

The Functional Relevance of Left Frontal and Temporal Cortex for Semantic Processing: A Condition-and-Perturb TMS-EEG study

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1. Introduction

- **Speech comprehension** is a complex process that unfolds rapidly over time. The context of a given sentence helps to generate specific **predictions** about upcoming input. At the neurophysiological level, the **N400** is an index of fulfilled semantic predictions, with words that follow a low predictive relative to a high predictive context eliciting a larger N400.
- **Krocze et al. (2019)** combined TMS and EEG in a simultaneous fashion to probe the functional relevance of left posterior inferior frontal gyrus (pIFG) and left posterior temporal gyrus (pSTG) in sentence comprehension. That study **did not provide clear results**, suggesting that other areas of the semantic network, in particular the **angular gyrus (AG)**, may have **compensated** for the TMS induced disruption.
- We used a **condition-and-perturb** TMS-EEG approach to probe the contribution of the left pIFG and pSTG after activity in the left AG was temporarily inhibited using continuous theta-burst stimulation (cTBS). We expected that **combined disruption** of two semantic key regions should significantly disrupt sentence comprehension.

3. Methods

Participants

- Healthy, native German speakers (N=24)

Stimuli

- Participants *listened* to short sentences that varied in their predictability of the final sentence noun.

Experimental task

- Lexical decision (word vs pseudoword) on the final sentence word.

High predictability

Er trinkt das Bier / Gorl
 He drinks the beer / Gorl

Low predictability

Er sieht das Bier / Gorl
 He sees the beer / Gorl

Transcranial magnetic stimulation (TMS)

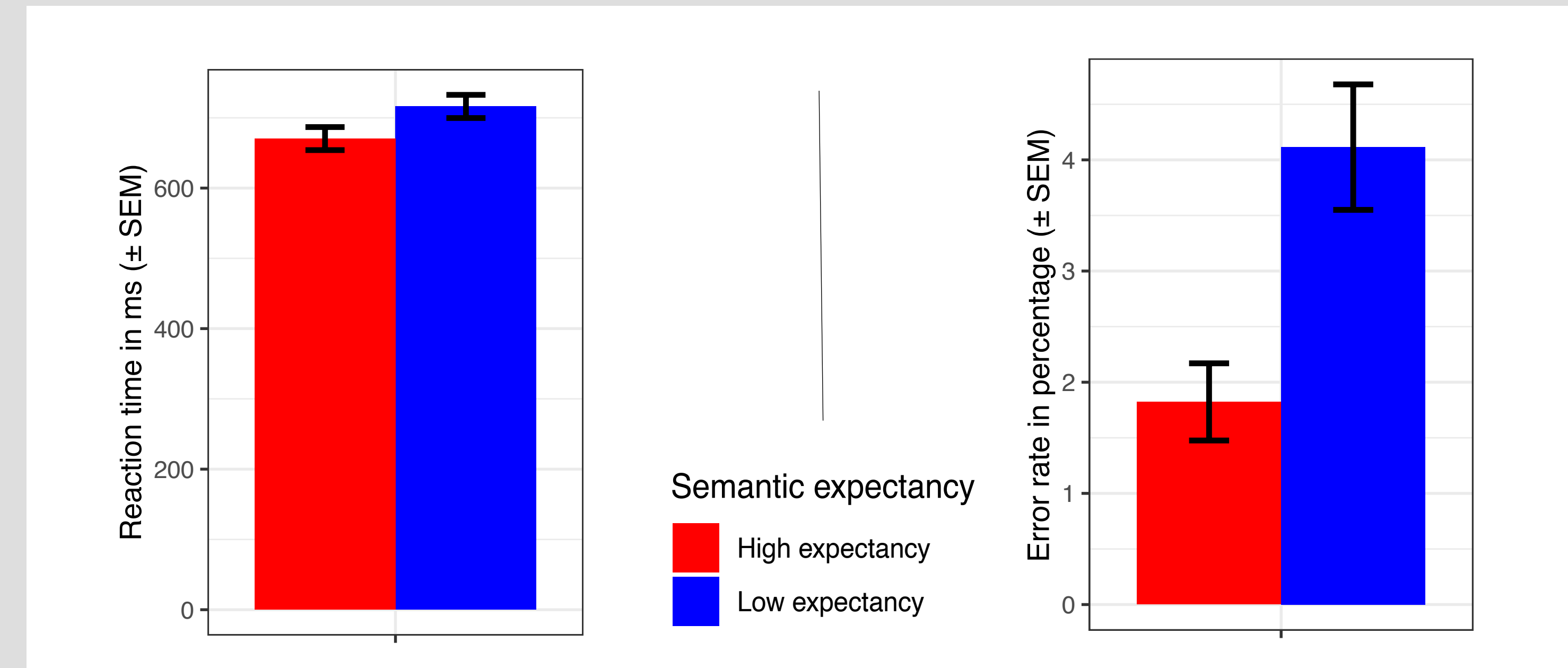
- 40s of cTBS at left AG (offline TMS).
- 3 pulses of 10 Hz effective or sham TMS with verb onset over either pIFG, pSTG or vertex (online TMS).

