

Exploring spectral instability in EEG data

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Project Scientist

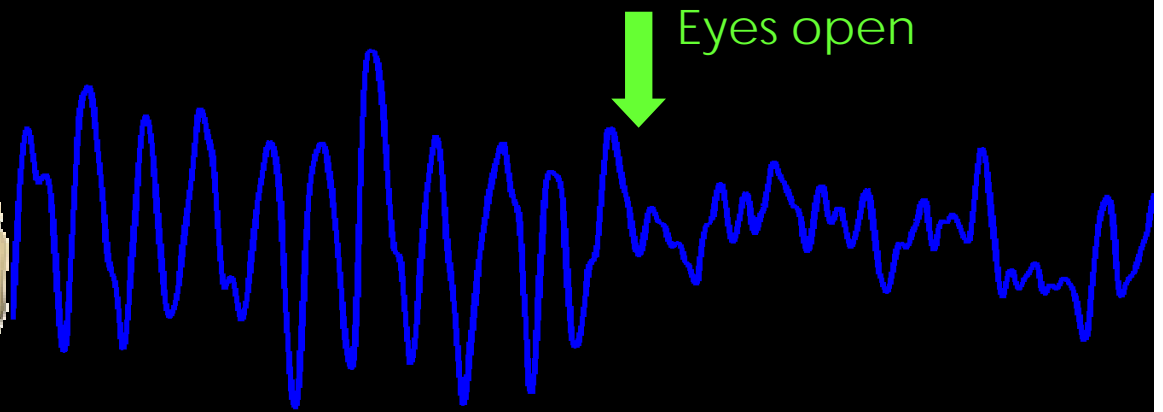
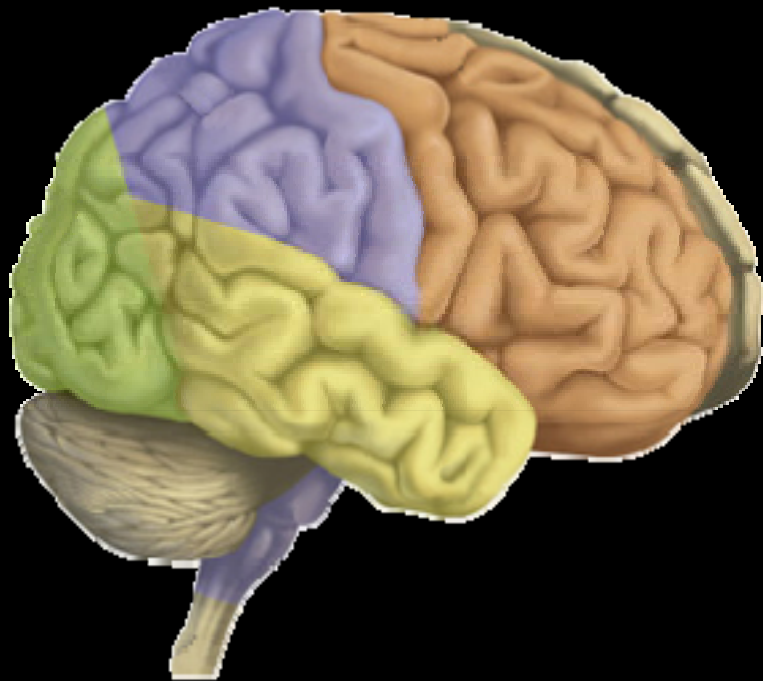
Swartz Center for Computational Neuroscience
University of California, San Diego

Outline

- Spectral instability
- The state of EEG analysis
- New approach to analyzing spectral instability
- Relationship to cognitive and/or emotional states

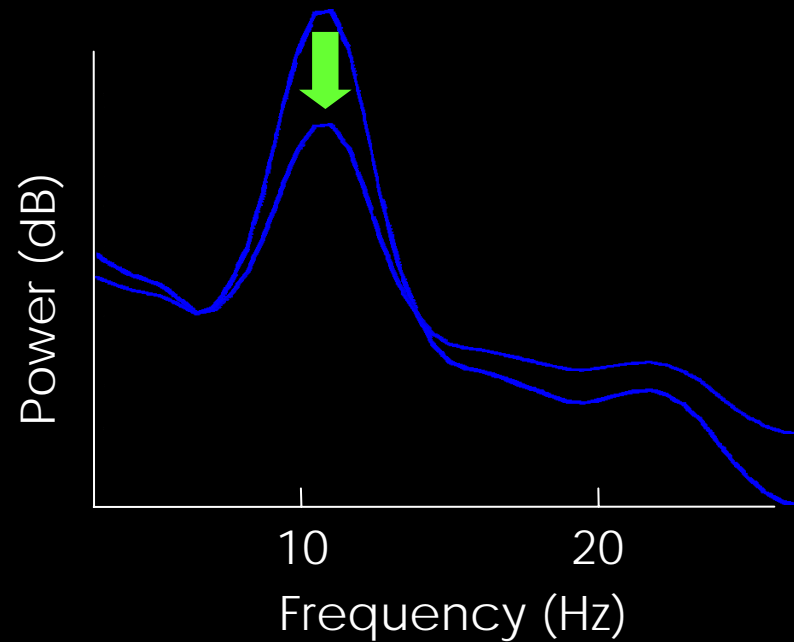
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What is spectral instability?

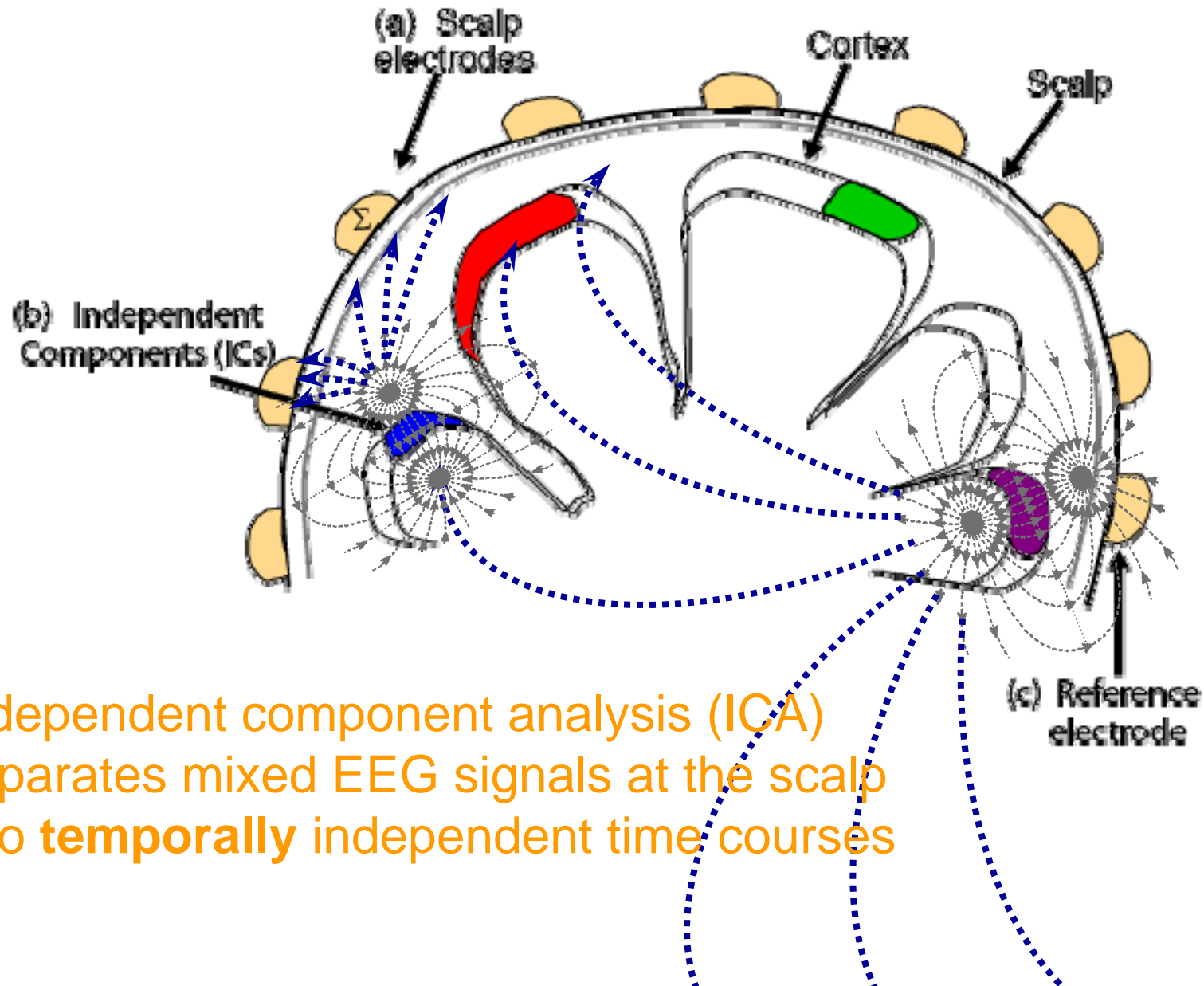
Change in frequency power over time



Outline

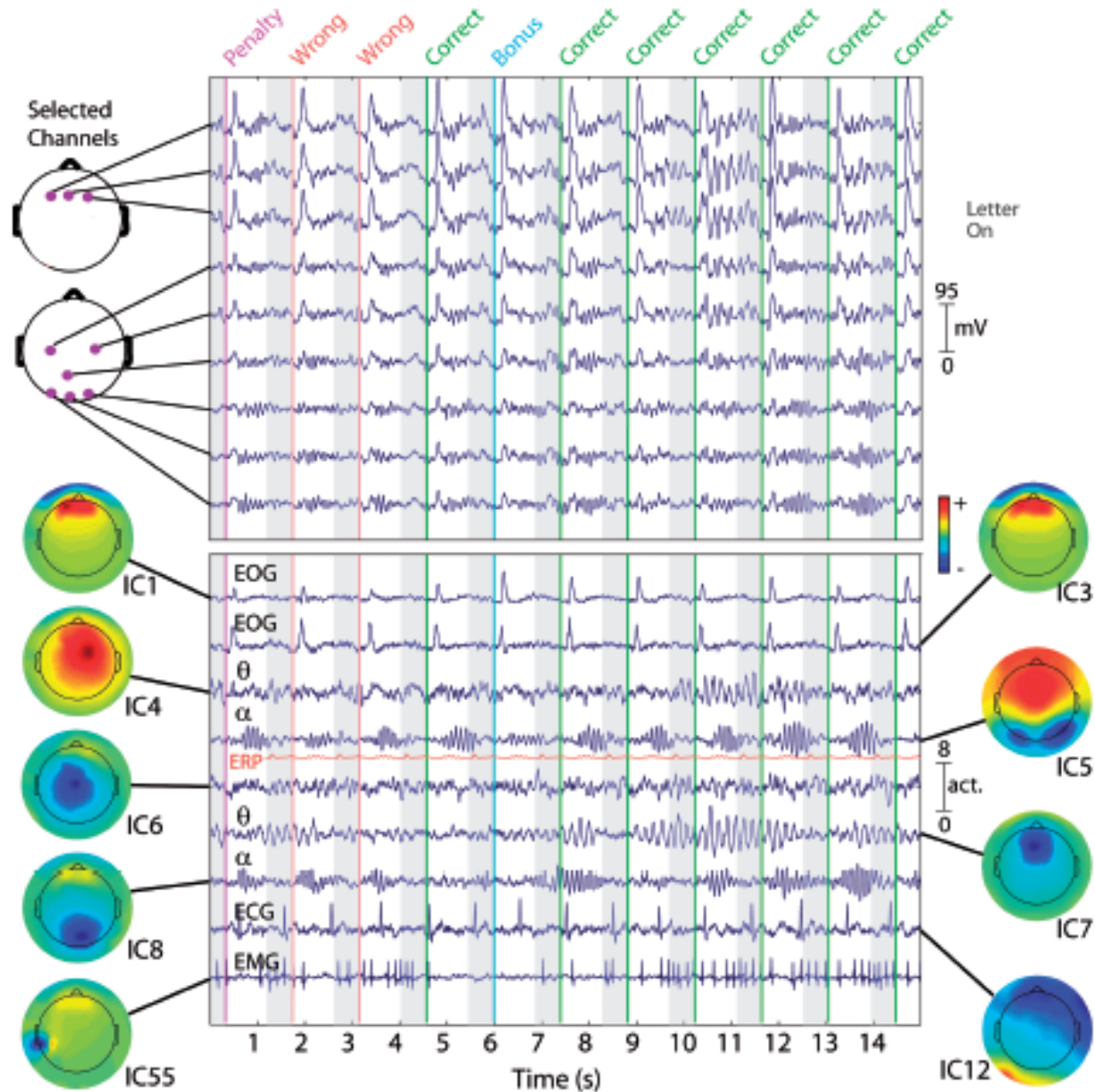
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Separating EEG source activities

