

Introduction

- EEG and MEG index the time-course of neural activity associated with incoming stimuli.
- ERPs/ERFs: differences in the engaged neurocognitive processes evoked by different stimuli.
 - e.g. the reduced N400 ERP/ERF to plausible versus anomalous words reflects easier semantic retrieval/access [1]
- Representational Similarity Analysis (RSA): differences in the underlying representations associated with different stimuli.
 - e.g. animate versus inanimate [2]
- However, representation and process are tightly linked [3]
- We directly compared ERPs/ERFs and spatial similarity patterns in an EEG and MEG dataset of two studies.

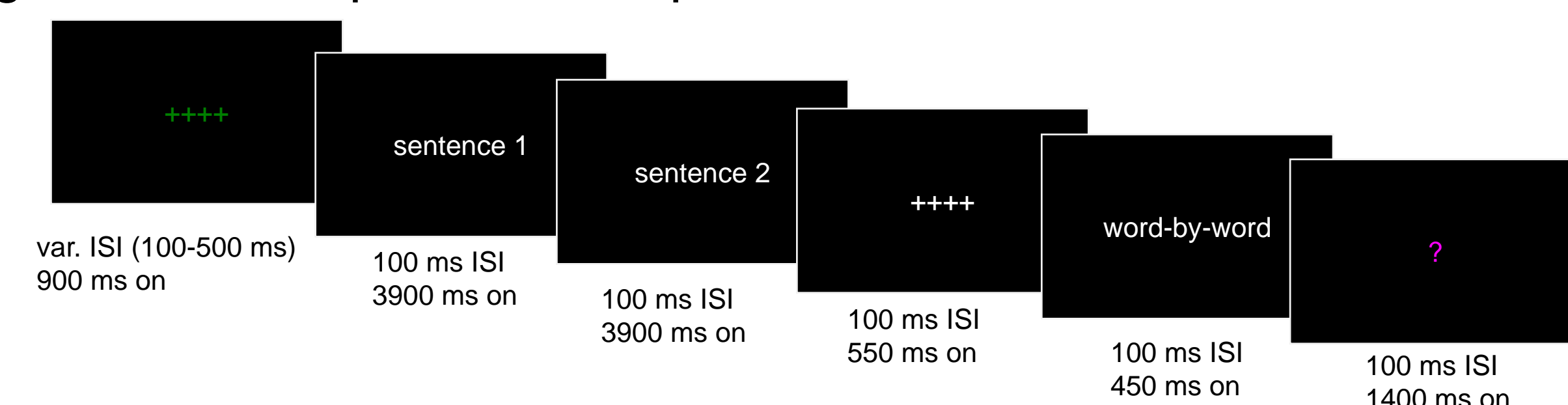
Methods

- Study 1: MEG and EEG; 32 native English speakers (16 females)
- Study 2: EEG only; 40 native English speakers (19 females)
- The two studies had the same experimental design and overlapping sets of stimuli.
- Experimental design: 2 plausibility (plausible, anomalous) X 2 animacy (animate, inanimate) of nouns in discourse context
 - Three-sentence discourse
 - A fixed structure in the third sentence: an adjunct phrase + a subject + a verb + a determiner + a direct object noun + three additional words
 - ... *cautioned the trainees / drawers*
 - ... *unfolded the trainees / drawers*

• Number of discourses: 200 in Study 1, 160 in Study 2.

• Procedure: word-by-word visual presentation of the third sentence (450ms + 100ms).

Fig 1. Sentence presentation procedure.