Electroencephalography (EEG)

- EEG data were recorded from 64 electrodes and sampled at 2000 Hz.
- We were interested in two time-windows: one time-locked to the noun (-0.2 to 1.0 s); another time-locked the verb (-0.25 to 1.0 s).

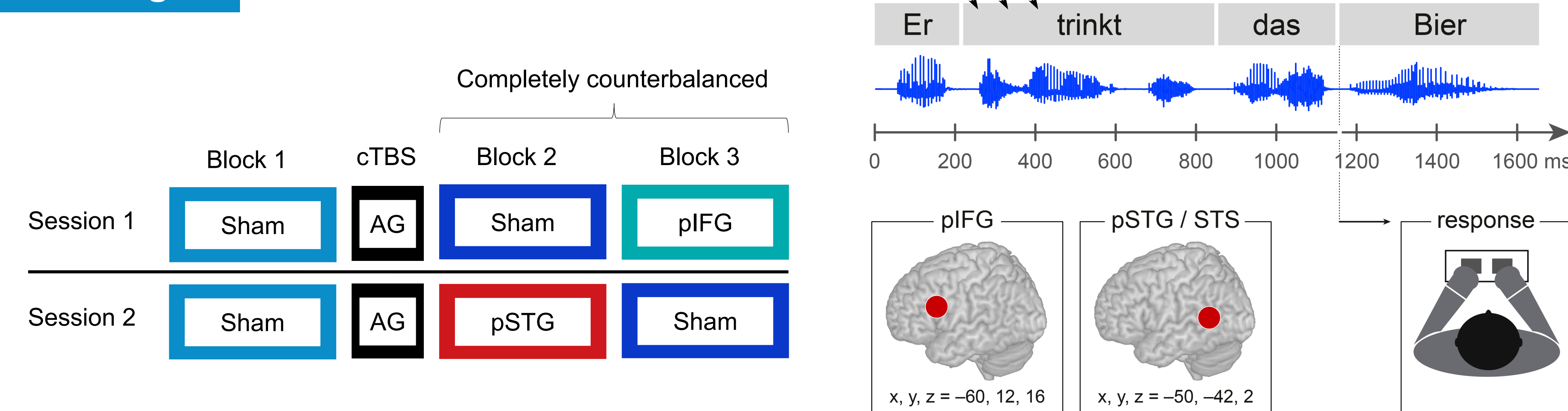
Here we focus on the results of pSTG TMS.

4. Behavioural results



- Behavioural effects of online pSTG and sham TMS after AG cTBS. Responses are averaged across stimulation conditions, as *there was no interaction with stimulation site*.