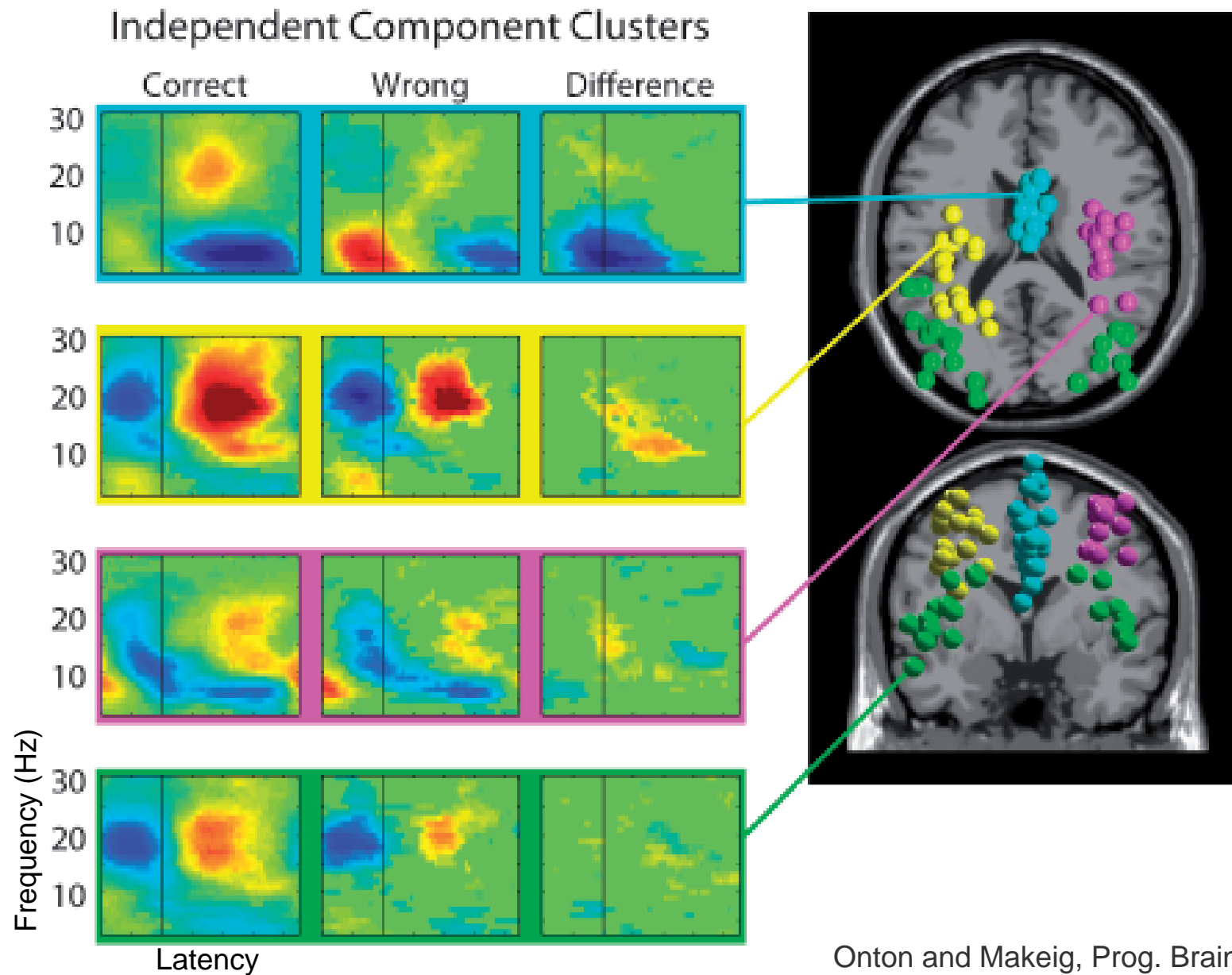


Independent component analysis (ICA) separates mixed EEG signals at the scalp into **temporally** independent time courses

Independent temporal dynamics



Complex dynamics in time/frequency space



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What causes spectral instability?

Thalamocortical loop

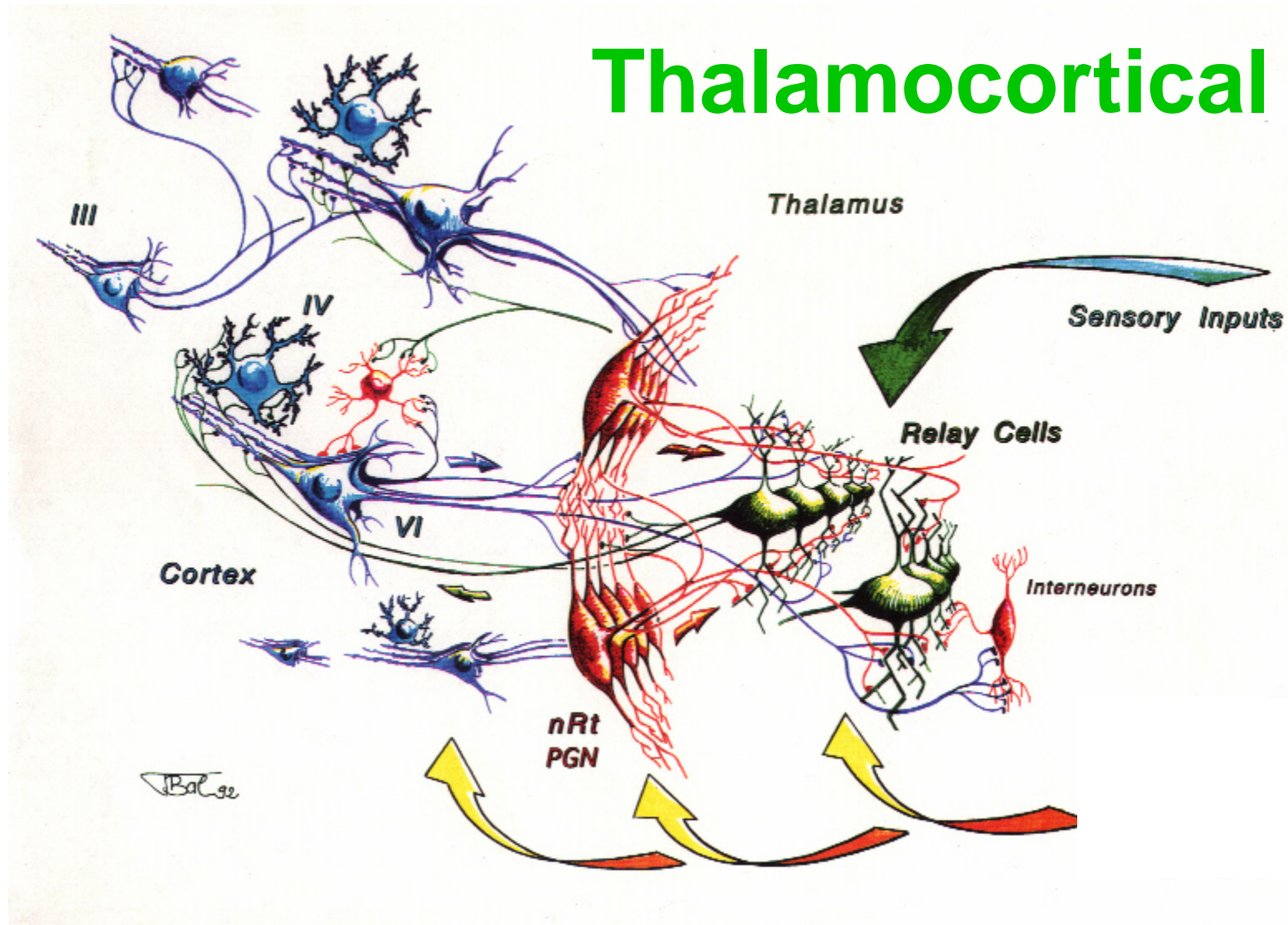
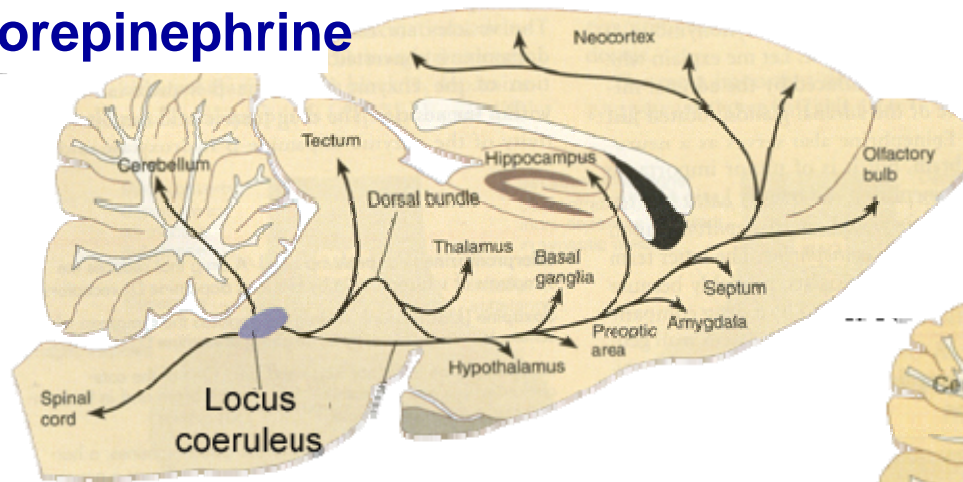
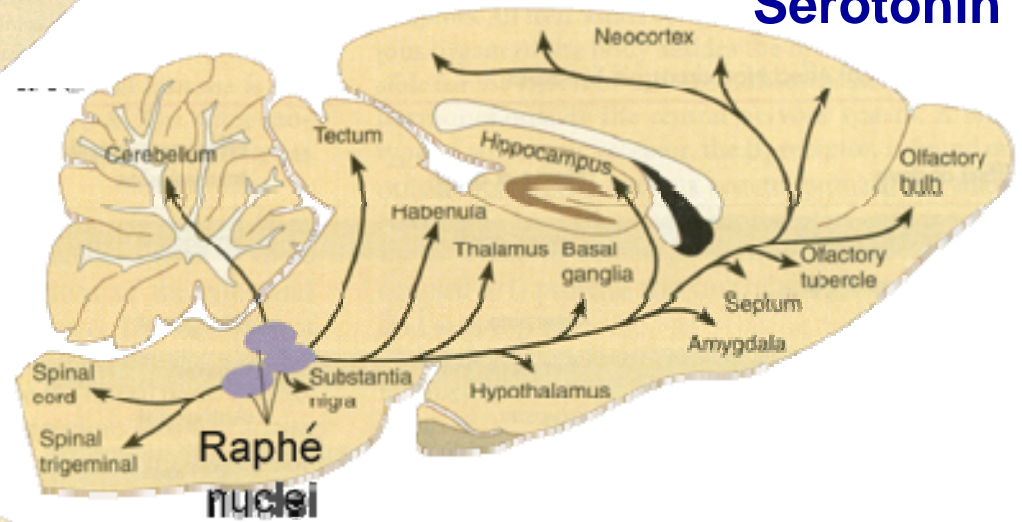


