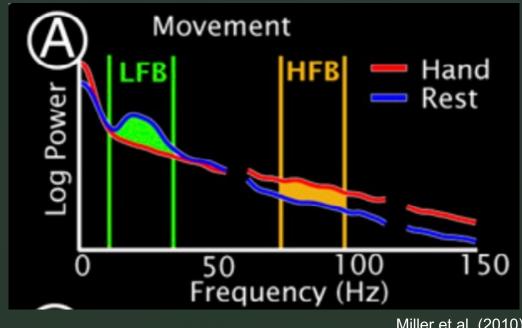
Motor power modulations during imagined movements

Neuromatch 2022

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Background

- relative power in **beta** frequency decreases within motor cortex during movement (event related desynchronization, ERD)
- relative power in high gamma frequency increases during movement (event related synchronization, ERS)



Miller et al. (2010)

Aims

- 1. Replicate prior ERD/ERS findings
- 2. Investigate how power profiles during <u>imagined</u> and <u>actual</u> movements differ
- 3. Design and build ML pipeline to classify actual and imagined movements, with and without high gammas

Hypotheses

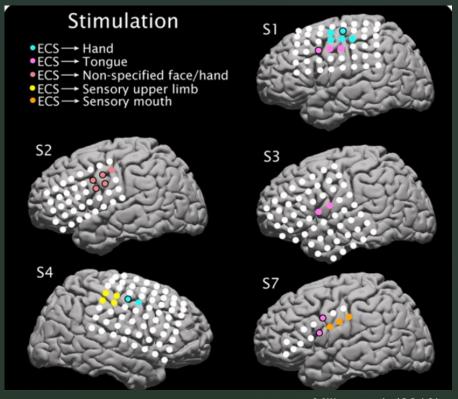
- A. Similar ERD in beta frequency between actual and imagined
- B. Attenuated changes in high gamma frequency for imagined movements in comparison with actual movements
- C. Models without high gamma input will significantly underperform in the discrimination task

Data

- ECoG recordings from subjects undergoing treatment for medically refractory epilepsy
- Two interleaved tasks at rate of once per second (1 Hz), alternating between task and rest, on-screen cue:
 - hand (synchronous flexion/extension of all fingers)
 - tongue (protrusion/retraction of tongue with mouth open)
- Two conditions: real movement, imagined movement
- Dataglove or EMG to verify absence of movement during imagined condition

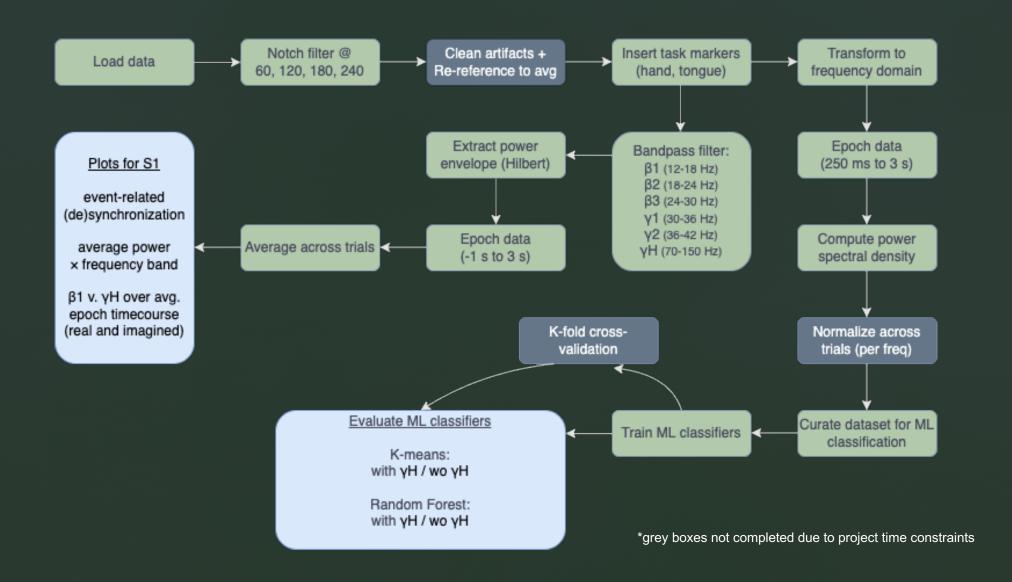
Data

- Electrocortical mapping for five participants (for clinical purposes)
- Provides indication of electrodes where stimulation causes movement
- Analyzed S1

