Does Imagery Movement Share Similar Neural Mechanisms with Actual Movement?

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neuromatch academy

Our webpage

Want to know more?

Introduction

- “Imagery”: Imagined motor movement
  - preparation of actual movements
  - learning of complex motor skills.

- Miller et al. (2010):
  - the spatial distribution of activities in the primary motor area for imagery and actual movements overlap in low frequency band (8-32Hz), but does not overlap in high frequency (76-100Hz).

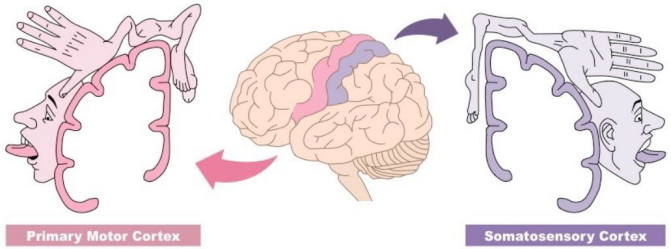
  However, Brinkman et al. (2014):
  - oscillatory power differ in the alpha (8-12 Hz) and beta frequency bands (18-25Hz) over sensorimotor regions during imagery

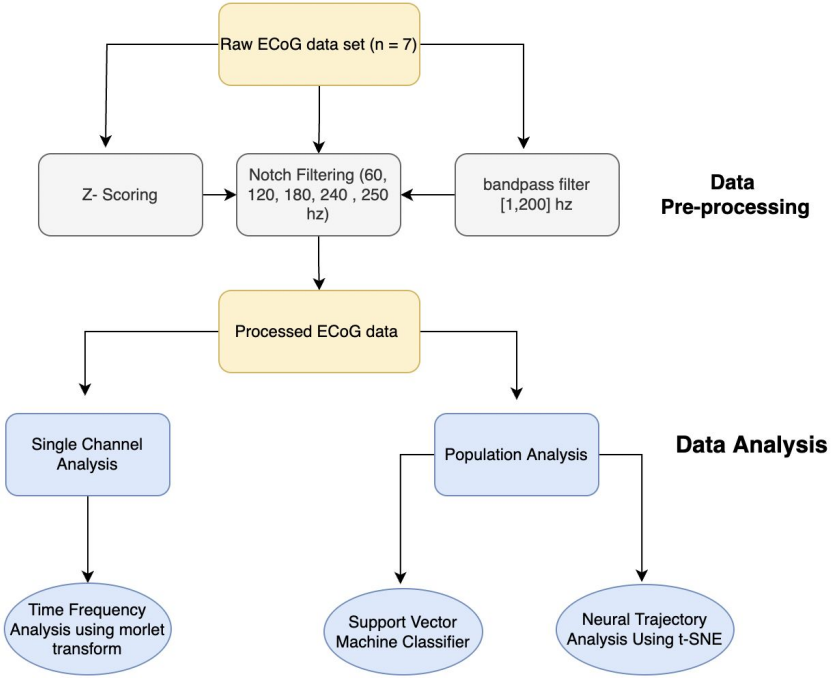
- Current study:
  - imagery ≈ actual movements？
    - both single-channel level and population level
  - Hypothesis:
    - alpha band_imagery, beta_actual movement

Method

Two tasks (n=7) :

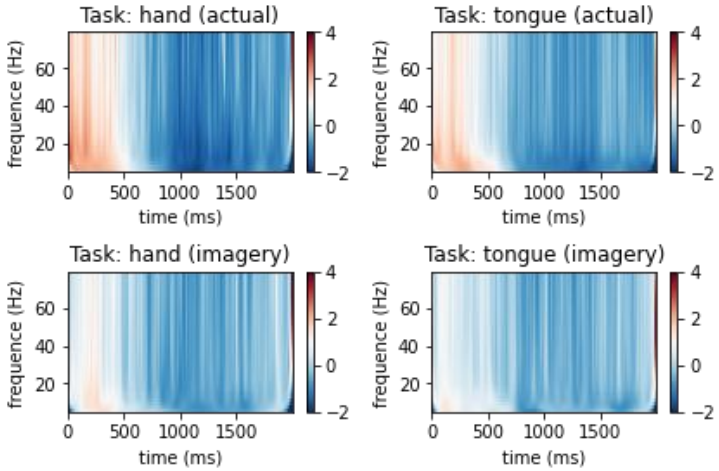
- **Actual Movement**
  - Tongue (30 trials)
    - *protrusion and retraction (1-2 Hz)*
  - Hand (30 trials)
    - *flexion and extension of all fingers (1-2 Hz)*
- **Imagery Movement (kinesthetic)**