Figure drawn by Thierry Bal

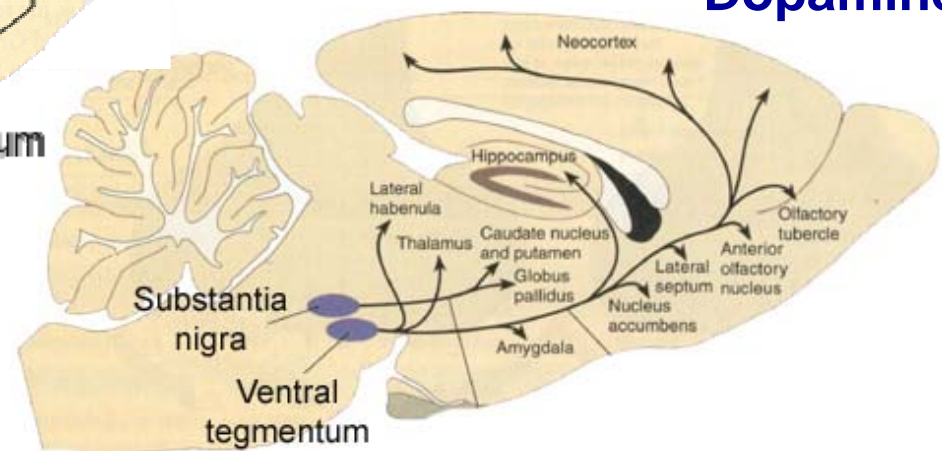
Norepinephrine



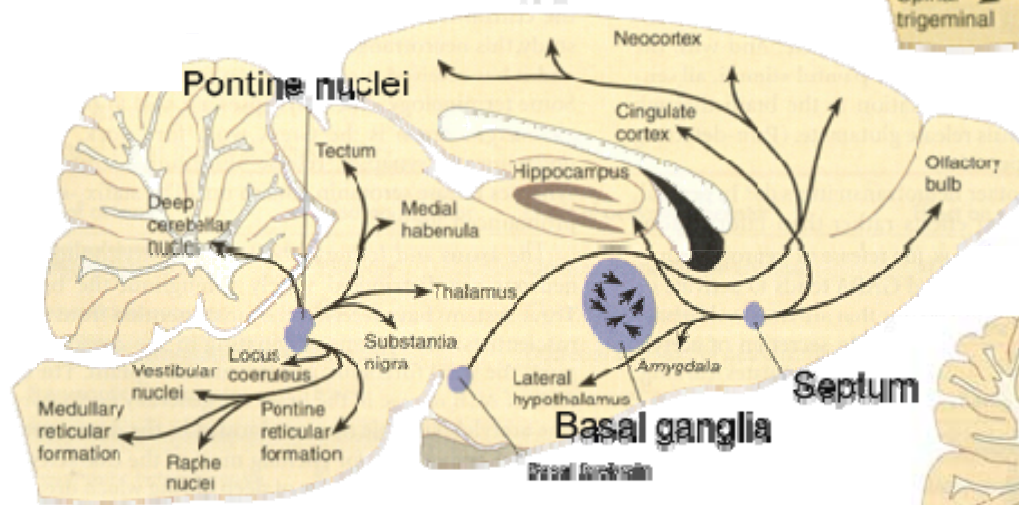
Serotonin



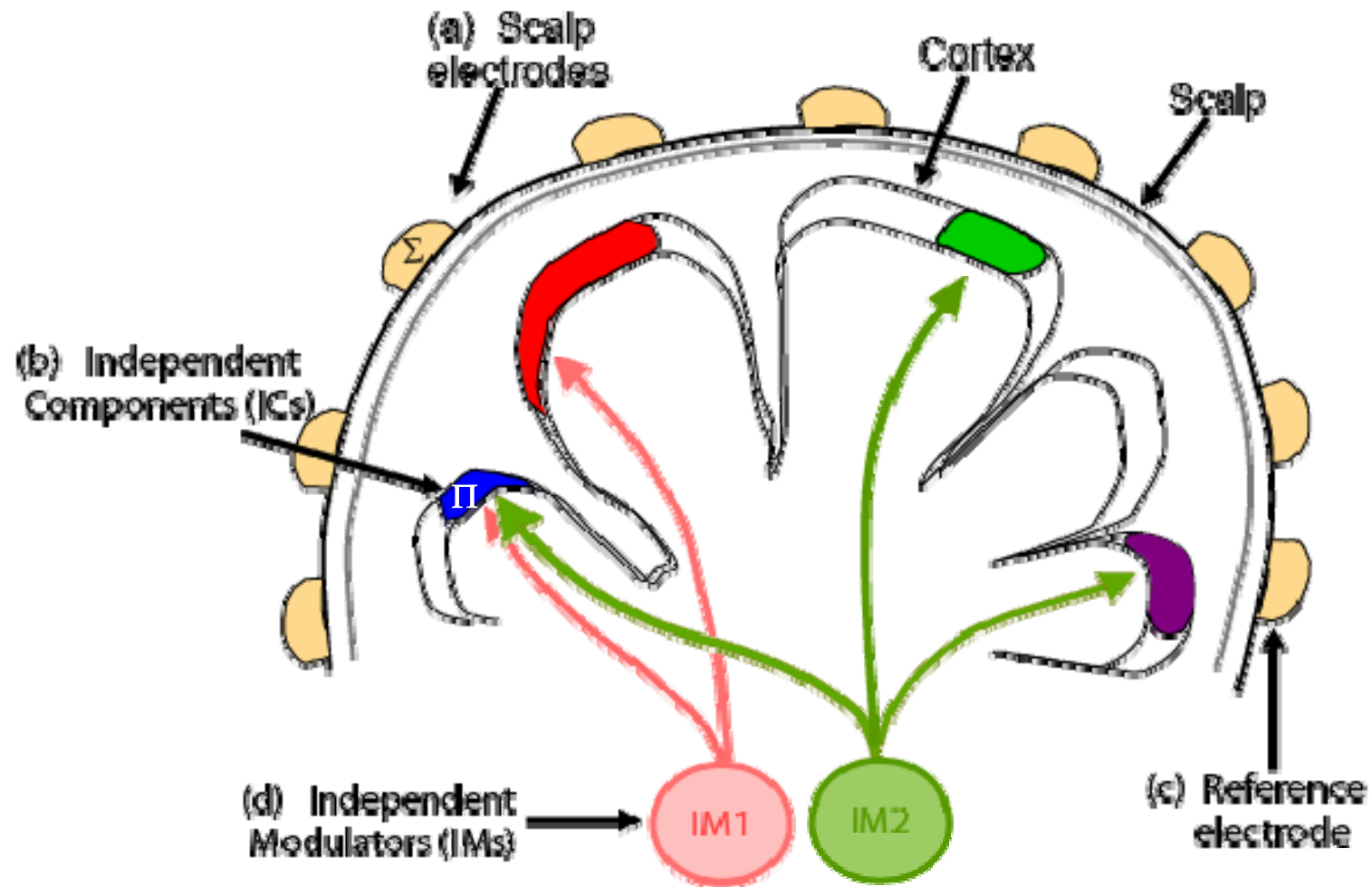
Dopamine

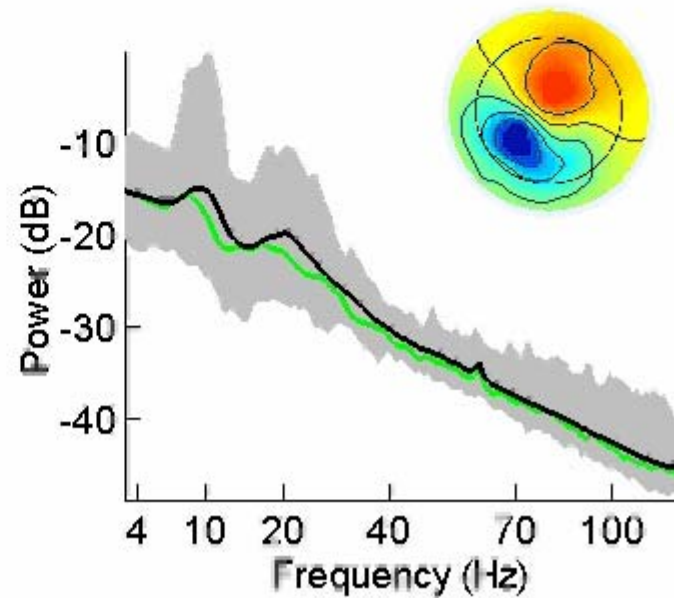
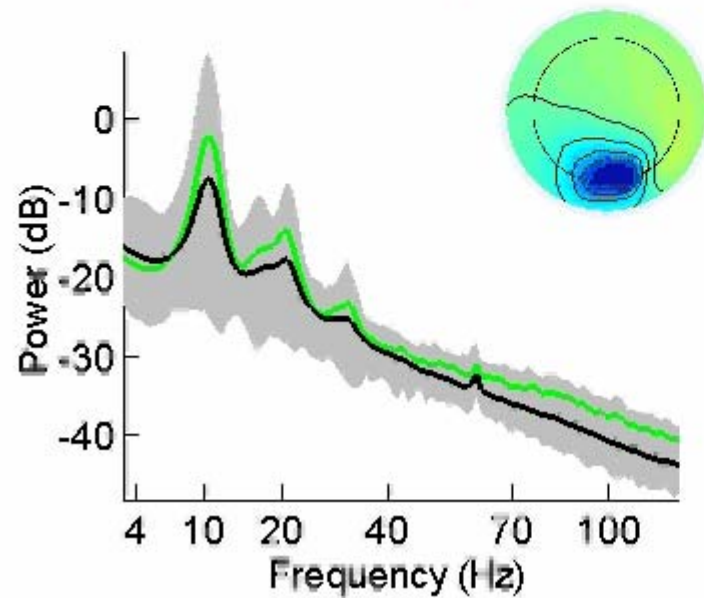
