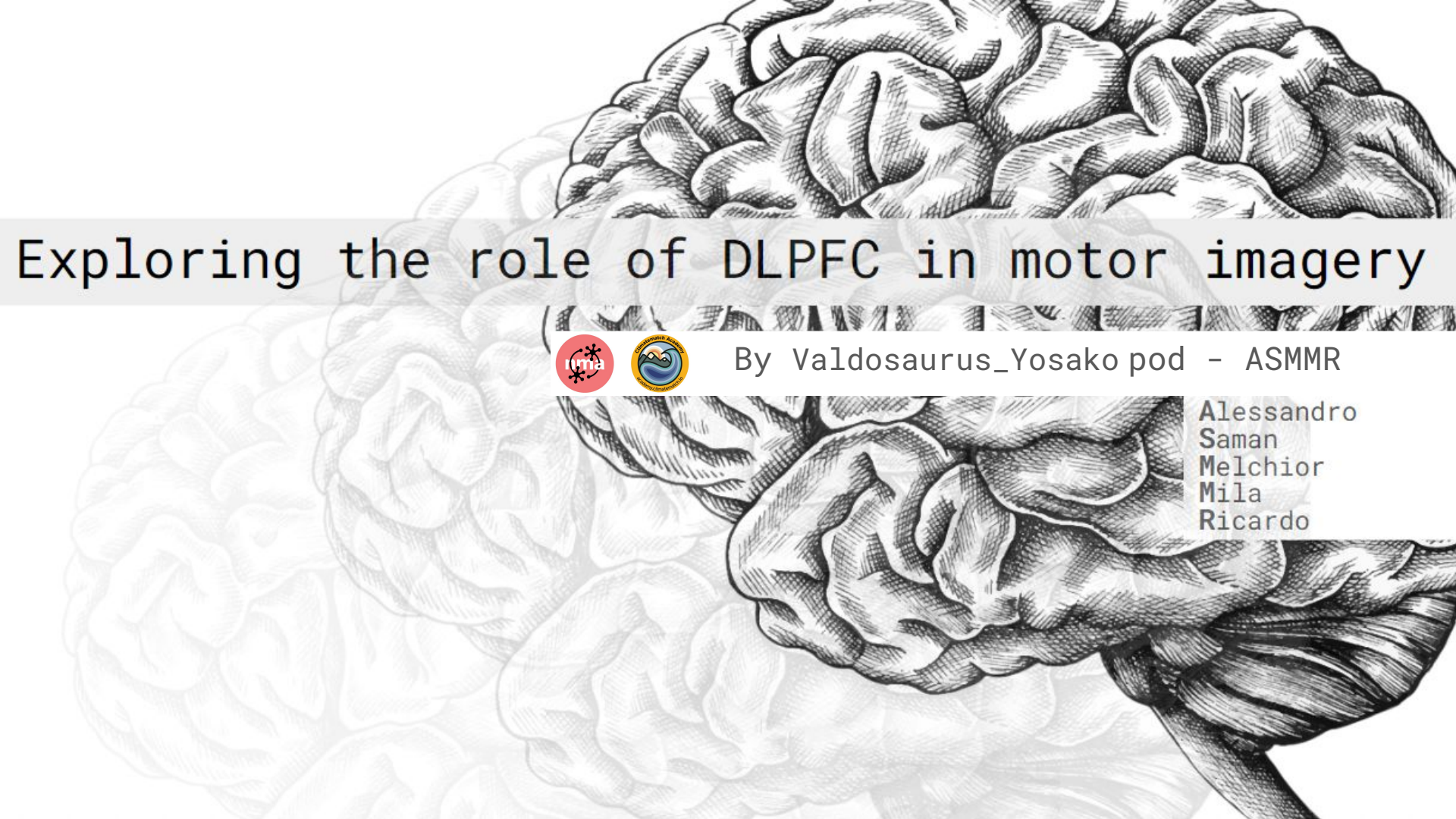

Exploring the role of DLPFC in motor imagery

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Saman
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Mila
Ricardo