2. Design



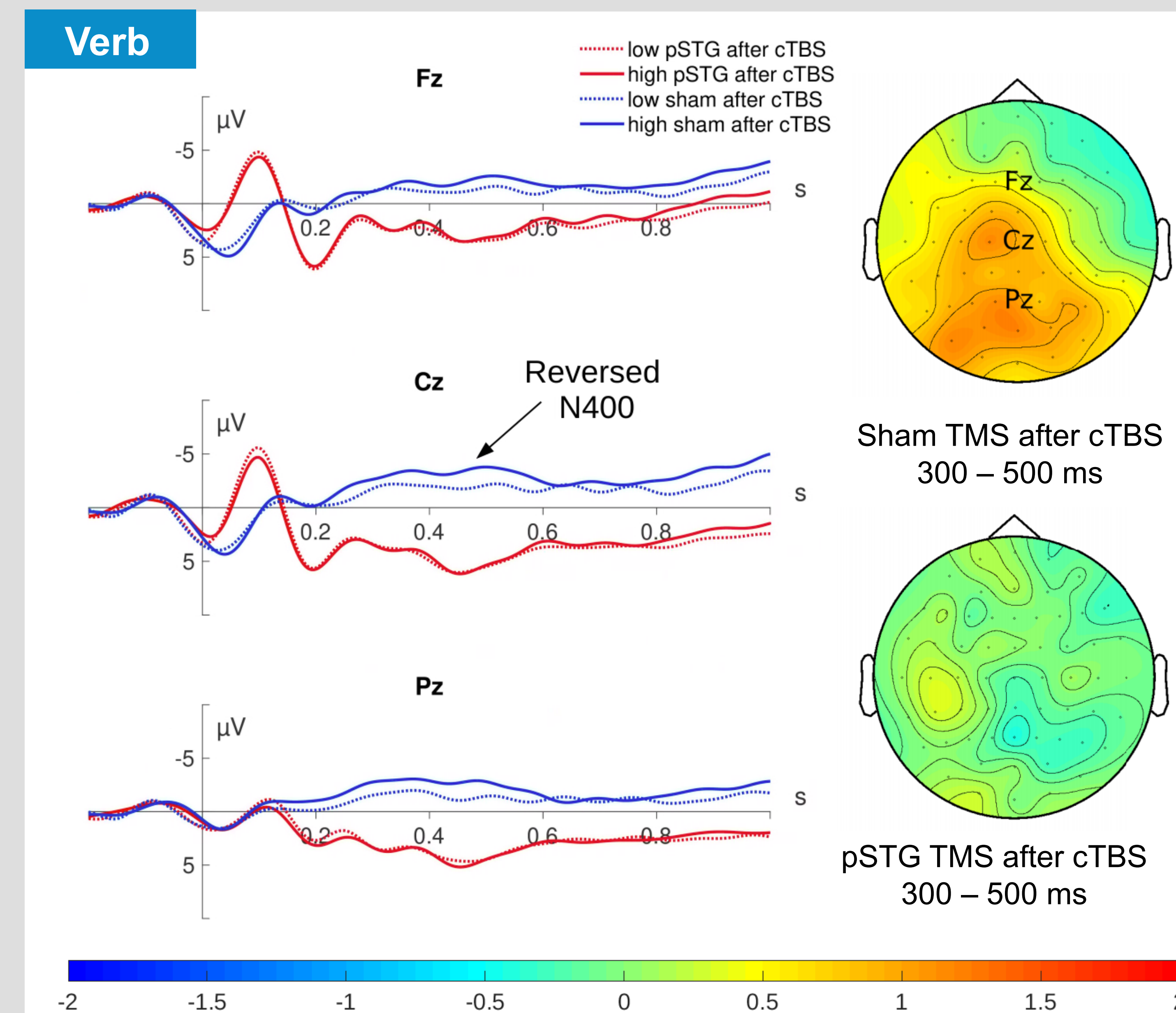
6. Discussion

- The effect of TMS over left pSTG outlasted the stimulation duration at the verb and affected processing of highly predictable nouns.
- Conditioning AG with cTBS caused a dysfunction in this area, which increased the functional relevance of the left pSTG for semantic processing at the sentence level.
- Despite effects on the N400, however, TMS did not influence behavioural measures. This apparent discrepancy might be explained by the implicit and automatic nature of the lexical decision task.
- The effect of pIFG TMS is currently still under examination.