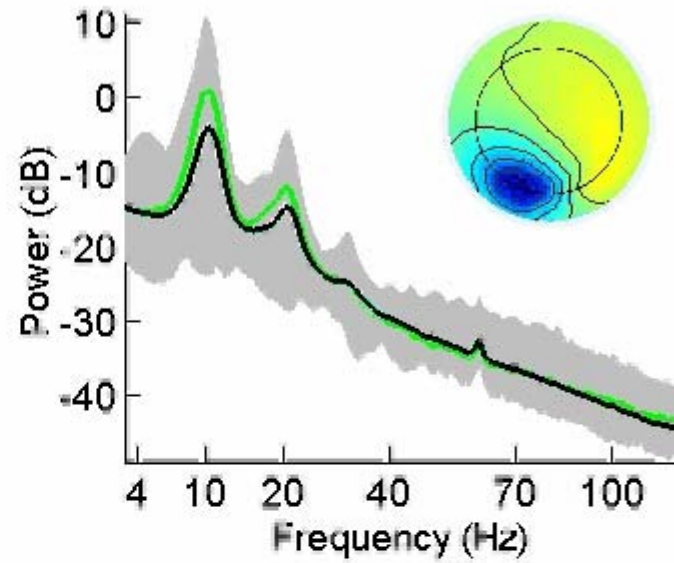
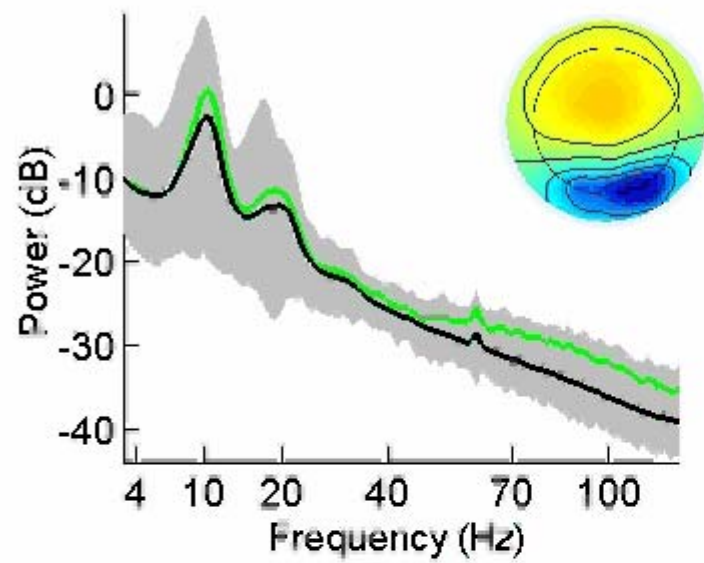


Acetylcholine

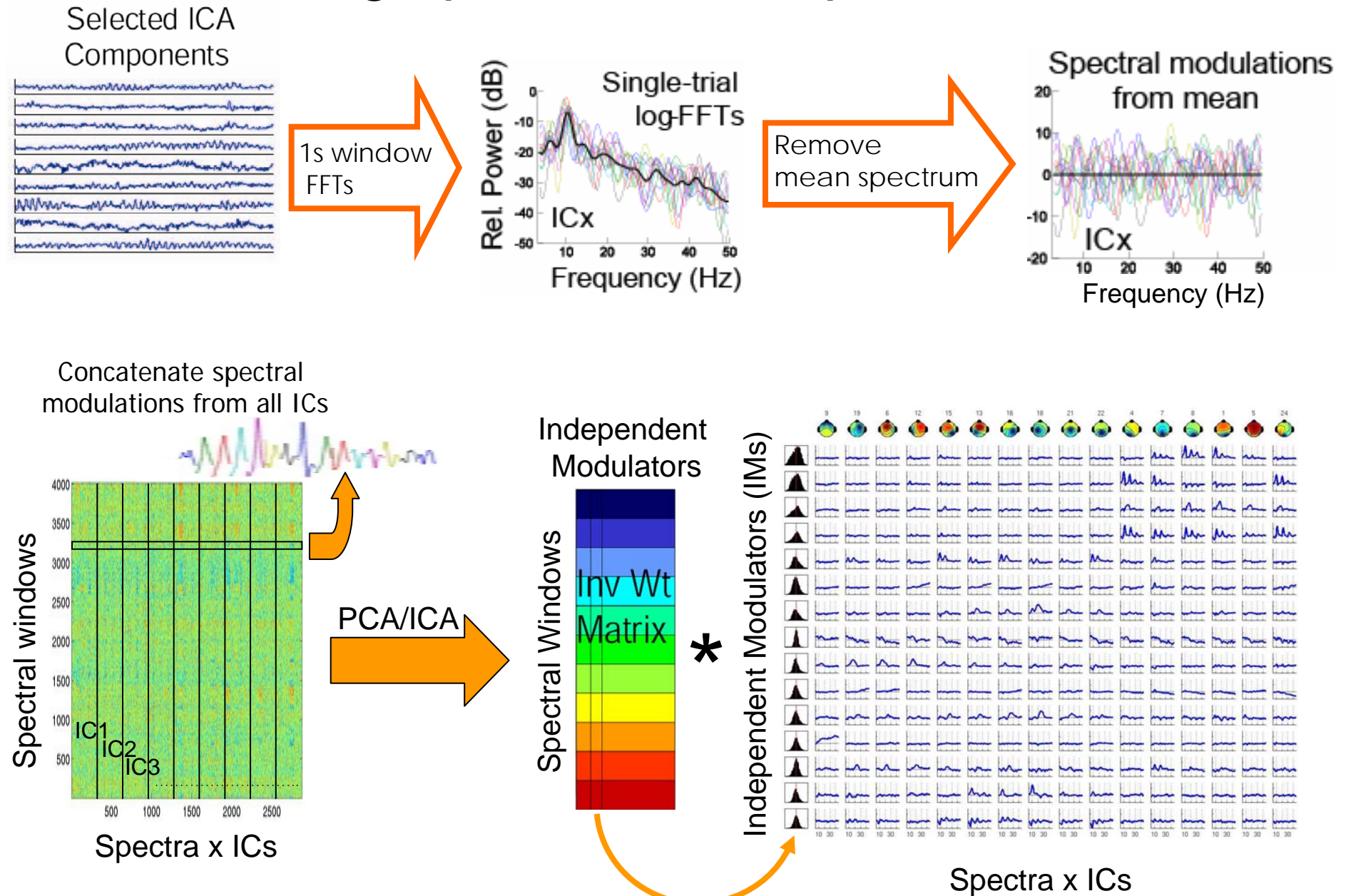


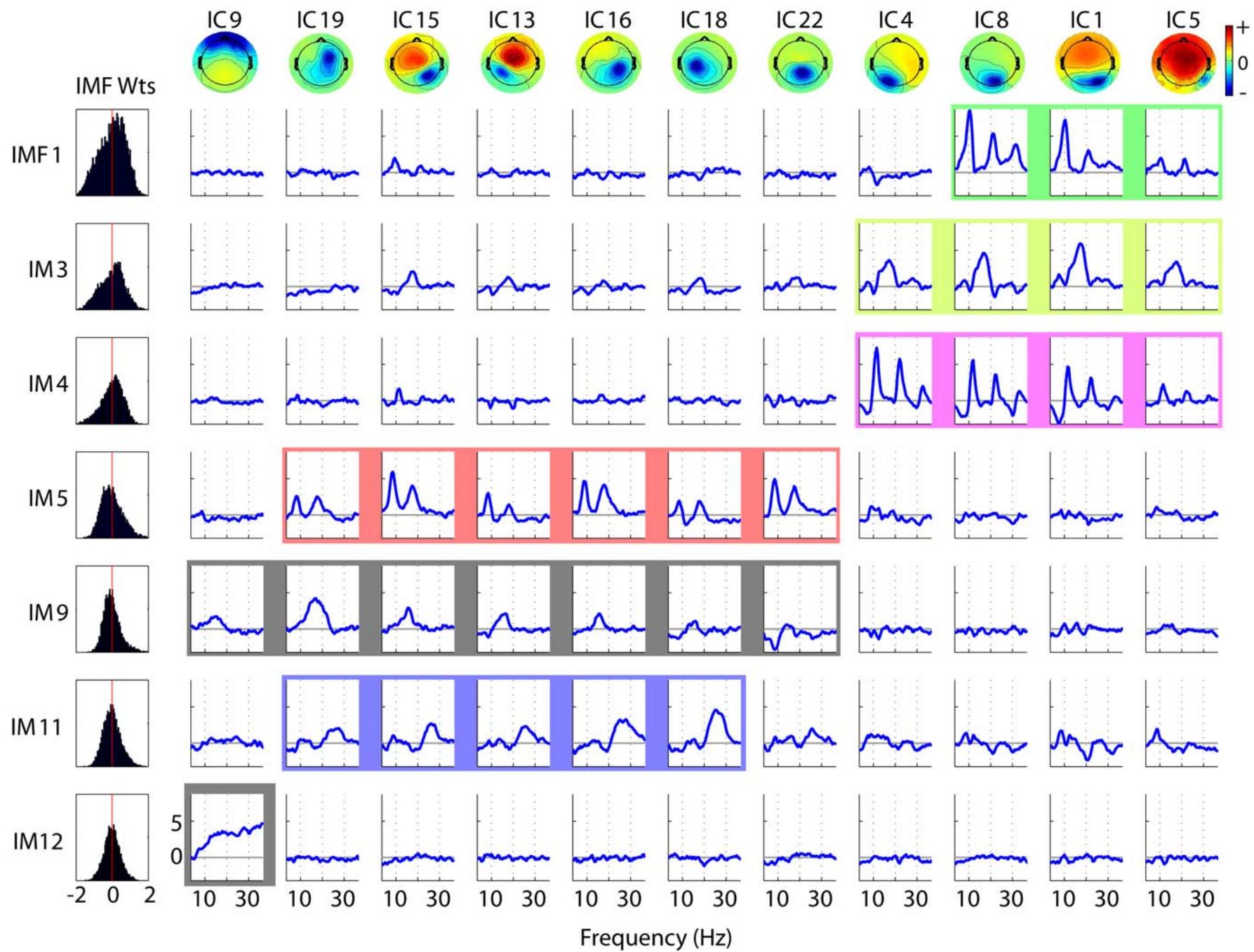
Independent (Co-)Modulators of EEG Source Activities