• Task: Plausibility judgement of the whole discourse

• Recordings:

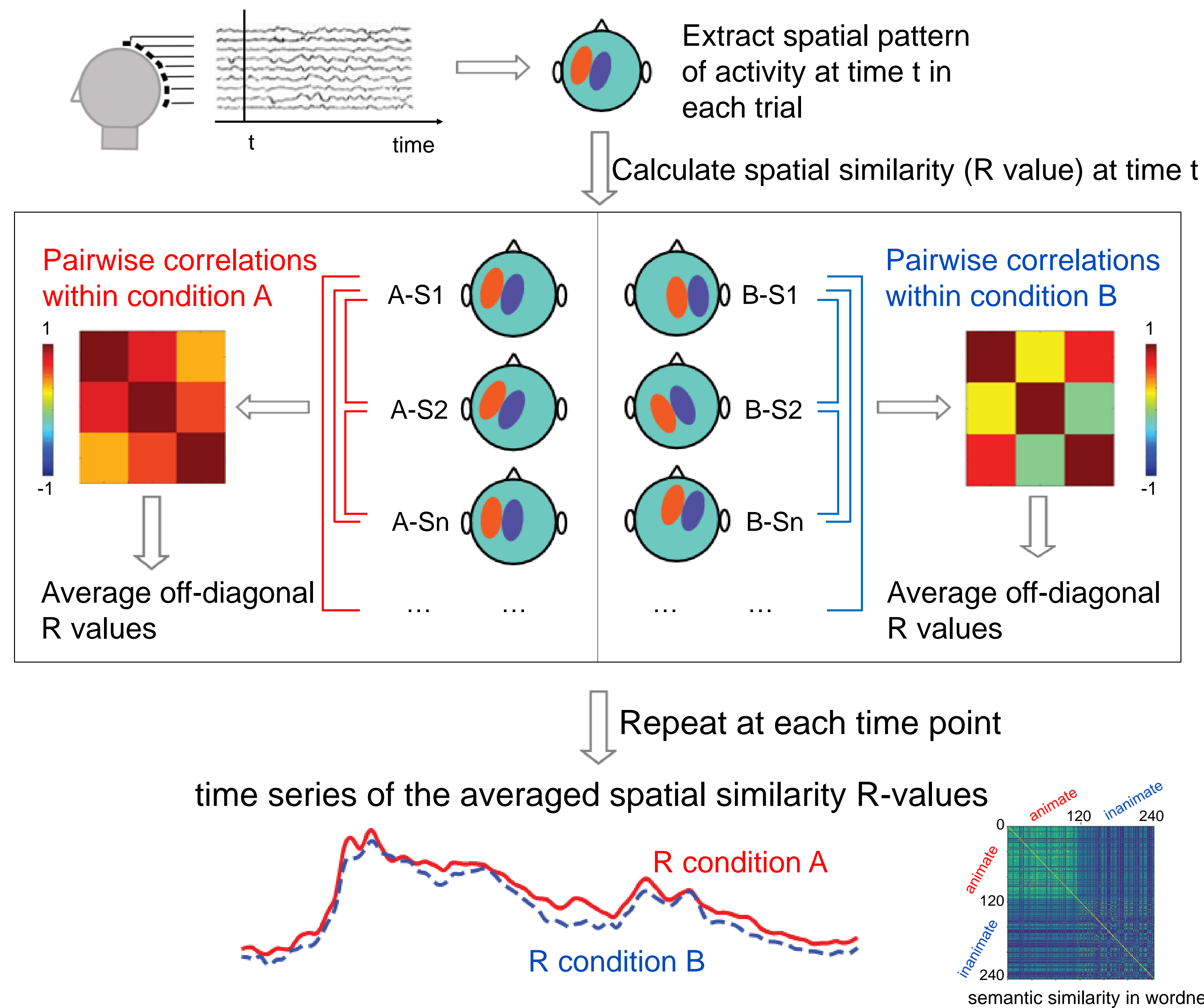
- Study 1: MEG (Elekta-Neuromag, 306 sensors) and EEG (BrainProducts, 72 channels) signals were simultaneously recorded.
- Study 2: EEG (Biosemi Active, 32 channels)

• Epochs: time-locked to the onset of nouns (-100ms – 1000ms).