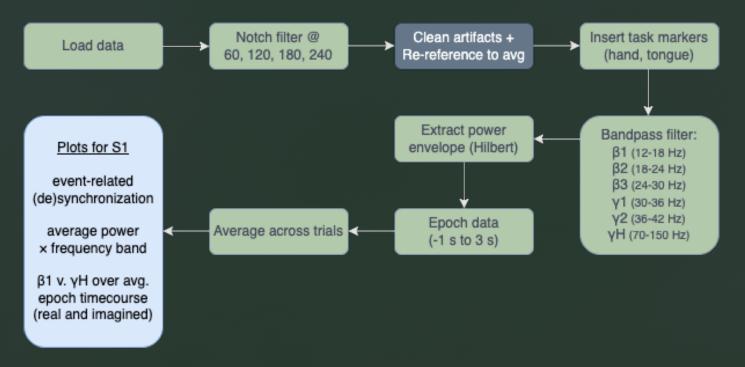


Miller et al. (2010)

Methods



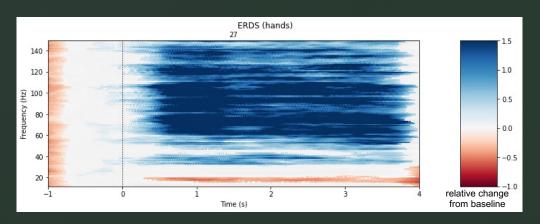
ExploratoryAims 1 and 2

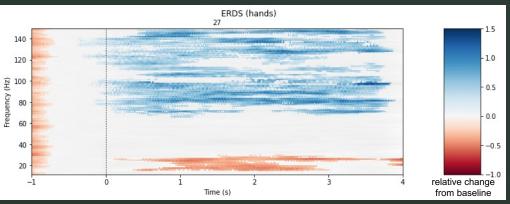


Aim 1: Replicate prior ERD/ERS findings

actual movement

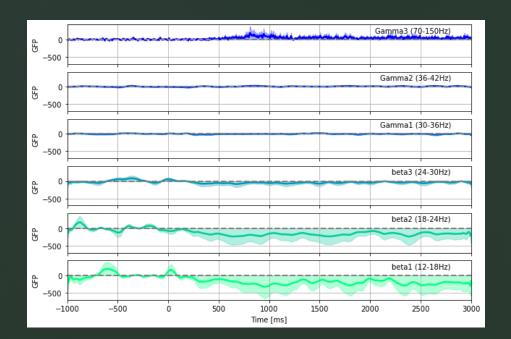
imagined movement



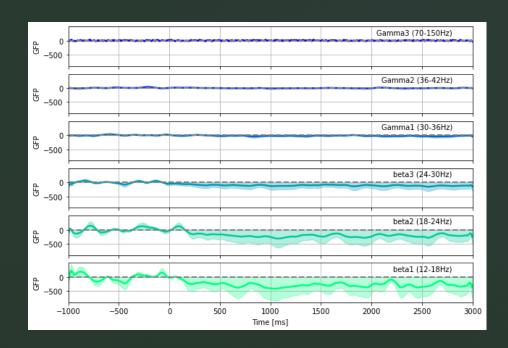


Aim 1: Replicate prior ERD/ERS findings

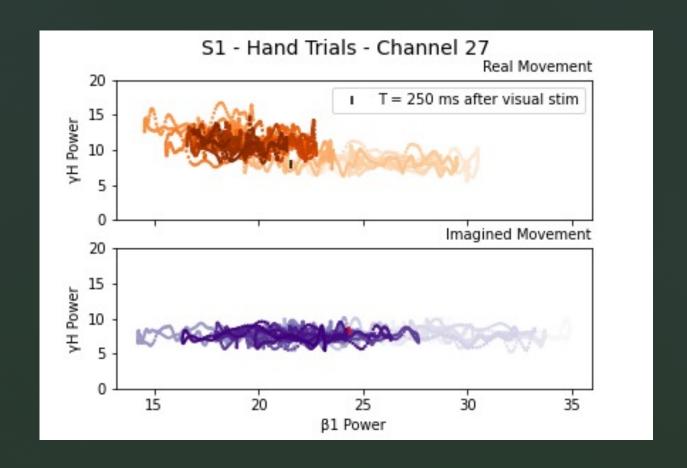
actual movement



imagined movement



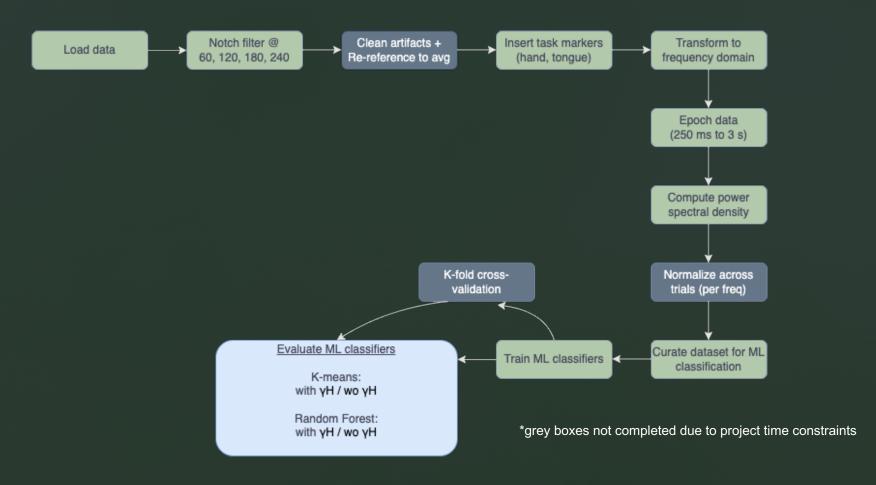
Aim 2: Investigate real v. imagined power