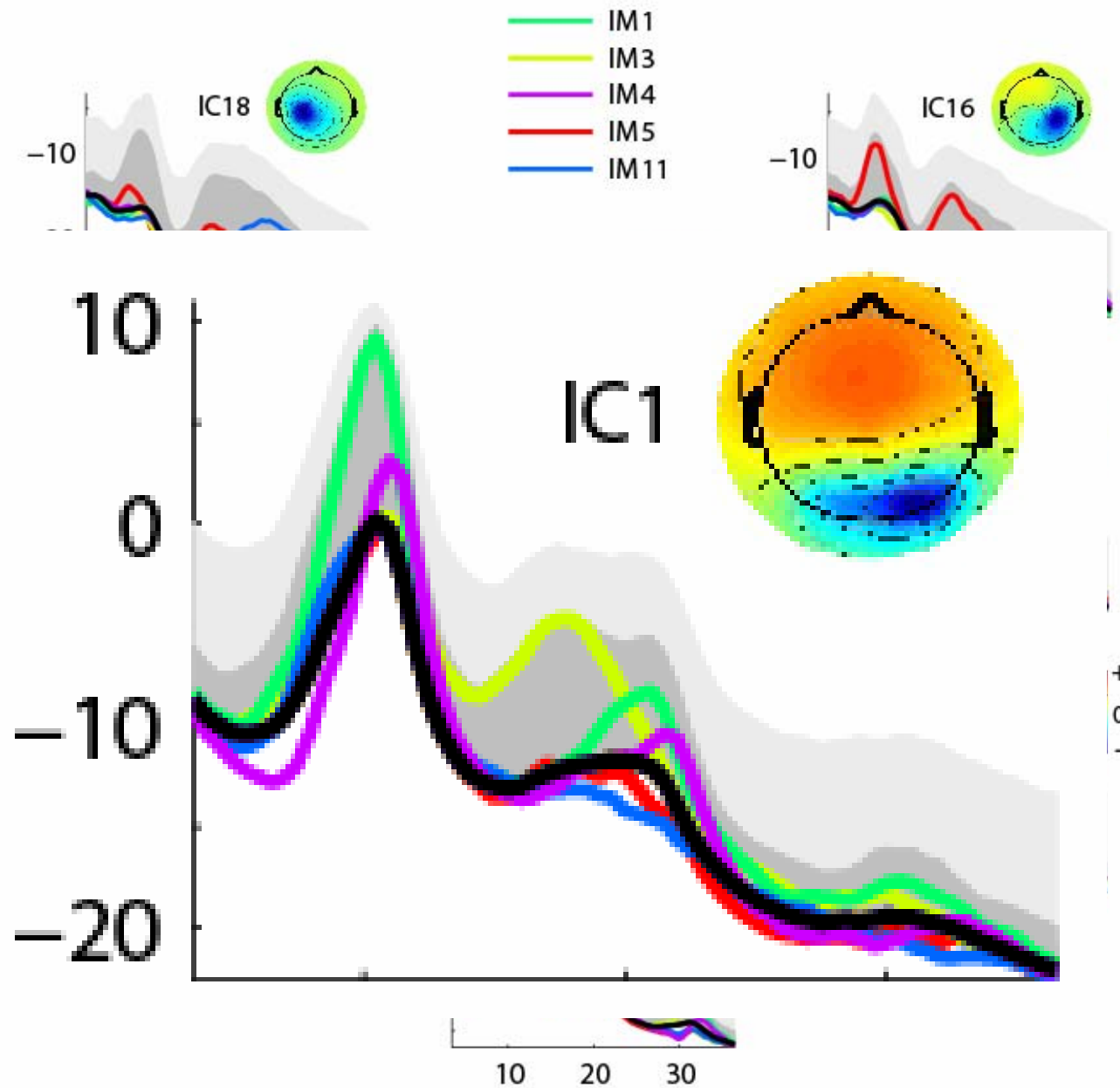


Log-spectral decomposition

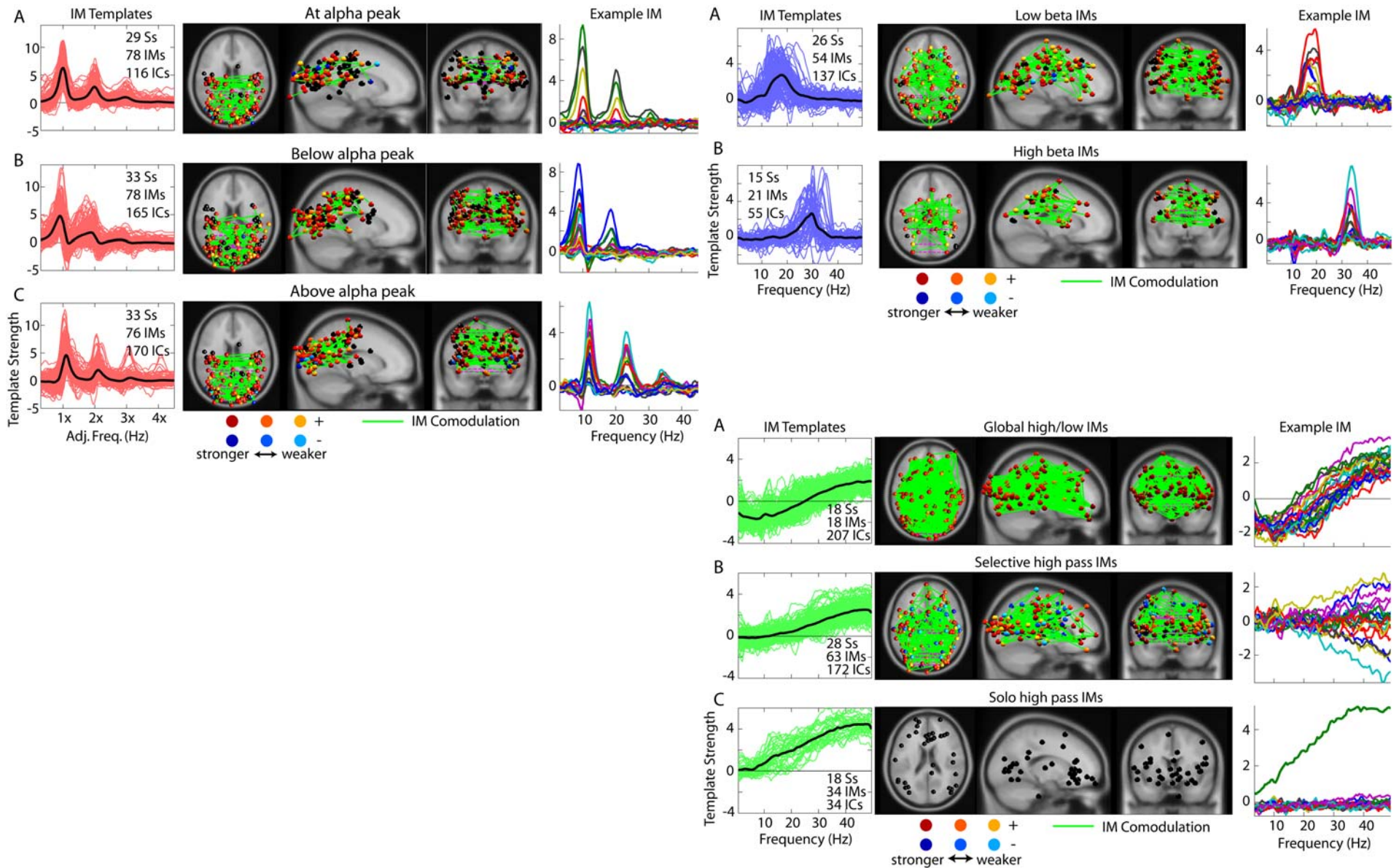




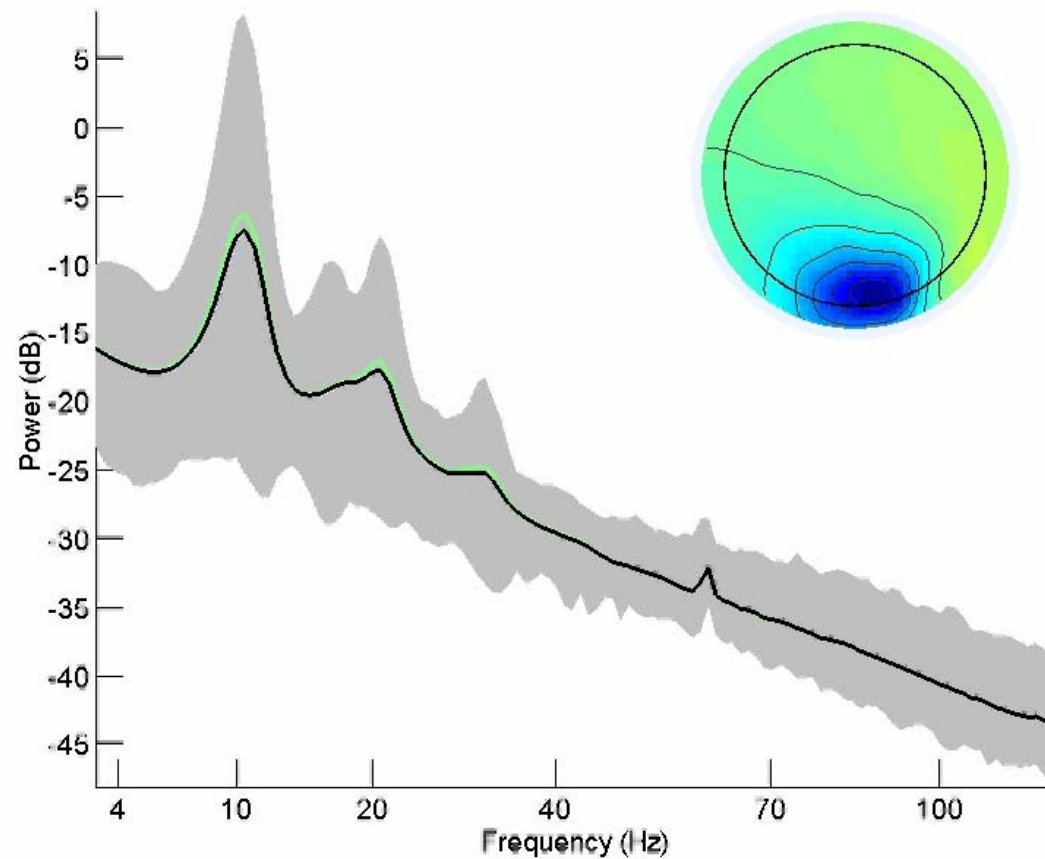
Spectral modulation envelopes



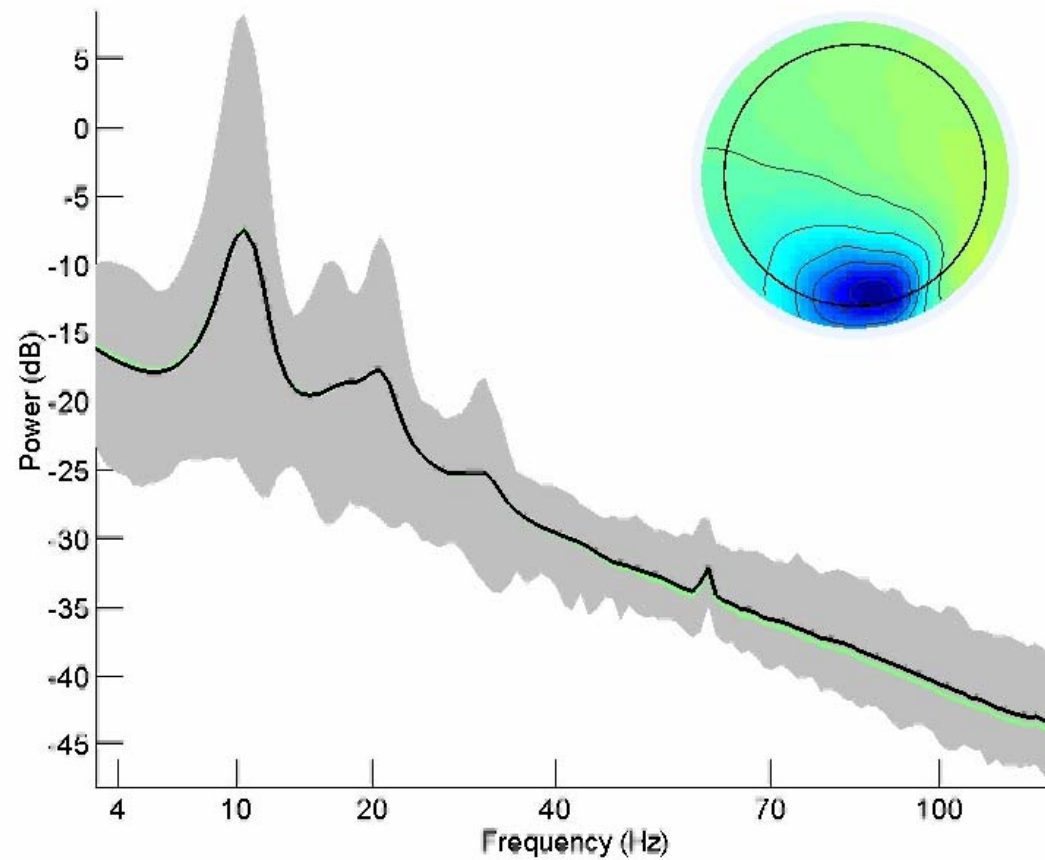
Clusters of spectral modulators



