NORTHWESTERN UNIVERSITY FEINBERG SCHOOL OF MEDICINE

Cerebellar theta and beta noninvasive stimulation rhythms differentially influence episodic memory versus linguistic prediction

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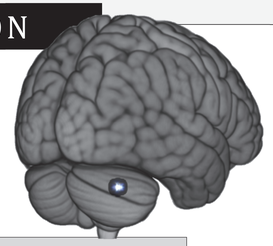
INTRODUCTION



- Complex cognitive function is supported by coordinated neural activity across large-scale brain networks. Several association cortex networks interface with the **right lateral cerebellum.**[1]

Question: how does the right lateral cerebellum engage with distinct networks to accomplish different cognitive functions?

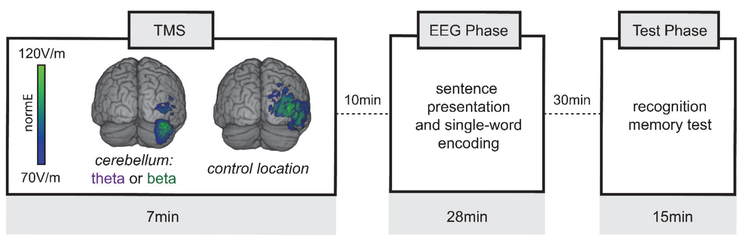
HYPOTHESIS

- **Cerebellar contributions to cognition are guided by neural oscillations with function-specific frequency bands.**
- Cognitive networks have preferred endogenous rhythms, e.g.:
  - The episodic memory network shows increased **theta (3-8Hz)** synchrony during encoding. [2]
  - Linguistic prediction during reading tasks has been linked to increased **beta (13-30 Hz)** power across the language network. [3]

Test: can we bias cerebellar participation in episodic memory versus linguistic prediction by noninvasively stimulating with **theta versus beta rhythmic TMS**?

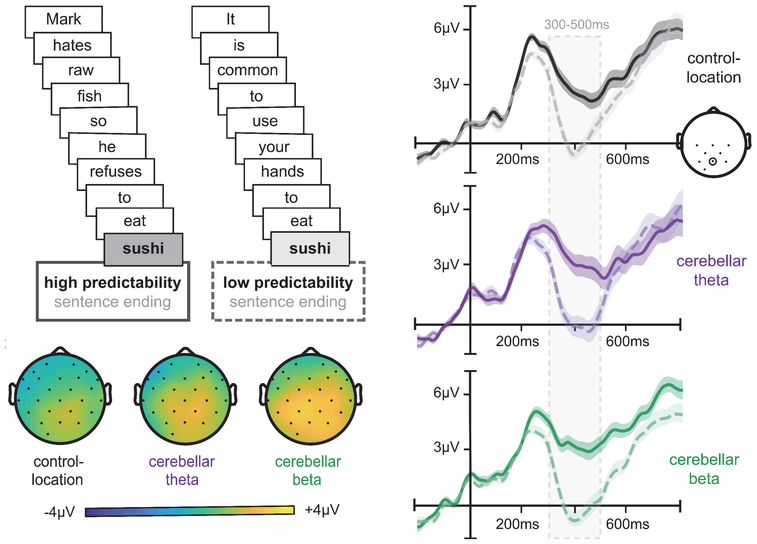
STUDY DESIGN

- Across 3 sessions, 24 subjects received each of 3 TMS conditions : cerebellar theta, cerebellar beta, or occipital control-location stimulation (theta or beta) (illustrated via the induced electrical field (normE)).
- Following stimulation, subjects performed a mixed sentence reading and single-word encoding task while EEG was recorded. After a delay, we tested recognition memory for words studied during the EEG phase.

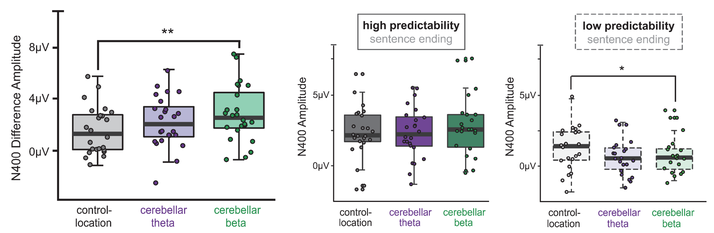


STIMULATION FREQUENCY EFFECTS ON LINGUISTIC PREDICTION

- Subjects read sentences ending with high or low predictability words. ERP activity to these endings showed typical N400 effects of linguistic predictability were elicited across all stimulation conditions.



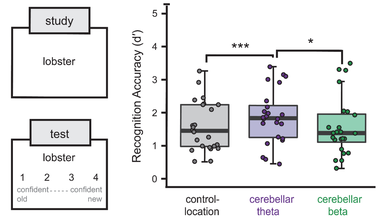
- N400 amplitudes over centro-posterior electrodes increased following cerebellar beta TMS relative to the control condition. Beta TMS weakly increased N400 amplitude to predictable words and significantly decreased N400 activity to less predictable words.

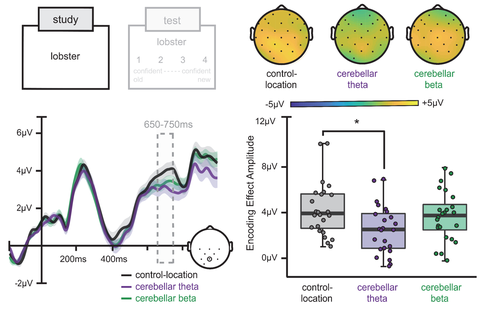


Contextual predictability more strongly influenced word processing following language network-preferred beta rhythmic TMS

STIMULATION FREQUENCY EFFECTS ON MEMORY ENCODING

- The cerebellar theta TMS encoding condition led to better performance (d') for the subsequent memory test versus both other stimulation conditions

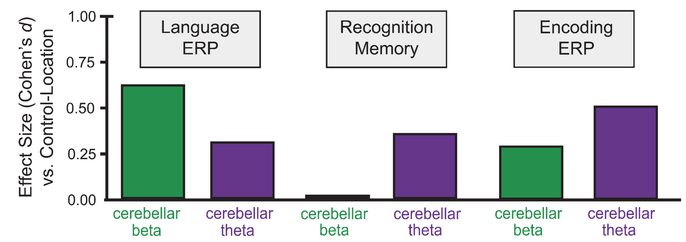




- Subjects showed typical late parietal positive ERPs linked to successful encoding. Late parietal ERPs were reduced following cerebellar theta TMS relative to the control condition.

Neural and behavioral correlates of memory encoding were influenced by episodic memory network-preferred theta rhythmic TMS

DISCUSSION



- Beta vs. theta cerebellar TMS had opposite effects on linguistic prediction and episodic memory, supporting a double dissociation of cognitive function by TMS frequency. These findings provide evidence that **cerebellar involvement in network functions may be guided by function-specific frequency bands.**

Citations: 1. Buckner et al., 2011, *J. Neurophysiology.* | 2. Lega, Jacobs, & Kahana, 2012. *Hippocampus.* 3. Engle, Fries, & Singer, 2001. *Nat. Rev. Neuroscience.*

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