The question

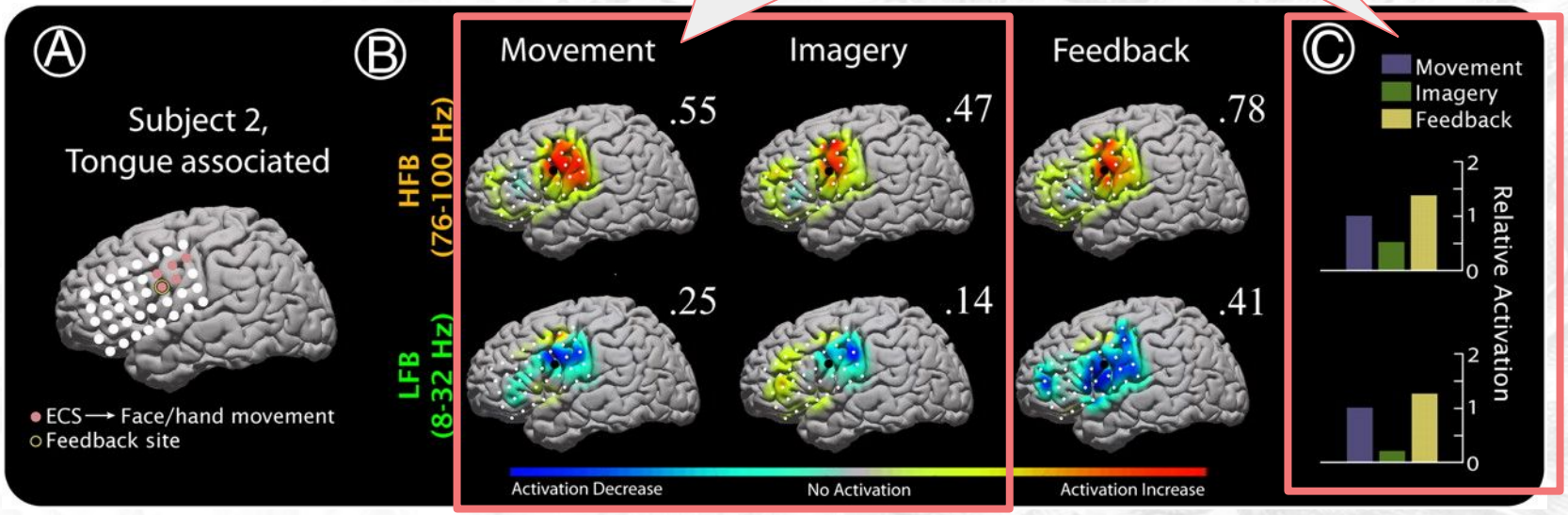
Is the activity of TBFp in DLPFC relevant in the discrimination between Motor Imagery and Motor Execution?

Introduction

Activity in Motor Imagery vs Motor Execution*

Spatial distribution: roughly similar

Power: higher in ME



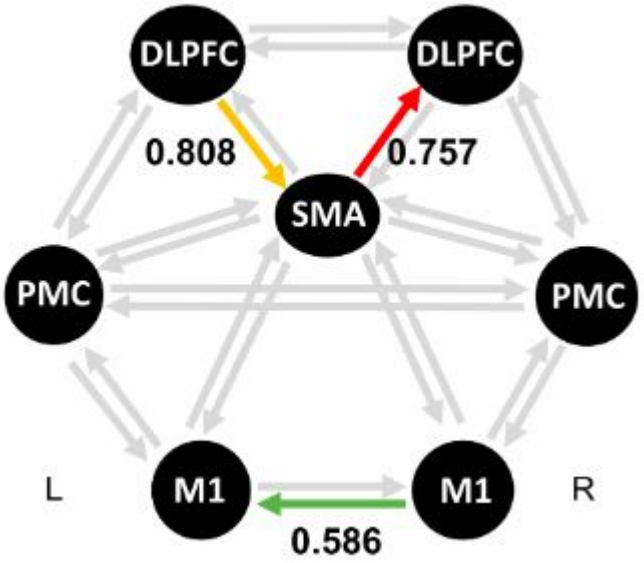
*Miller, Kai J., Gerwin Schalk, Eberhard E. Fetz, Marcel Den Nijs, Jeffrey G. Ojemann, and Rajesh PN Rao. "Cortical activity during motor execution, motor imagery, and imagery-based online feedback." Proceedings of the National Academy of Sciences (2010): 200913697. doi: 10.1073/pnas.0913697107

Introduction

Connectivity studies:

Significant role for DLPFC in motor imagery*

Significant role for Theta band in particular



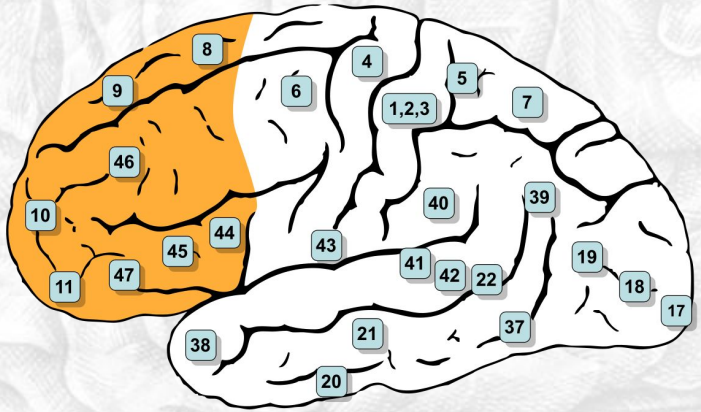
*Lee, M., Yoon, J. G., & Lee, S. W. (2020). Predicting Motor Imagery Performance From Resting-State EEG Using Dynamic Causal Modeling. Frontiers in human neuroscience, 14, 321. https://doi.org/10.3389/fnhum.2020.00321