- Combined EEG dataset: 72 participants, 40 trials per condition
- MEG dataset: 32 participants, 42 trials per condition

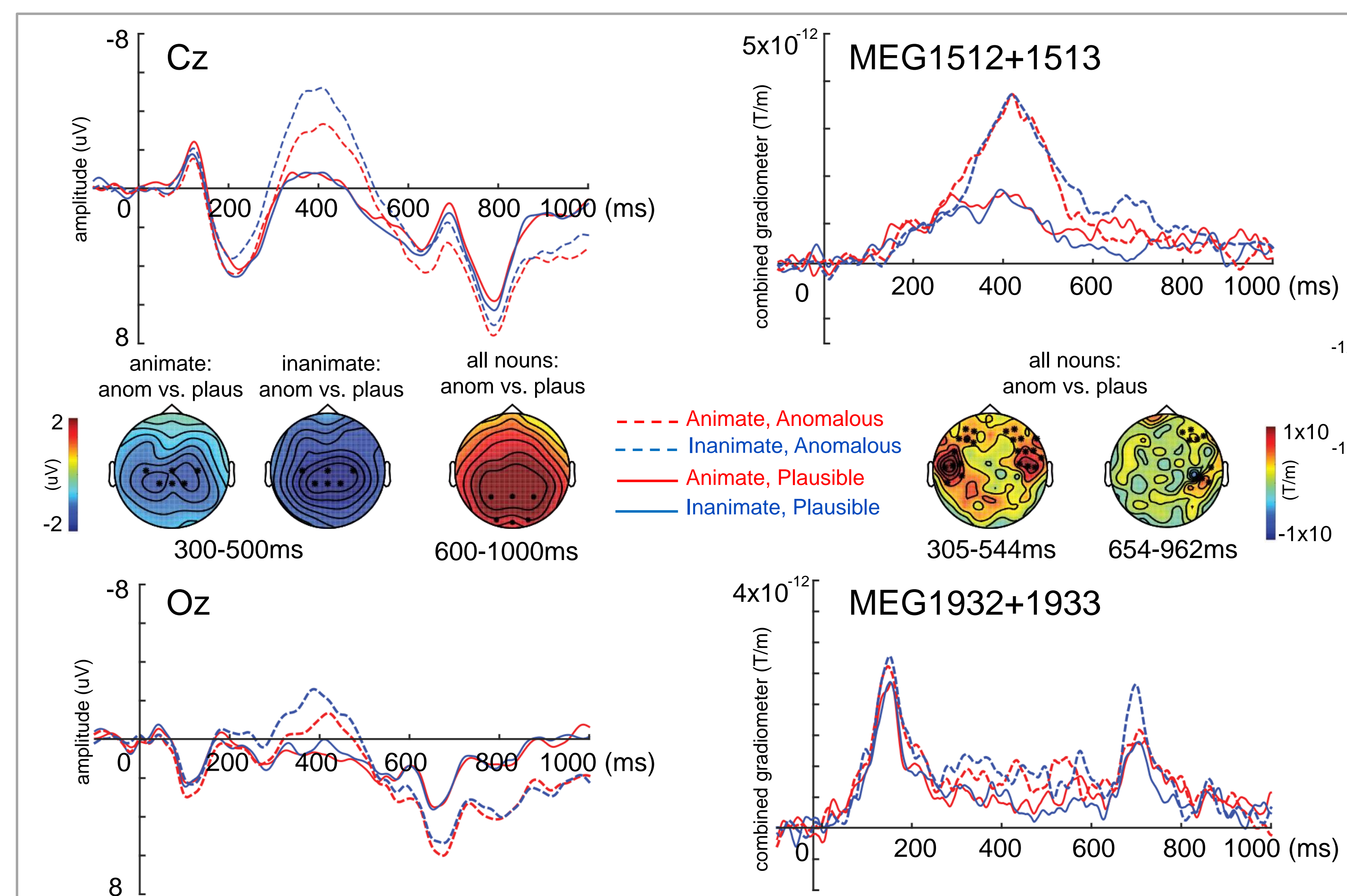
Spatial Similarity Analysis

Fig 2. Illustration of spatial similarity analysis.



Results: ERPs/ERFs

Fig 4. ERPs (left) and ERFs (right) at two representative channels.