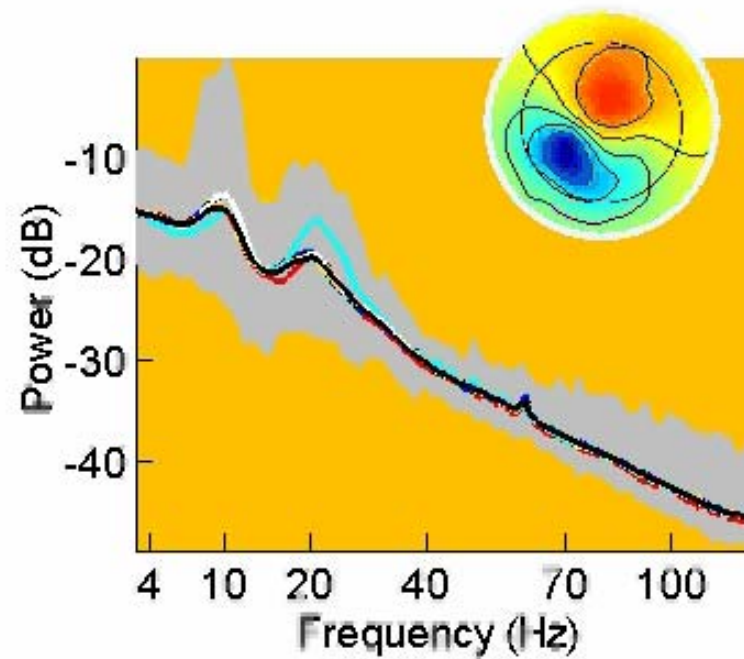
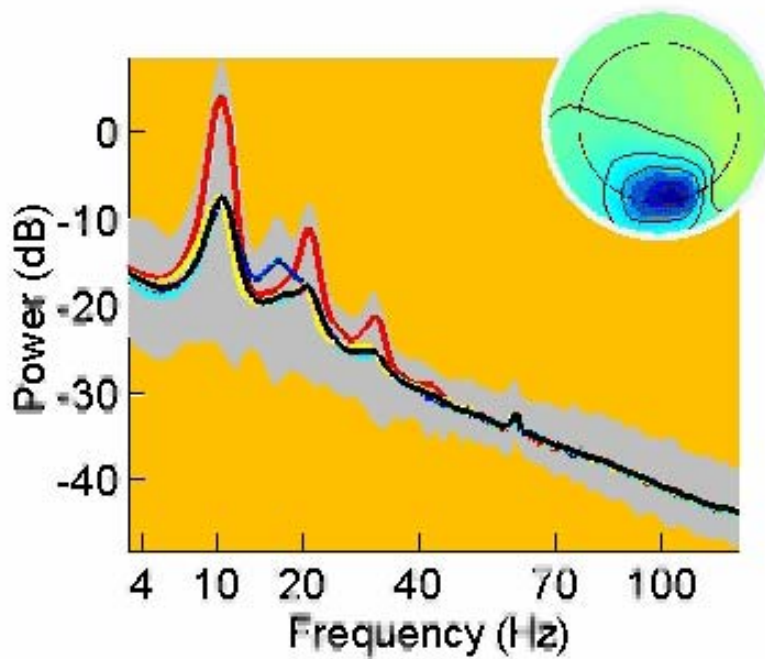
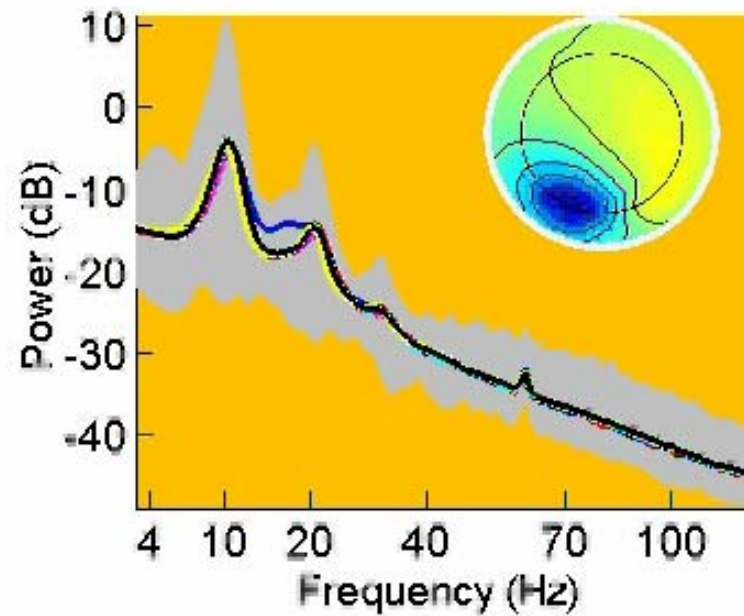
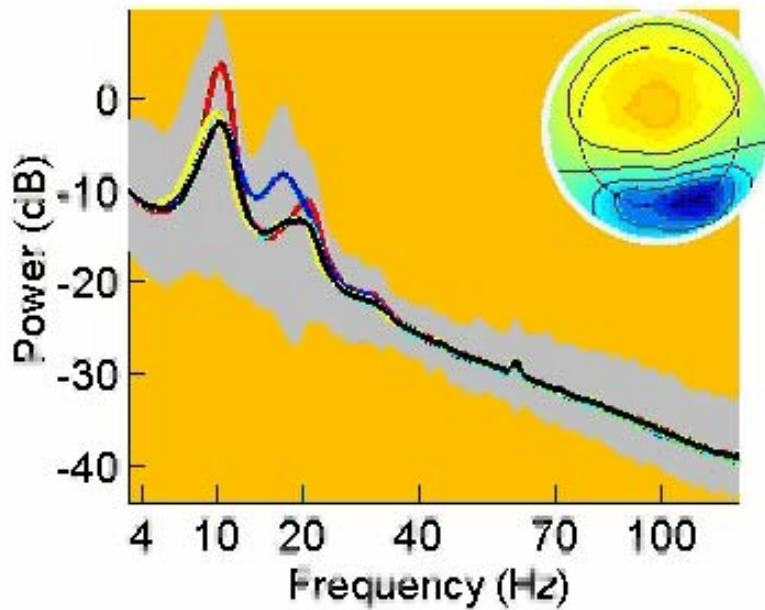
Alpha (+ harmonic) modulation



High frequency modulation



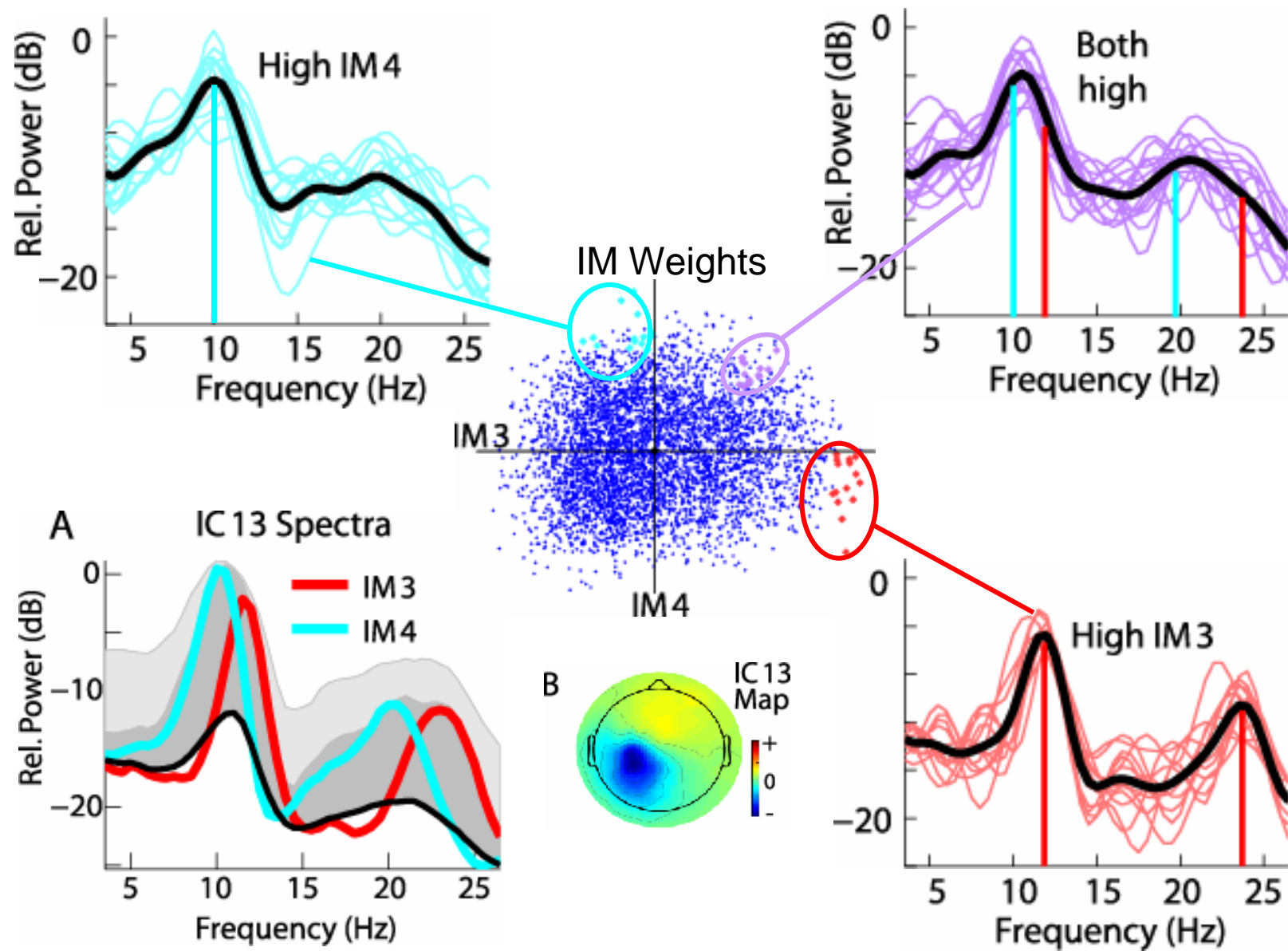
Many ICs, many IMs...