The hypothesis

DLPFC activity during Motor Imagery is different from its activity during Motor Execution

These conditions can be differentiated by the TFBp activity in **DLPFC**

(Brodmann areas - 9, 46)

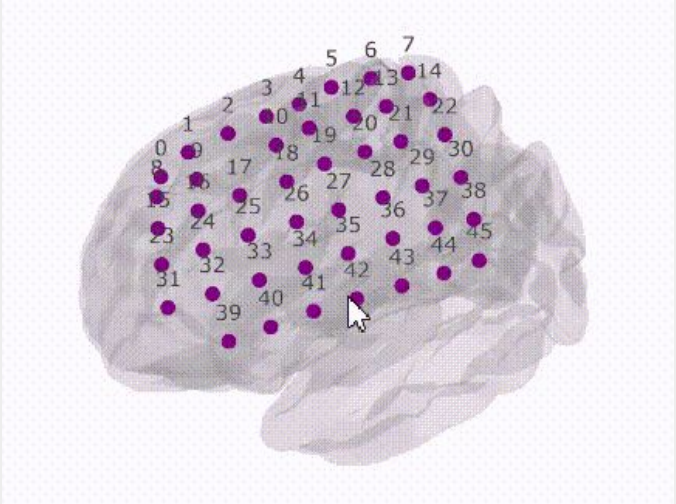


The data

*Miller ECoG data of motor imagery**

Continuous ECoG time series from **left frontal** and **parietal** lobes:

- 46 electrodes
- 1000 Hz
- 30 trials per condition (hand/tongue, MI/ME)
- 376 seconds



Miller et al. 2010

*Originally described in this paper - Miller, Kai J., Gerwin Schalk, Eberhard E. Fetz, Marcel Den Nijs, Jeffrey G. Ojemann, and Rajesh PN Rao. "Cortical activity during motor execution, motor imagery, and imagery-based online feedback." Proceedings of the National Academy of Sciences (2010): 200913697. doi: 10.1073/pnas.0913697107

Model specifics

Objective:

distinguish MI and ME, in hand and tongue movements separately

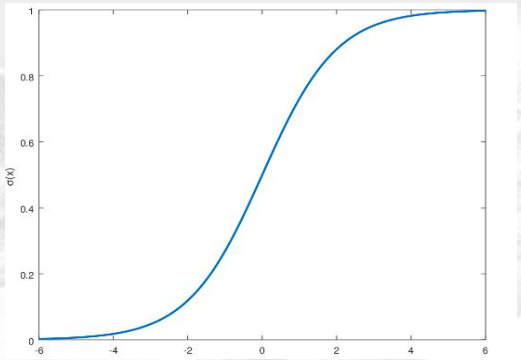
Model:

A logistic regression classifier with:

- 8 fold cross-validation
- L2 penalty

Features:

- BA9: Theta band(4-8Hz) power in Brodmann Area 9, in time domain
- BA46: Theta band(4-8Hz) power in Brodmann Area 46, in time domain
- HFBp: High (70-100Hz) frequency band power in Motor areas, in time domain
- LFBp: Low (8-32Hz) frequency band power in Motor areas, in time domain



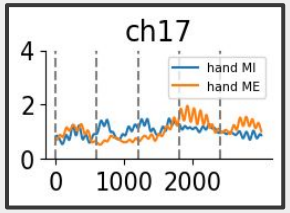
Additional considerations:

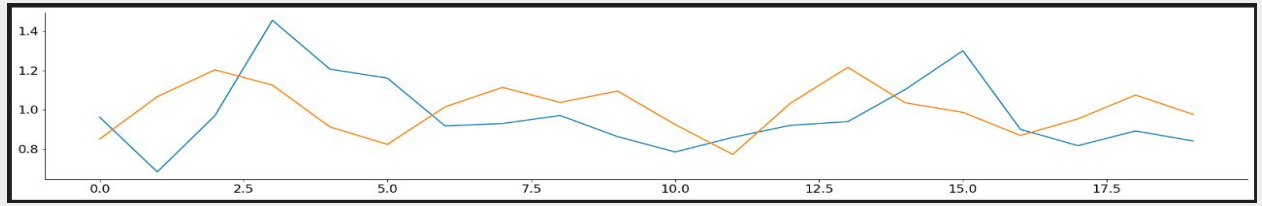
to ensure appropriate proportions in the design matrix, the power data in each trial were averaged over 5 consecutive windows, reducing the total number of features.