• Statistical analysis

- Spatial similarity of EEG and MEG data and ERFs: cluster-based permutation test (1000 permutations) across the 0 – 1000ms time window
- ERPs: 300-500ms; 600-1000ms

Acknowledgment: This work was funded by the NICHD (R01 HD08252) to G.R.K.

Results: Spatial similarity

Fig 3. Spatial similarity results of EEG (left) and MEG (right) data.

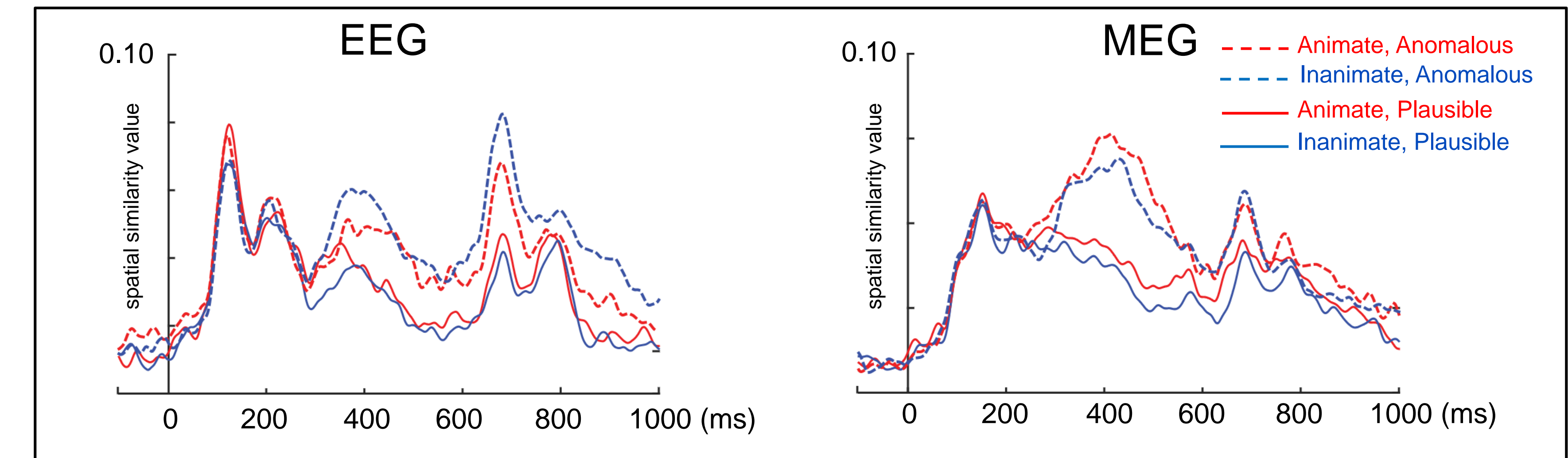
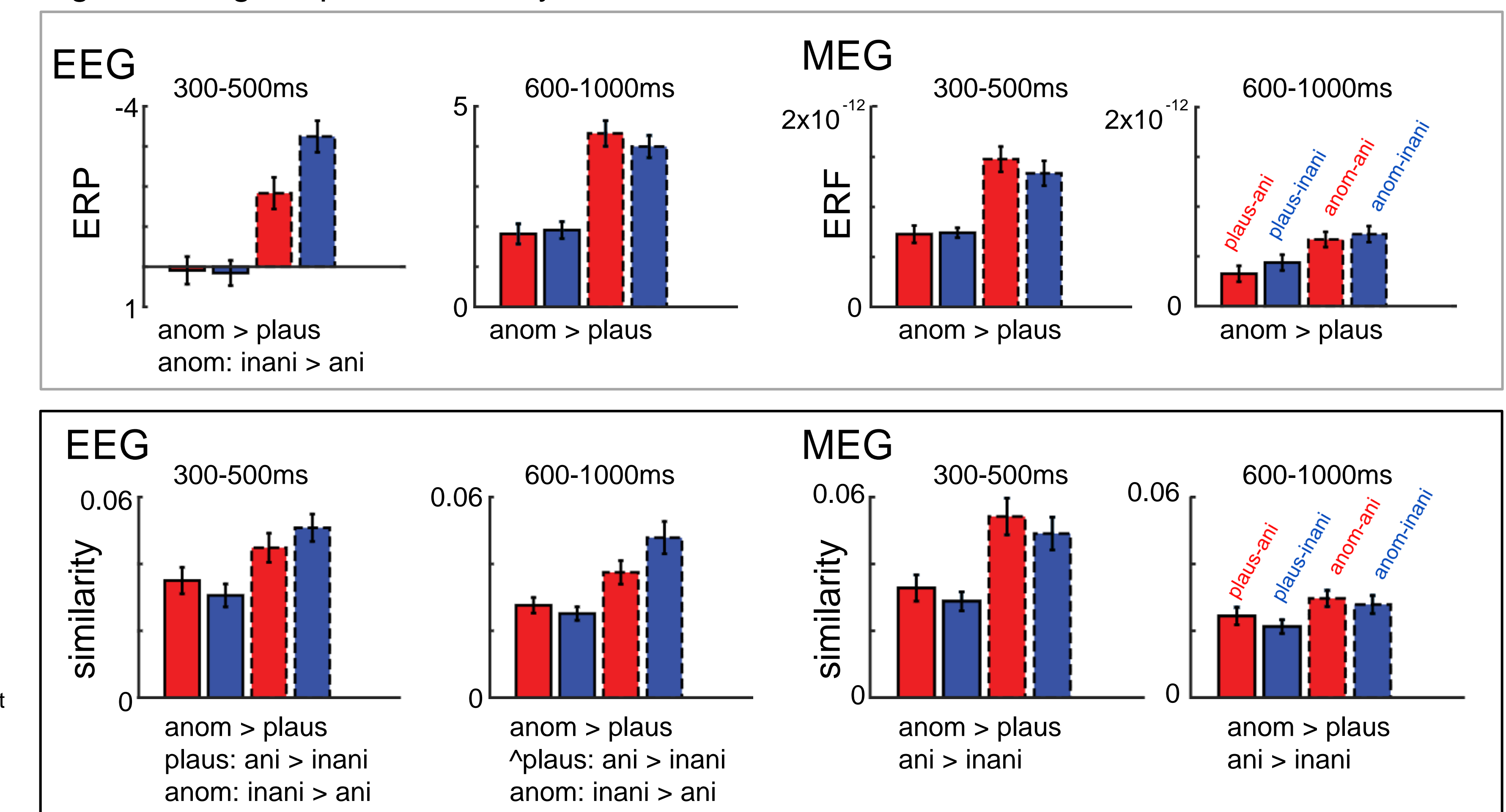


