

# Functional communication within a perceptual network processing familiar and unfamiliar visual objects

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"To the uneducated, the letter 'A' is just three sticks."  
 (Eeyore in Pooh's little instruction book, Milne 1995)

## Background

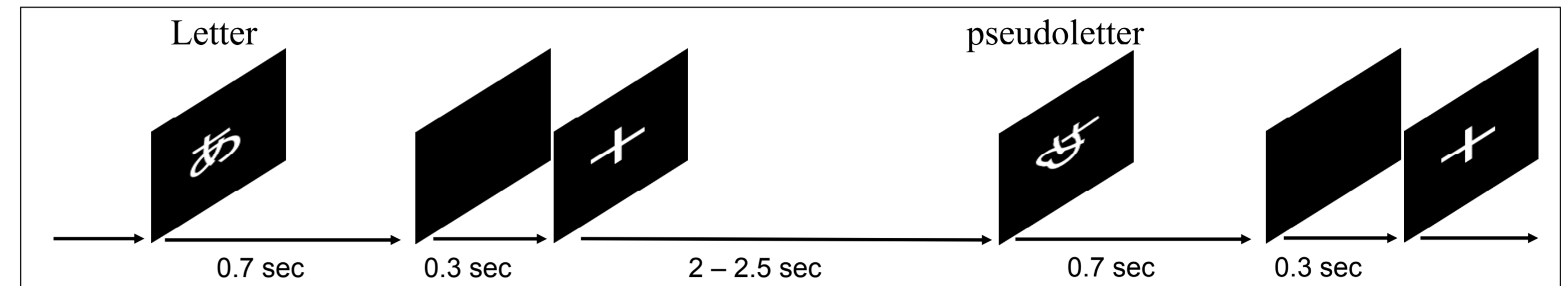
- Many studies have identified regions within human ventral visual stream to be important for object identification and categorization; however, knowledge of how perceptual information is communicated within the visual network is still limited.
- Current theories posit that if a high correspondence between incoming sensory information and internal representations exists then the object is rapidly identified, if there isn't then the object requires extra detailed processing.

## Methods

### Stimuli :

**Letter** – Hiragana symbols for vowel sounds /a/, /o/, /u/, and /i/

**Pseudoletter** – made from the letter stimuli by segmenting and mixing up different line forms



**Participants:** Nine native Japanese young adults with normal visual and cognitive status.

**Procedure:** MEG was recorded while participants identified by button press if a stimulus was a letter or pseudoletter. They were asked to withhold their button press until a cross-hair appeared after stimulus offset. Accuracy was greater than 95%.

### Event-Related Responses Analyses:

- Global field power (GFP), event-related field (ERFs) and event-related beamformer (ERB) analyses were performed on artefact free trials.
- Peak amplitudes and latencies across letters and pseudoletters for the P1m (maximal peak between 60-120 ms), N170m (maximal peak between 120-190ms), and P2m (maximal peak between 190-250 ms) were measured from GFP, ERF and ERB waveforms. ANOVAs were performed to determine significant differences amongst stimulus conditions and hemispheres.