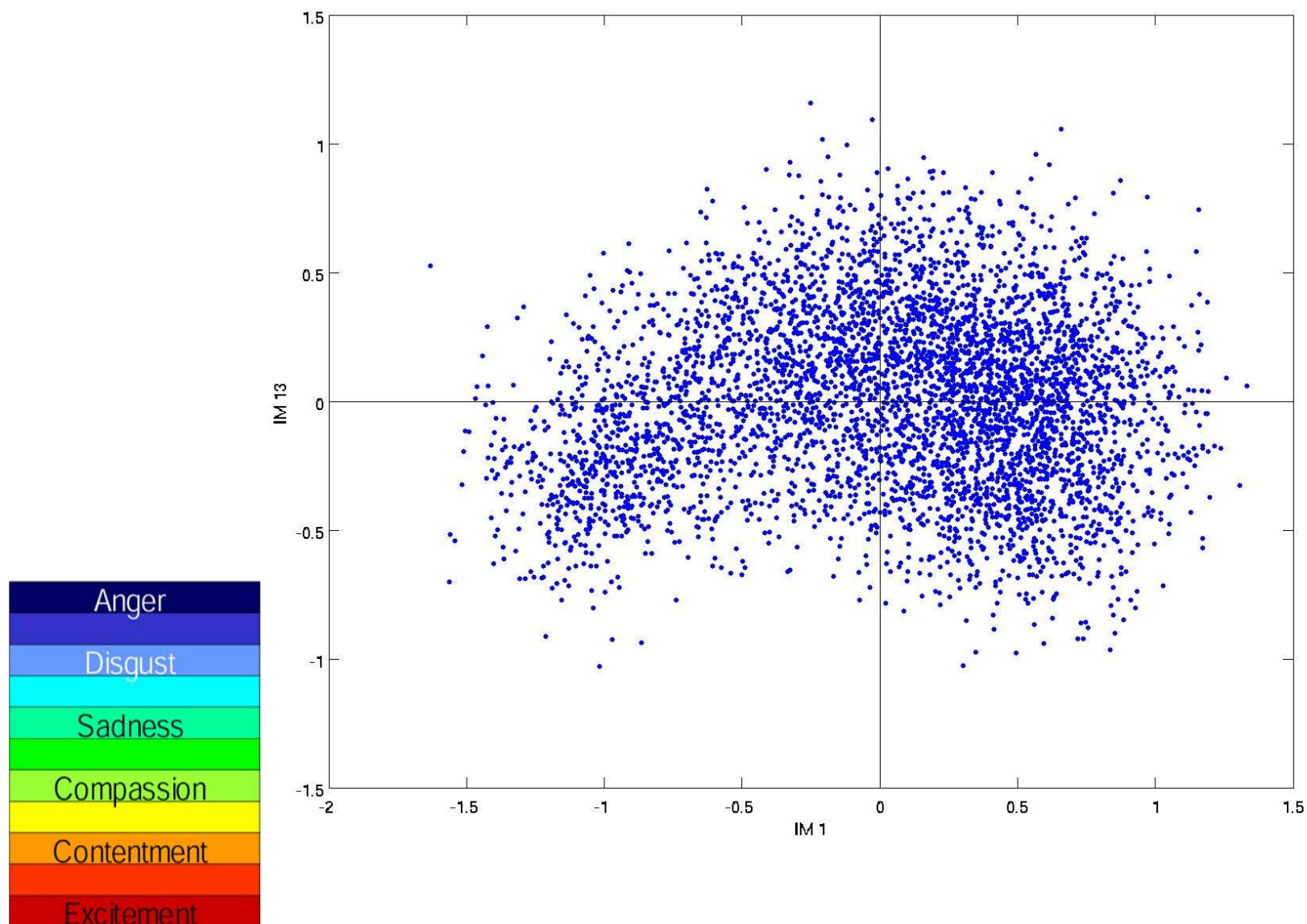
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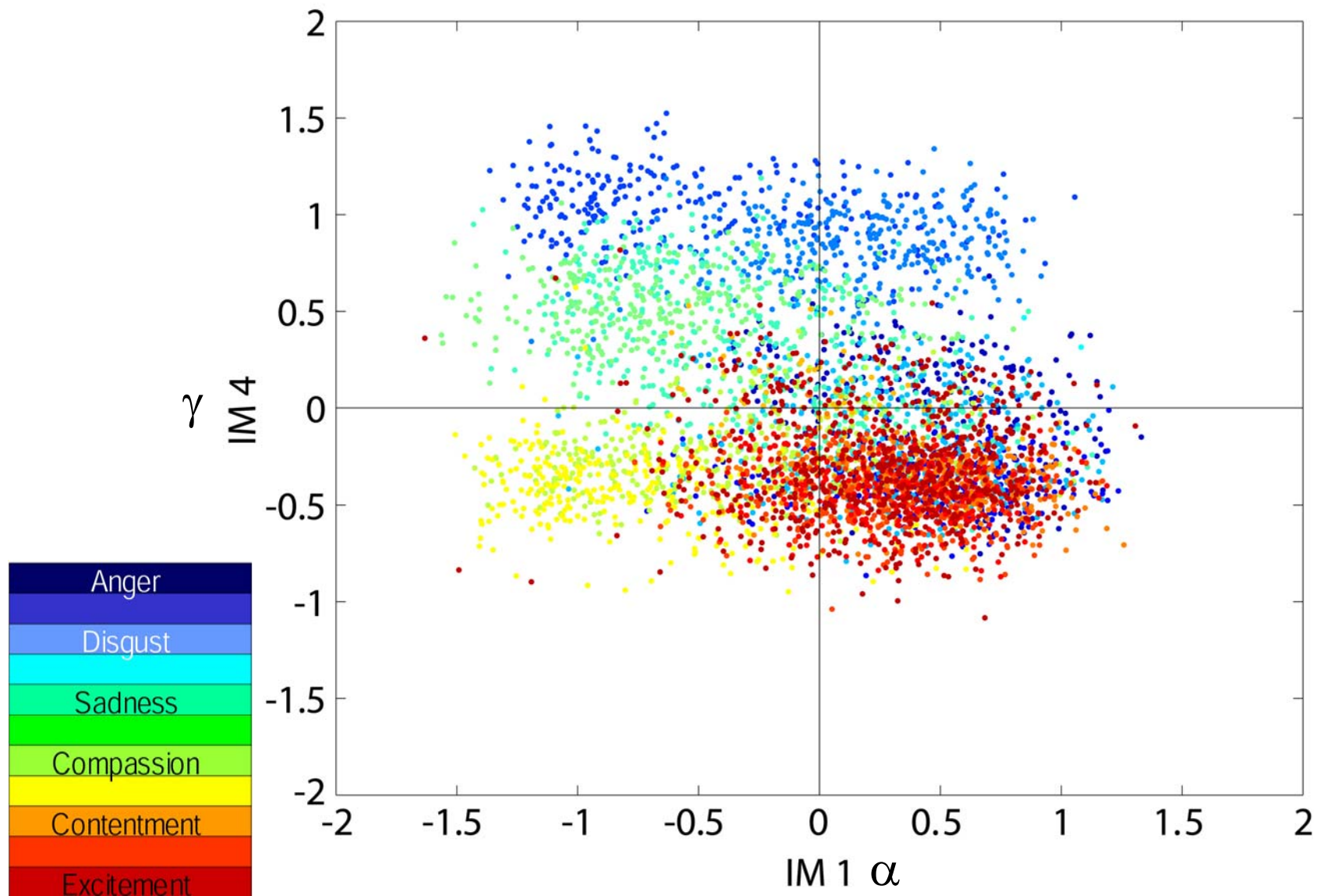
Trial-to-trial spectral differences