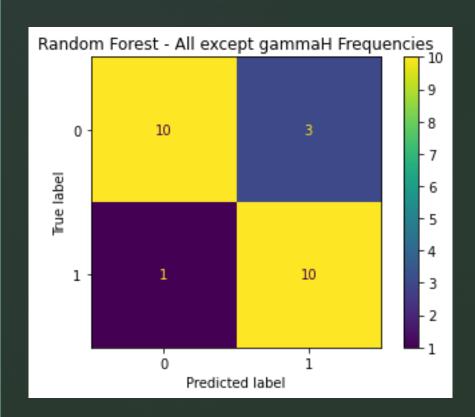
color (light > dark) indicates time course over epoch window (-1000 to 3000 ms)

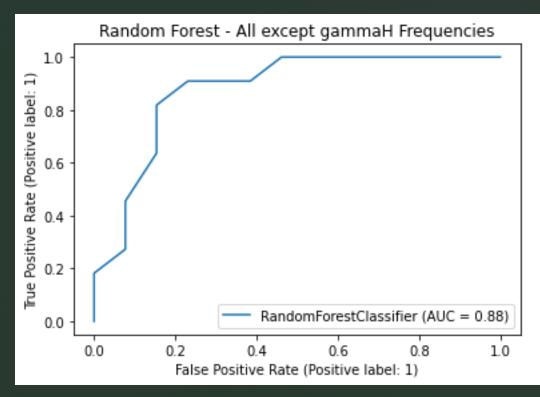
Aim 3

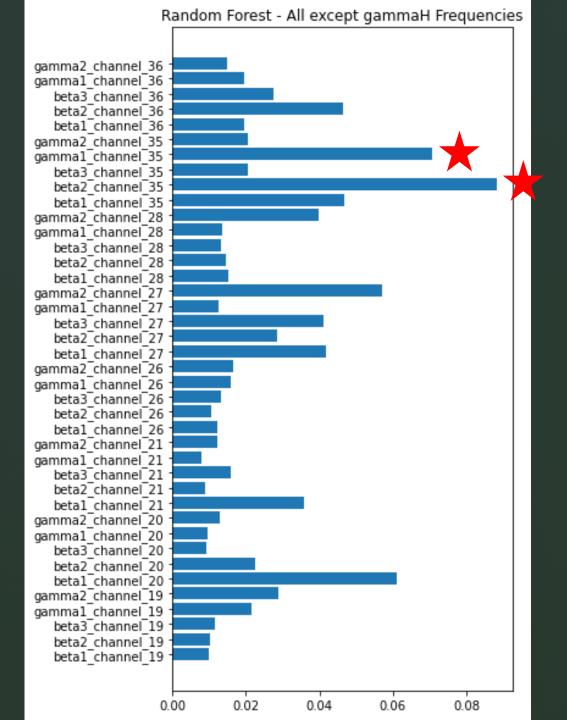
To what extent do lower frequency bands distinguish actual versus imagined movement?



Aim 3: Classify without high gamma







Aim 3: Classify without high gamma

Conclusions

- Similar ERD in beta frequency between actual and imagined
- Attenuated changes in high gamma frequency for imagined movements in comparison with actual movements
- 3. Low frequency only models will significantly underperform in the discrimination task

Better performance than anticipated (but models with high gamma still perform better...)

Limitations

- specific subject population reduces generalizability of findings
- project time constraints led us to simplify our preprocessing:
 - did not re-reference data to the average
 - did not perform ICA or other methods to identify and remove noisy (or epileptic) epochs in the channels we analyzed
- project time constraints led us to simplify our analyses:
 - did not z-score across trials within bands before classification
 - single randomized split for training/test (no thorough crossvalidation)

Code Availability

https://github.com/jessb0t/motorImagery

References

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- Unterweger, J., Seeber, M., Zanos, S., Ojemann, J. G., & Scherer, R. (2020). ECoG Beta Suppression and Modulation During Finger Extension and Flexion. Frontiers in Neuroscience, 14, 35.
- Code for creation of the GFP graphics based on the detailed example provided here:
 https://mne.tools/stable/auto examples/time frequency/time frequency global field power.html



Dr. José Biurrun Manresa, Project TA

Thanks!



Anis Zahedifard, Pod TA



Neuromatch Organizers and Volunteers



Dr. Jason Ritt, Project Mentor