

# Individual differences in neural activity predict the transcranial magnetic stimulation-evoked response

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## Introduction

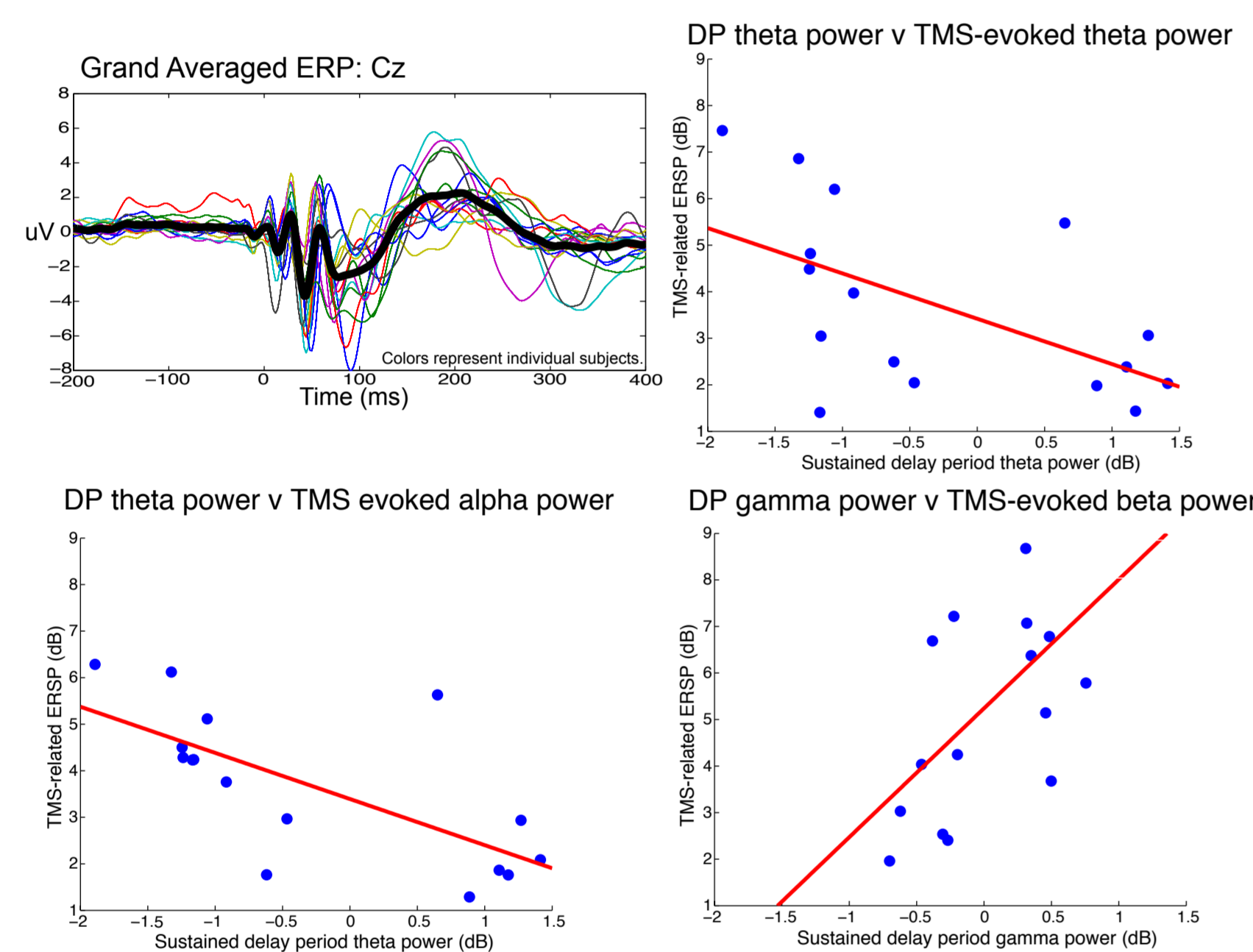
Repetitive TMS (rTMS) creates a virtual lesion?

**NO** → rTMS biases task-related brain activity

- Spatial STM: Delay-period rTMS (10Hz) to SPL modulates alpha-band power (Hamidi et al., 2009)
- Verbal STM: Delay-period rTMS (10Hz) to posterior superior temporal gyrus modulates theta-band power (Acheson and Postle, CNS 2010).
- In both studies, sign and magnitude of rTMS effect on EEG predicts sign and magnitude of rTMS effect on performance.