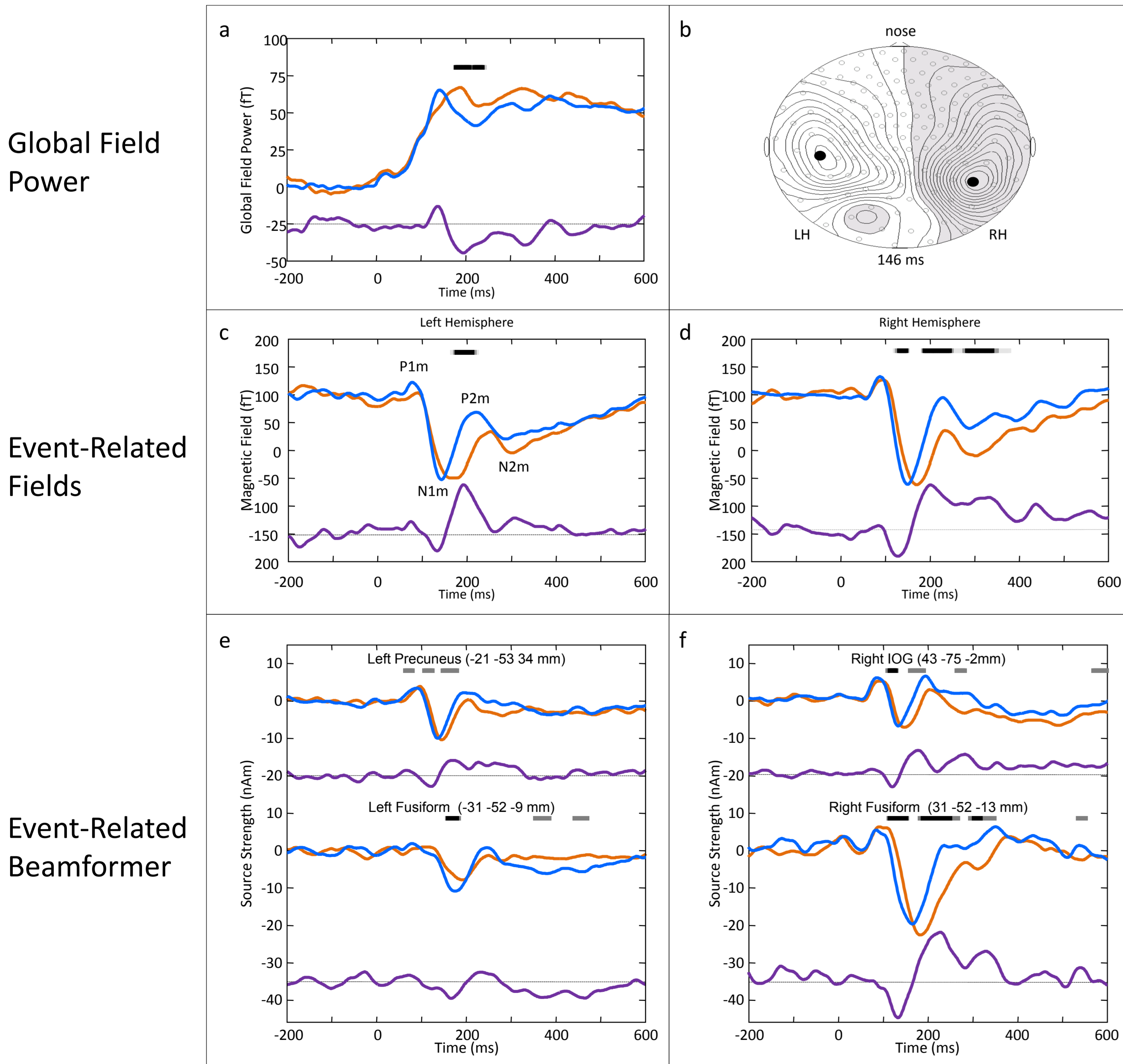
### Time-Frequency Response Analyses:

- Induced power changes relative to a 250-ms prestimulus interval were calculated on the virtual channel data for each participant by: 1) band-pass filtering the data using FIR filters with 50 log-spaced centre frequencies from 4 to 150 Hz and bandwidths of  $\pm 0.035 \times \text{centre frequency}$ ; 2) applying a Hilbert transformation; and 3) extracting the amplitude envelope of the Hilbert transformed data.
- Phase-Locking Values (PLVs) were also calculated for the 91 possible pair combinations of the 14 virtual channels for all trials  $n=[1, \dots, N]$  and centre frequencies  $f=[4, \dots, 150]$  across participants using the formula presented by Lachaux and colleagues (Lachaux et al., 1999). Induced changes in phase locking were considered significant if the PLV significantly exceeded bootstrapped surrogated PLV data determined by randomly mixing the trial order between channels before calculating a PLV.