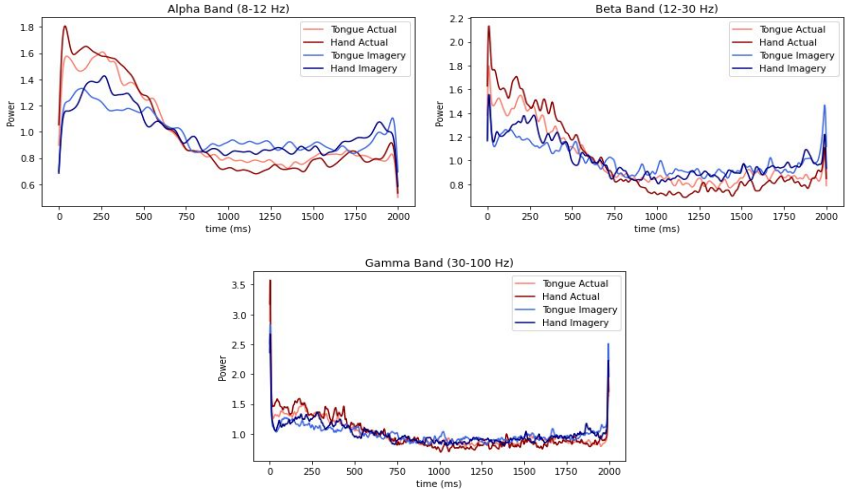


Do imagery and actual movement differ in alpha/beta power change?

Time Frequency Analysis

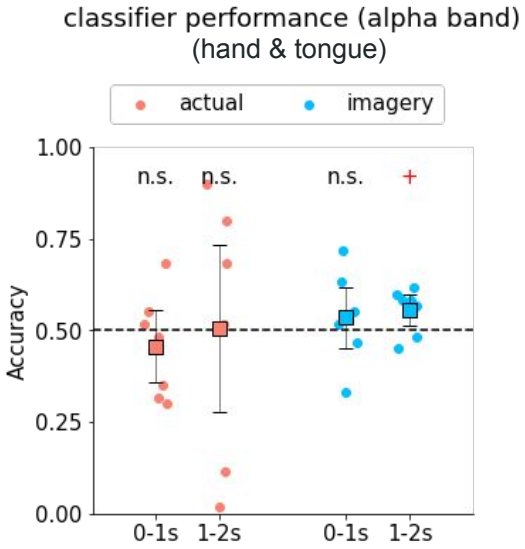


Band-Specific Activities (Alpha-Beta-Gamma)



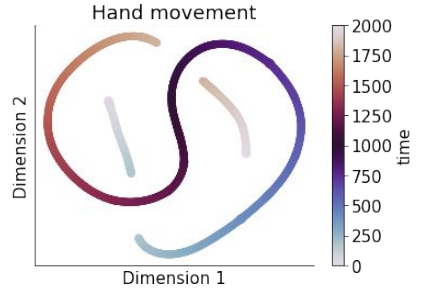
- ➔ Although imagery and actual movement differ in alpha/beta power change, both of them have similar power change between hand and tongue
- ➔ Further population-level analysis required

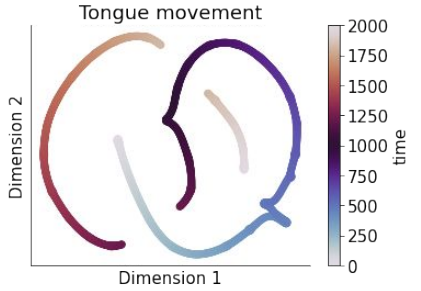
How do imagery and actual movement differ in representation of different movement types? (Alpha band)