Fig 5. Averaged spatial similarity and ERPs/ERFs of different conditions.



Discussion

- Convergence between spatial similarity and evoked responses
 - Overall increases and decreases of spatial similarity values: broadly patterned with the timing of the peaks of evoked components.
 - Whenever there was a difference in evoked responses (e.g. anomalous > plausible), the spatial similarity showed the same effect.
 - It is important to directly evaluate the influence of the magnitude of neural activity (e.g. evoked responses) to the similarity results.
- Spatial similarity can capture differences in representation even when there were no ERP/ERF differences across conditions
 - Equally small ERPs/ERFs to plausible animate and inanimate nouns within 300-500ms, but larger similarity values to plausible animate than inanimate nouns: greater semantic similarity among animate than inanimate nouns [4].
 - Equally large ERPs to anomalous animate and inanimate nouns within 600-1000ms, but larger similarity values to anomalous inanimate than animate nouns: greater semantic similarity associated with the re-activation of the predicted animate versus inanimate nouns.

References

[1] Kutas M. & Federmeier K. (2011). Annual review of psychology, 62: 621-647.
 [2] Cichy R., Dimitrios P., Aude O. (2014). Nature Neuroscience, 17(3), 455-462.
 [3] Anderson J.R. (1978) Psychological Review 85:249–277.
 [4] Wang L., Wlotko E., Alexander E.J., Schoot L., Kim M., Warnke L., Kuperberg G. (2019). bioRxiv.