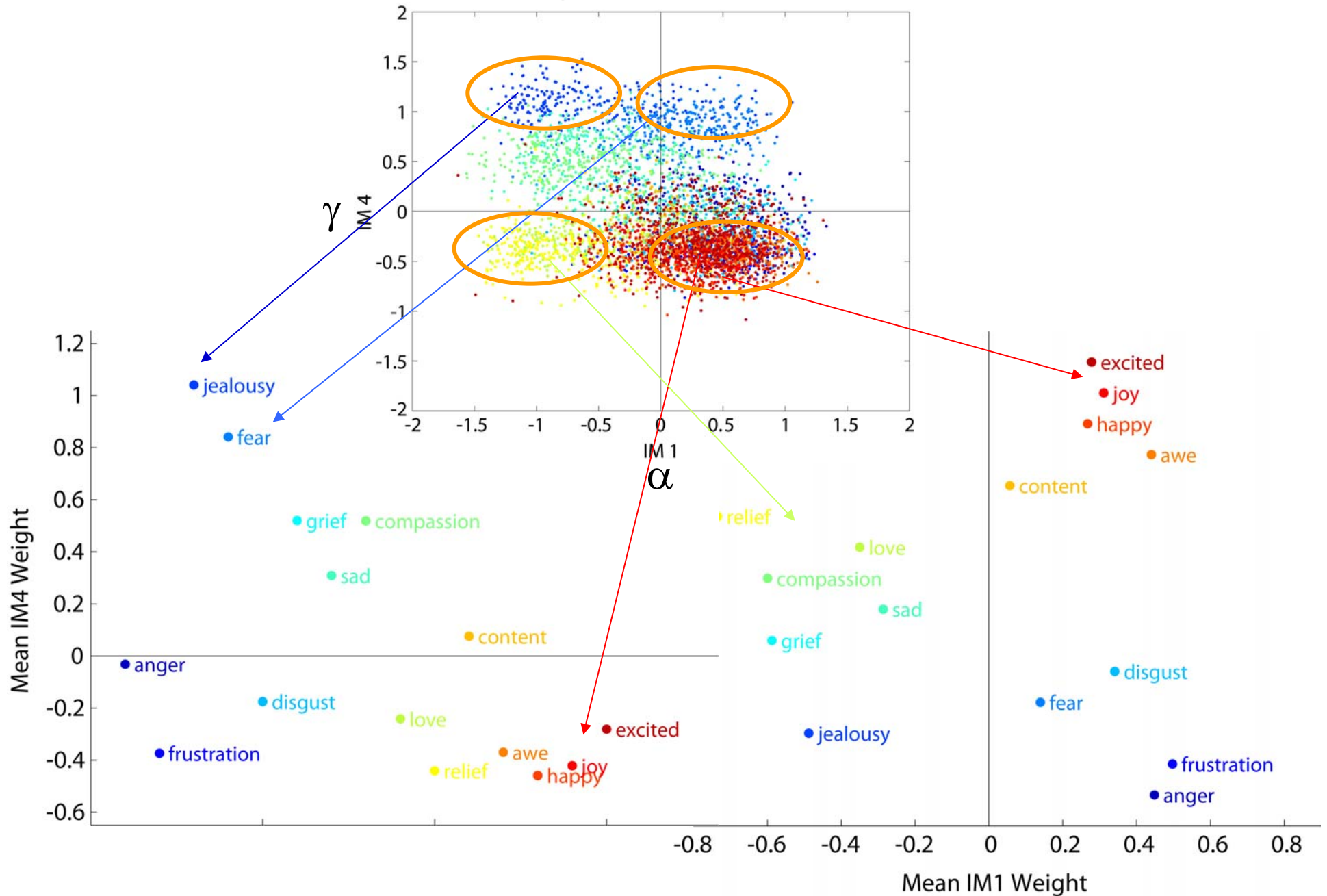
IM weight correlation



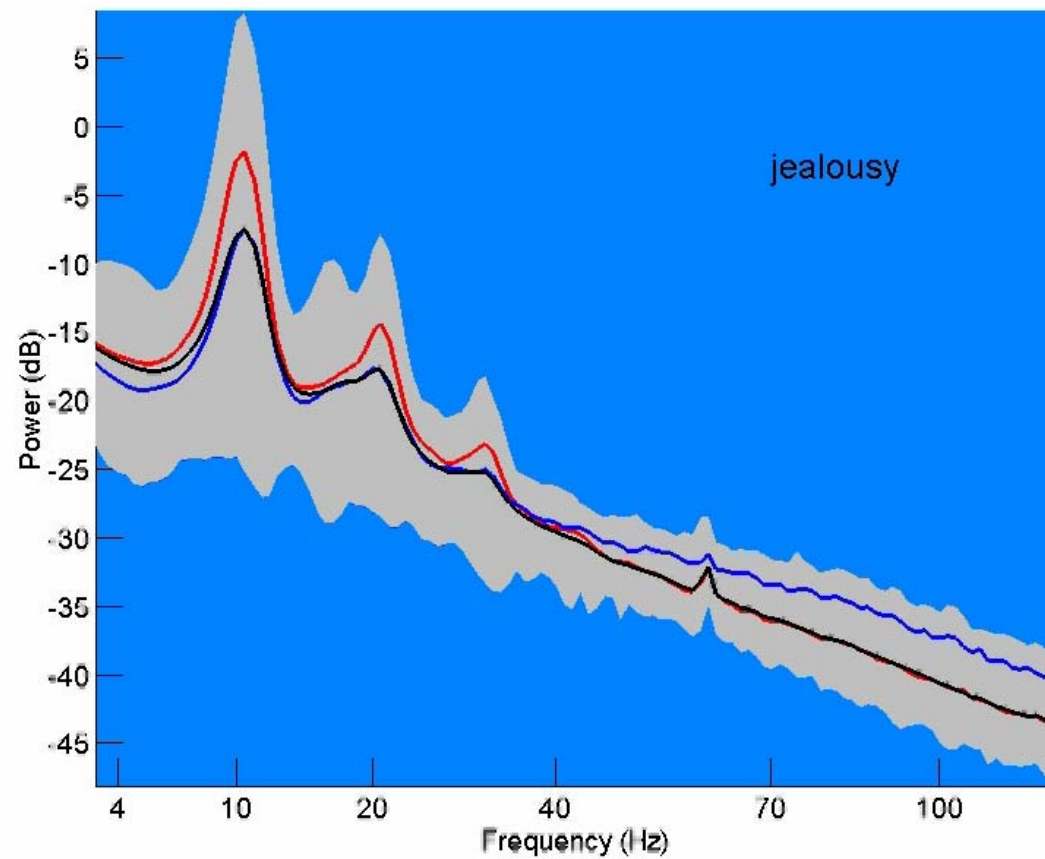
IM weight interactions



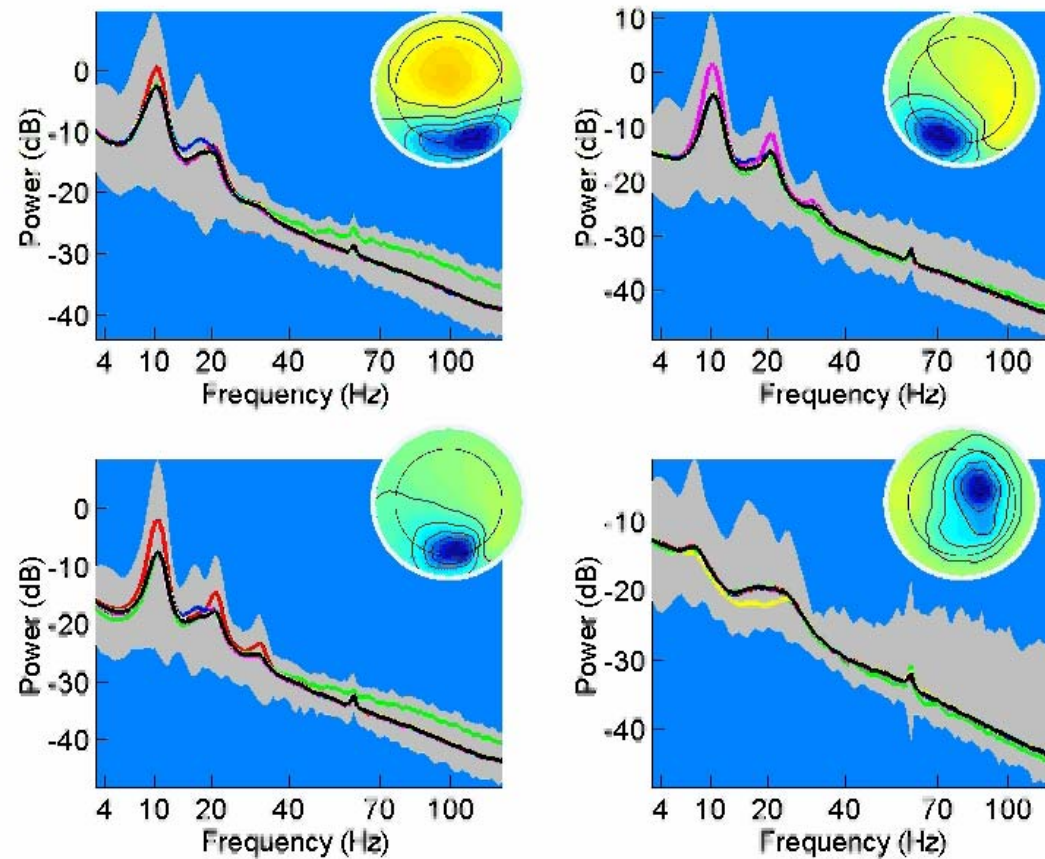
Mean weight for each emotion



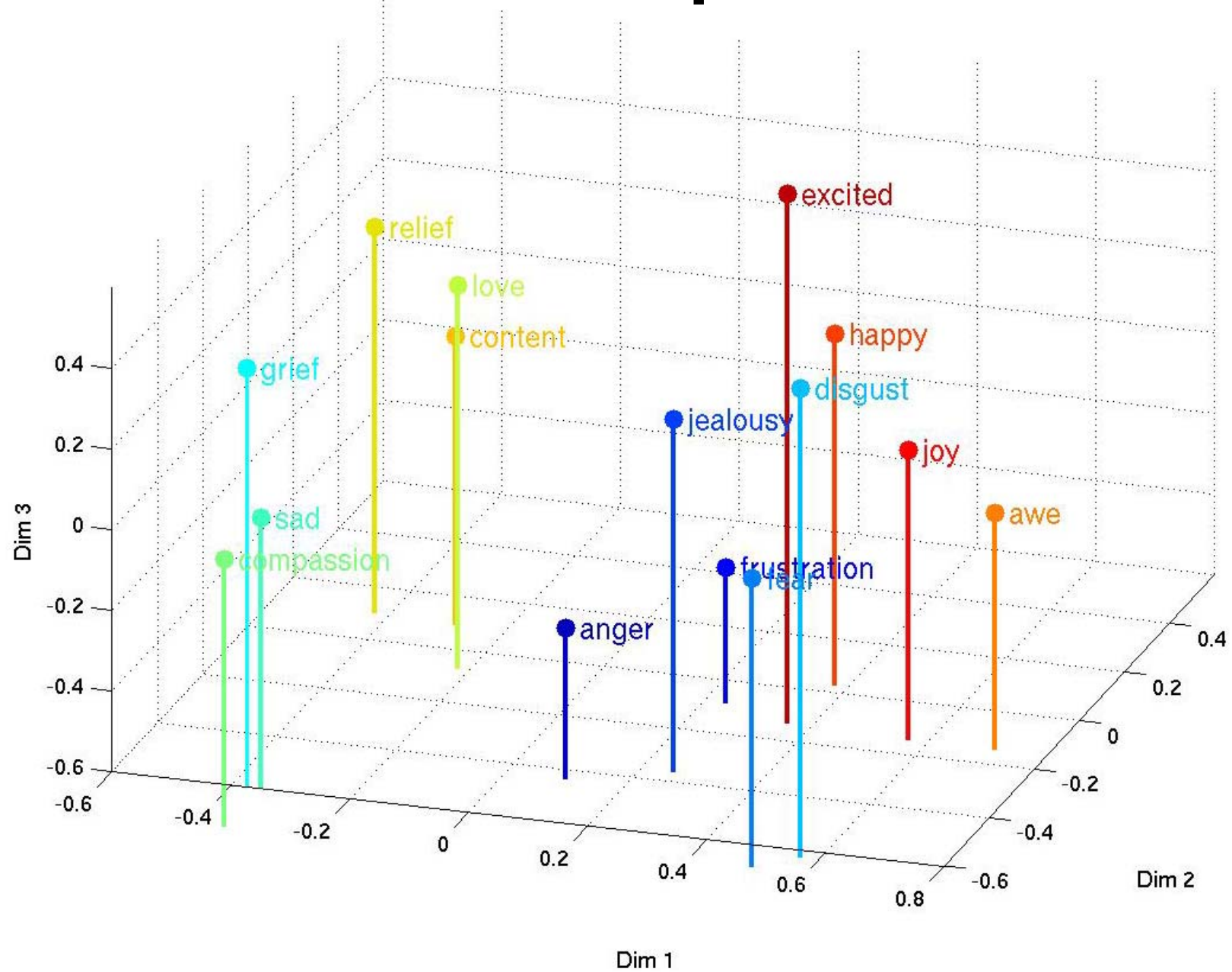
IM interactions during emotional imagery



IM interactions during emotional imagery



Emotion Space



Summary

- EEG data shows remarkable spectral changes over time
- Spectral changes can be modeled as independent modulators, possibly corresponding to neuromodulator influences
- Defining cognitive and/or emotional states will require consideration of joint actions of independent spectral modulators



*Thank you to
Jerry Swartz,
Scott Makeig,
and
thank you
for your attention*