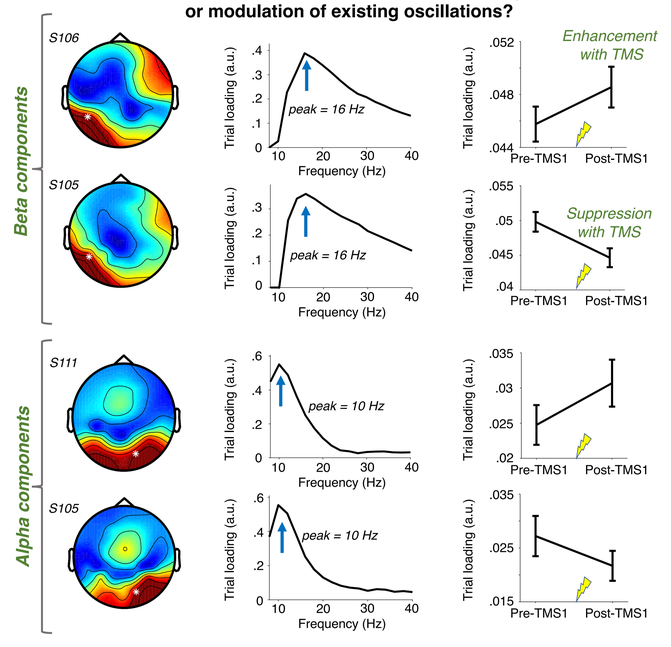


Per session:

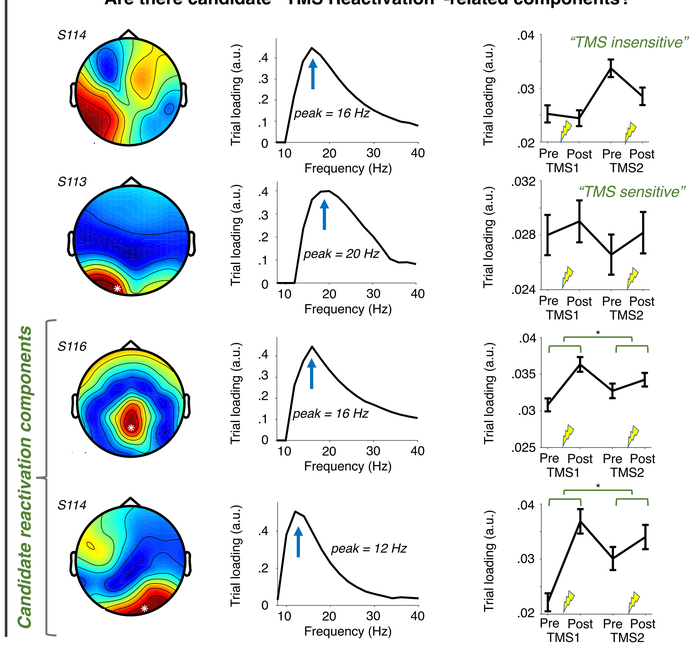
M = 22 (*SD* = 2) components
M = 13 (*SD* = 2) alpha components
M = 5 (*SD* = 2) beta components

TMS-related components

Do TMS effects arise from *de novo* evoked responses or modulation of existing oscillations?

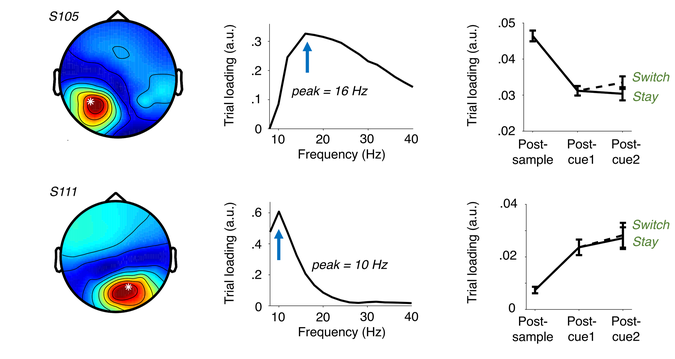


Are there candidate "TMS Reactivation"-related components?

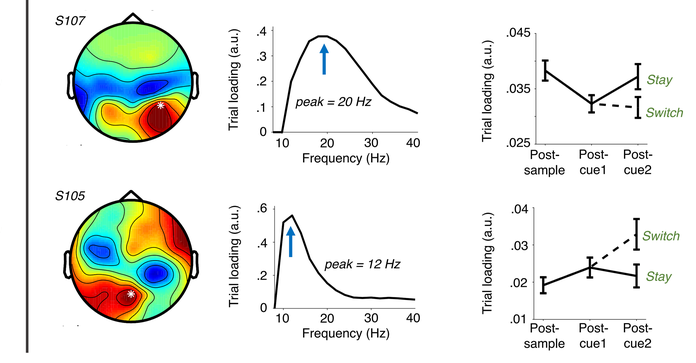


Cue-related components

Are there candidate components related to cue 1 prioritization operations?



Are there candidate components related to cue 2 stay/switch operations?



Conclusion

- SPACE decomposition of EEG data reveals a diverse array of responses to single-pulse TMS and retrocues during a dual-serial retrocue working memory task.
- These results are consistent with the idea that dynamics in the beta band accompany transitions between activation states in working memory and support the ability of TMS to reactivate UMIs through diverse responses in those dynamics.
- These results comprise a promising first step towards understanding the neurophysiology underlying previously-reported findings using multivariate approaches.

References and acknowledgment

[1]Rose, N., J.J. LaRocque, A.C. Riggall, O. Gosseries, M.J. Starrett, E. Meyering, and B.R. Postle. (2016). Reactivation of latent working memories with transcranial magnetic stimulation. *Science*, **354**: p. 1136-1139

[2]van der Meij, R., Jacobs, J., & Maris, E. (2015). Uncovering phase-coupled oscillatory networks in electrophysiological data. *Human Brain Mapping*, **36**: p. 2655-2680

[3]van der Meij, R., F. van Ede, and E. Maris. (2016). Rhythmic components in extracranial brain signals reveal multifaceted task modulation of overlapping neuronal activity. *PLoS ONE*, **11**: p. e0154881

Supported by MH095984 to B.R.P.

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