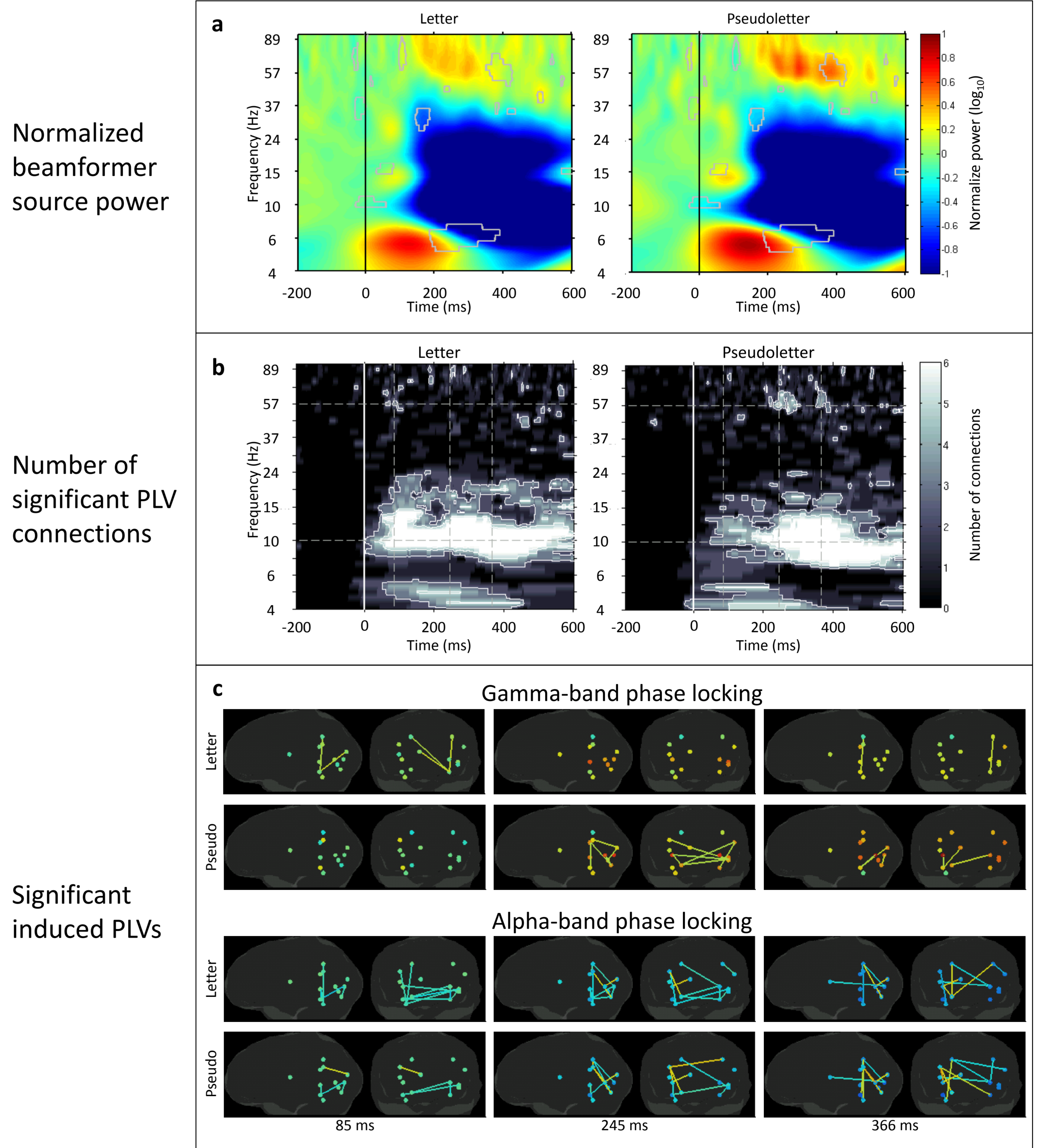
## Results

- 1) Delayed N1m responses to pseudoletters
- 2) Prolonged induced gamma-band power
- 3) Gamma-band communication occurs as early as 85 ms for processing letters
- 4) Gamma-band communication is delayed and in a more distributed network for processing pseudoletters

### Event-Related Responses Results



### Oscillatory and Functional Connectivity Results



## Conclusion

- Earlier N1m and gamma-band activity to letters reflect an initial feed-forward sweep for objects that have highly-consolidated representations formed through repeated exposure.
- Delayed N1m and prolonged gamma-band activity and communication to pseudoletters characterizes extra processing required to identify an object with absent internal representations
- A pseudoletters is a unfamiliar object that might also capture more attention in order to decipher its identity. Thus the greater and prolonged gamma-band activity and communication might result from attentional mechanism.

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