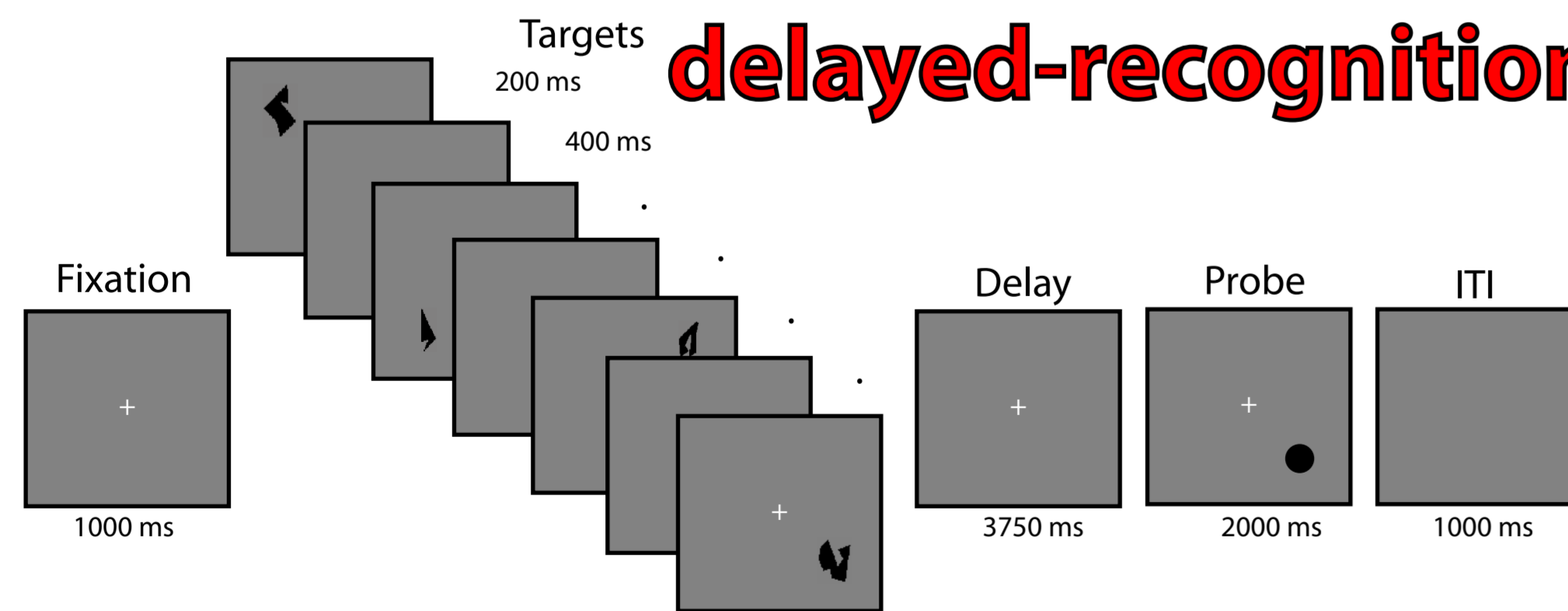
What factors account for these individual differences in behavioral performance due to TMS?

Individual differences in the sustained-delay period oscillatory power predicts the TMS-evoked event-related spectral perturbation (ERSP) and the intertrial coherence (ITC or trial-to-trial phase synchrony; Kundu et al, CNS 2010).



Does sustained-delay period activity show stable, trait-like characteristics?

## Test-retest reliability of spatial delayed-recognition



Subjects were instructed to remember the locations marked by each object and to ignore the object's identity. 160 delayed recognition trials per session. Test-retest period varied from 1 week to 2 months.