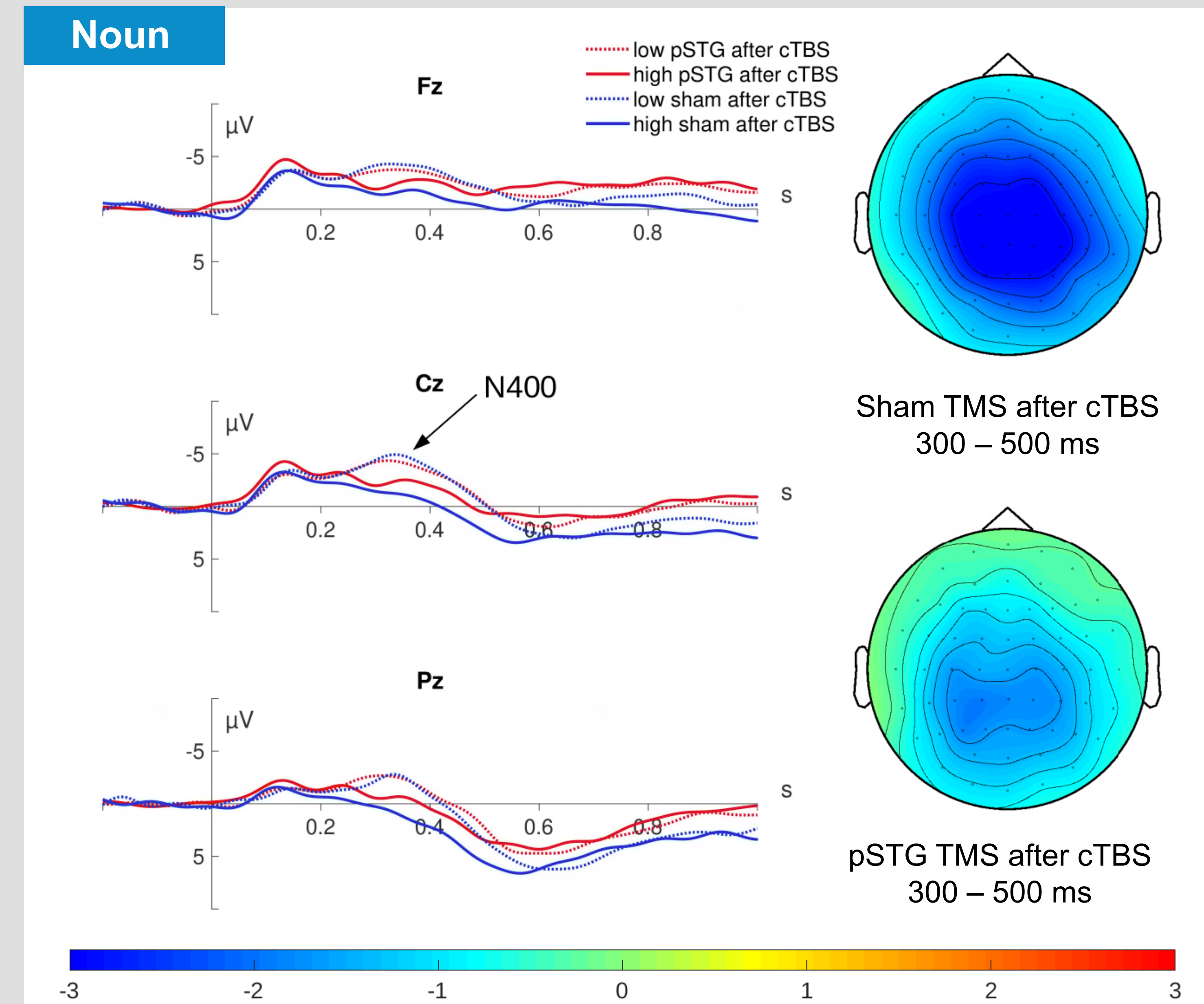
7. References

- Krocze, L. O., Gunter, T. C., Rysop, A. U., Friederici, A. D., & Hartwigsen, G. (2019). Contributions of left frontal and temporal cortex to sentence comprehension: Evidence from simultaneous TMS-EEG. *Cortex*, 115, 86-98.
- Maess, B., Mamashi, F., Obleser, J., Helle, L., & Friederici, A. D. (2016). Prediction Signatures in the Brain: Semantic Pre-Activation during Language Comprehension. *Front Hum Neurosci*, 10, 591.

5. Preliminary EEG results of pSTG TMS



- Previous work showed that highly predictive verbs are accompanied by a higher (i.e., more negative) N400 amplitude compared to low predictive verbs (Maess et al., 2016). Our results show that TMS over pSTG (after AG cTBS) interacted with these predictive processes and did not show this reversed N400 effect.



- Our findings show that TMS over pSTG (after AG cTBS) significantly interacted with the processing of the final sentence noun, potentially by selectively modulating the conditions with higher predictability (i.e., the N400 amplitude in the highly predictive condition seemed to become more similar to the low predictive condition).