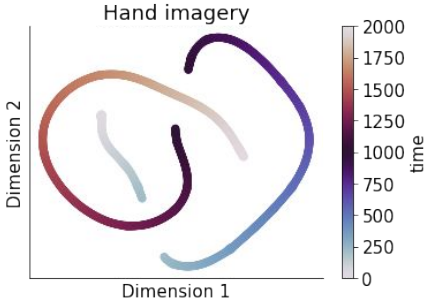


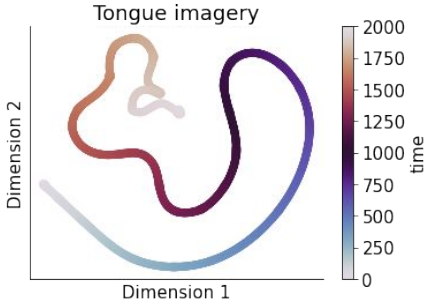
Actual

Imagery



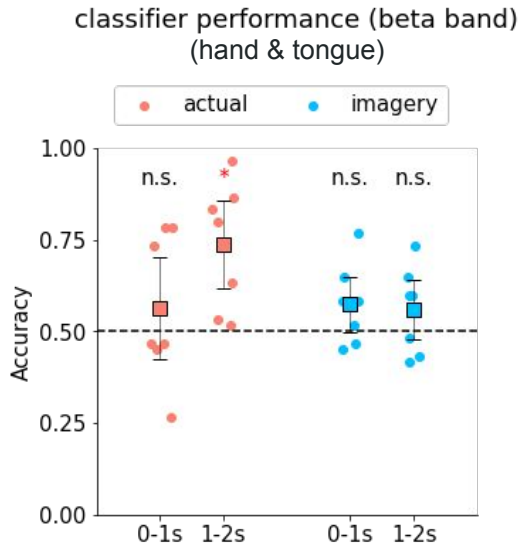






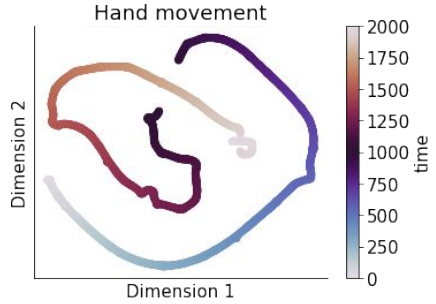
➔ Imagery representation relies on alpha power while actual movement does not

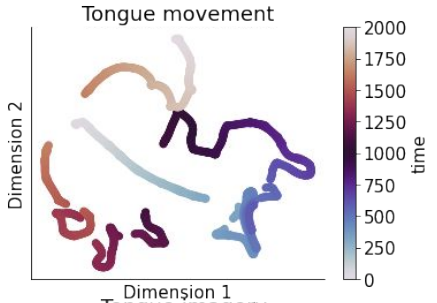
How do imagery and actual movement differ in representation of different movement types? (Beta band)

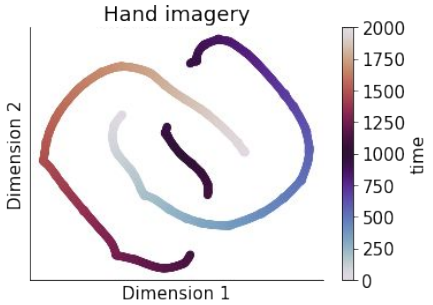


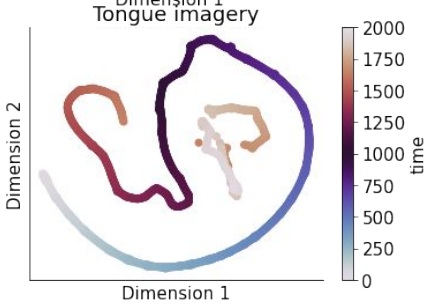
Actual

Imagery





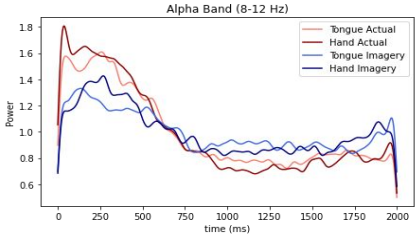


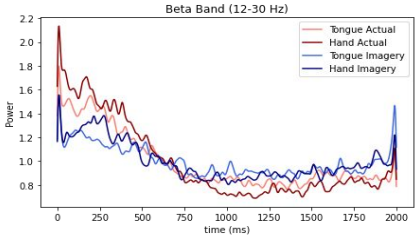


➔ Actual movement representation relies on beta power while imagery does not

Conclusion

- **Single-channel level**
  - imagery and actual movement differ in alpha/beta power change
  - alpha/beta power changes are similar within motion types
- **Population level (multivariate classification & neural trajectory)**
  - imagery and actual movement represents motion types at different frequency band
    - imagery relies on alpha band (arousal, working memory...)
    - actual movement relies on beta band (movement)





➔ **there exists distinct representation of imagery and actual movement**

Thank you!

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Contact us on our web 🥳

raclette-project.netlify.app

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References

1. Miller, K. J., Schalk, G., Fetz, E. E., Den Nijs, M., Ojemann, J. G., & Rao, R. P. (2010). Cortical activity during motor execution, motor imagery, and imagery-based online feedback. *Proceedings of the National Academy of Sciences*, *107*(9), 4430-4435.

2. Brinkman, L., Stolk, A., Dijkerman, H. C., de Lange, F. P., & Toni, I. (2014). Distinct roles for alpha-and beta-band oscillations during mental simulation of goal-directed actions. *Journal of Neuroscience*, *34*(44), 14783-14792.

3. Fronto-parietal networks shape human conscious report through attention gain and reorienting (i dont know how to cite in biorxiv)

Supplementary (code is available on github)

- **Time frequency analysis**
  - morlet (mne)
- **SVM classifier**
  - Leave-one-trial-out cross validation (sklearn.svm)
- **Neural trajectory**
  - First do PCA to reduce dimensionality to 20 dimensions (sklearn.decomposition)
  - Then do tSNE to reduce dimensionality to 2 dimensions (sklearn.manifold)