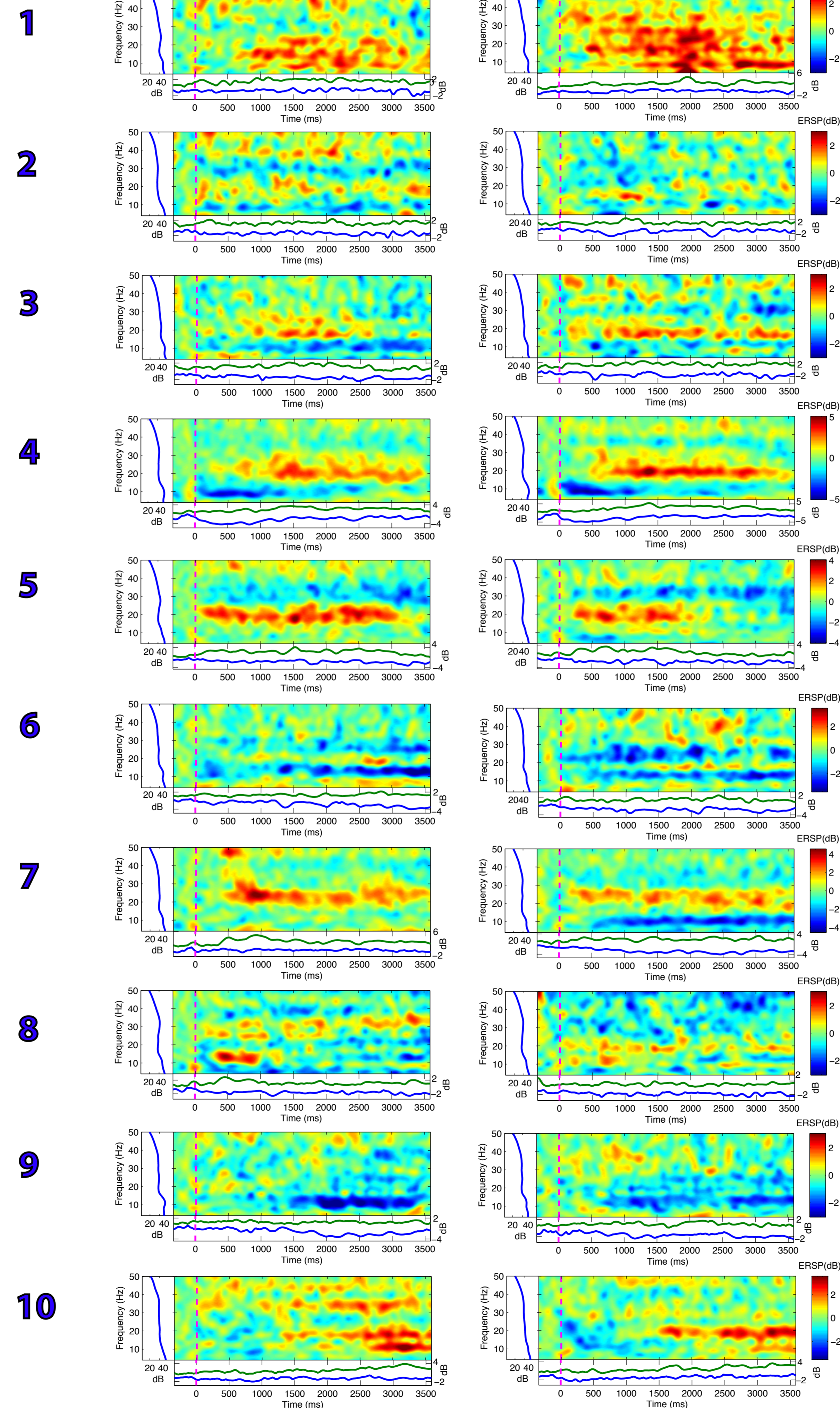
- EEG
- Recorded with a 60-channel TMS-compatible amplifier (Nexstim, Helsinki, Finland).
  - Sample-and-hold circuit holds amplifier output constant from 100  $\mu$ s pre- to 2 ms post-stimulus.
  - Data were acquired at 1450 Hz, downsampled (500 Hz) and filtered (2-80 Hz) offline.
  - All data processing was done with a combination of MATLAB (Mathworks Inc.), EEGLAB (UCSD), and Fieldtrip (Donders Institute, Nijmegen).

## Results

Subject

Test

Retest

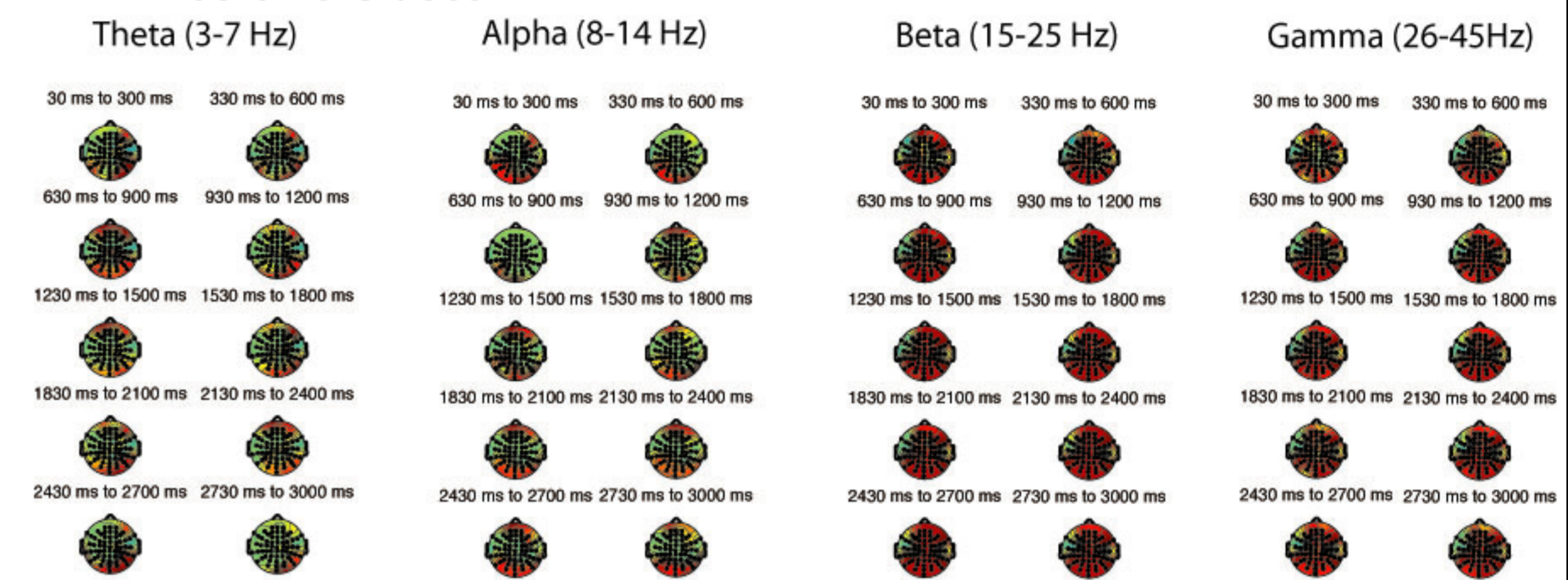


Raw data (Channel Cz) showing the sustained-delay period power for all subjects during both test and retest sessions. The pattern of underlying oscillatory activity is similar between test and retest conditions, but quite variable across individuals.

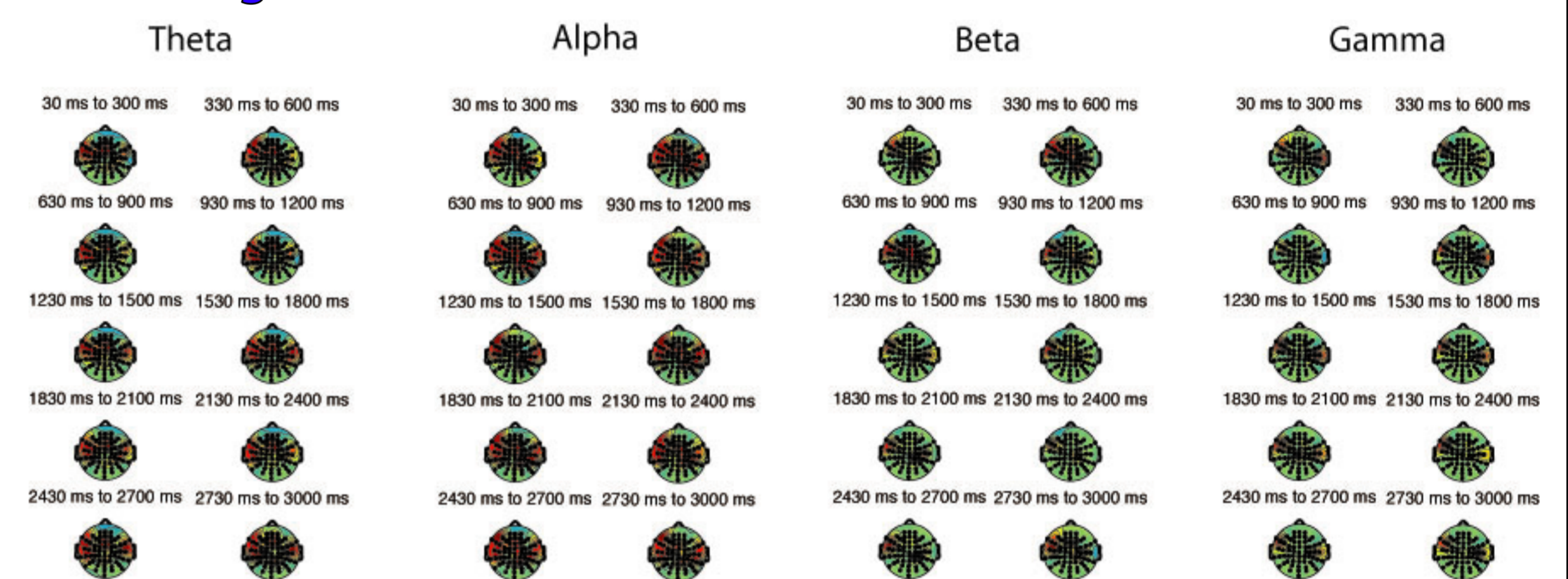
## Significance Testing

Between-subject effects

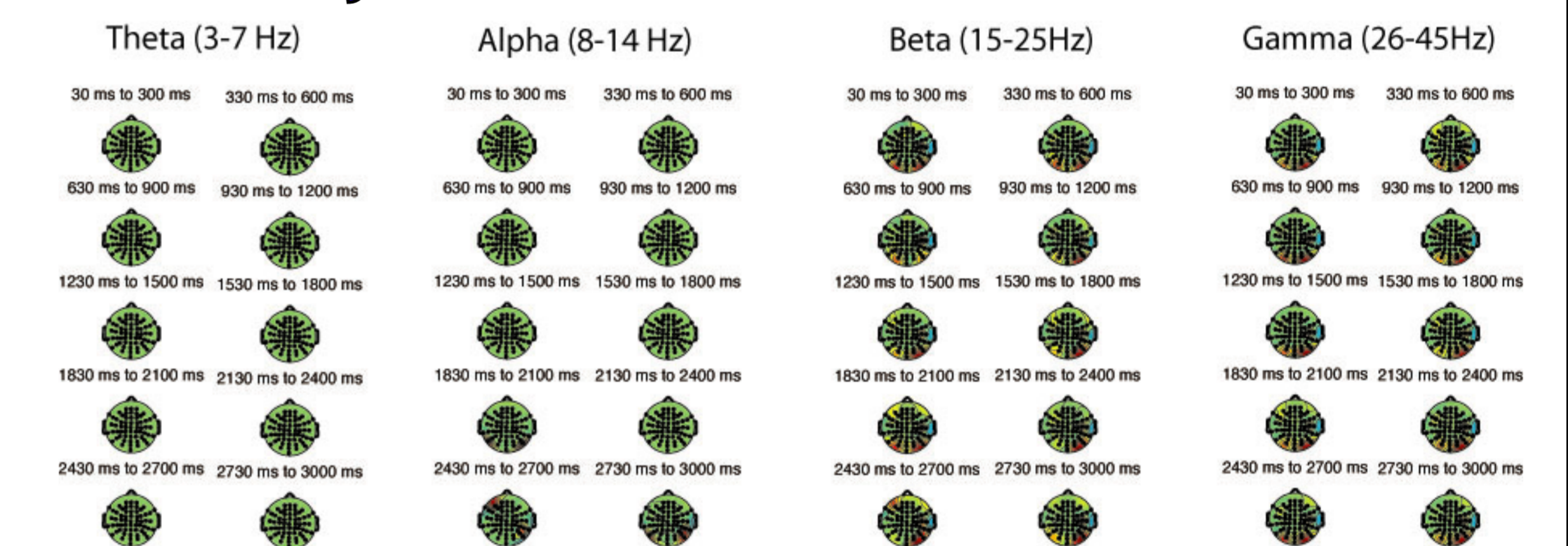
Positive Cluster



Negative Cluster



Within-subject effects



Cluster-based permutation test shows significant individual differences in delay period power. Two-sided T-statistic was used to evaluate the effect of subject. Significant positive cluster has cluster statistic = 473860,  $p=0.00$  (based on null distribution generated via Monte Carlo permutations). Significant negative cluster has cluster statistic = -75235,  $p=0.0067$ , number of randomizations = 300. Same test shows few significant differences between test and retest conditions across subjects. T-statistic used to measure the effect of condition. Cluster statistic = -23632,  $p=0.046$ , number of randomizations = 300. Trials treated as a repeated measure.

## Conclusions

- Sustained delay period activity shows trait-like individual differences that are stable across time.

Future Questions: Do differences in delay-period activity account for individual differences in the effects of delay-period rTMS (Hamidi et al, 2009; Acheson and Postle, 2010)? What are the functionally relevant features of delay-period activity (e.g., power in a particular band? Coherence between particular frequencies?)