Features

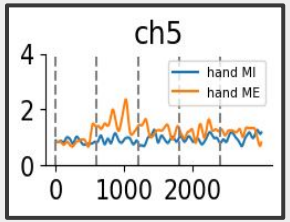
Frequency band powers in time domain, electrodes of interest

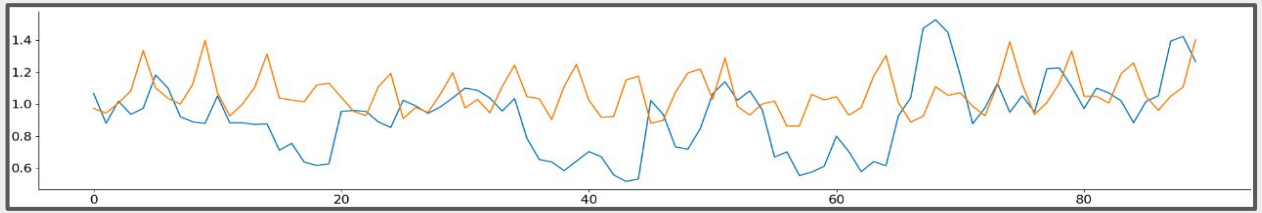
Theta-DLPFC



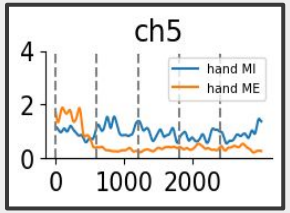


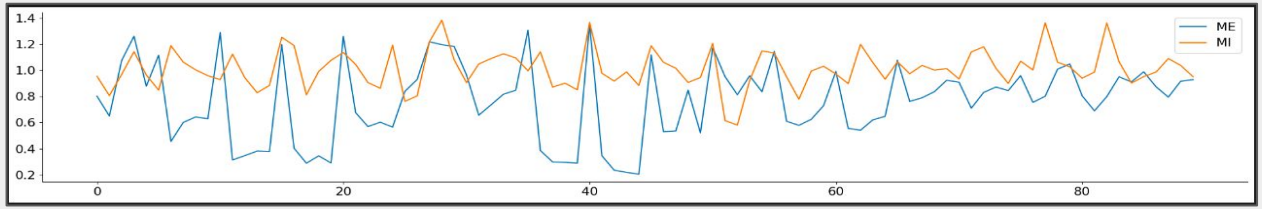
HFB-Motor



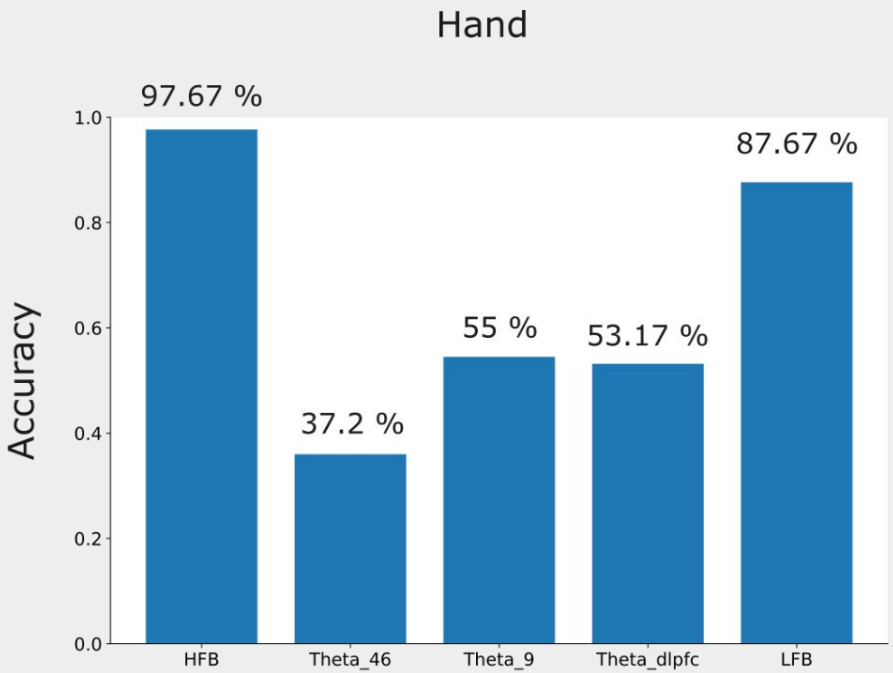


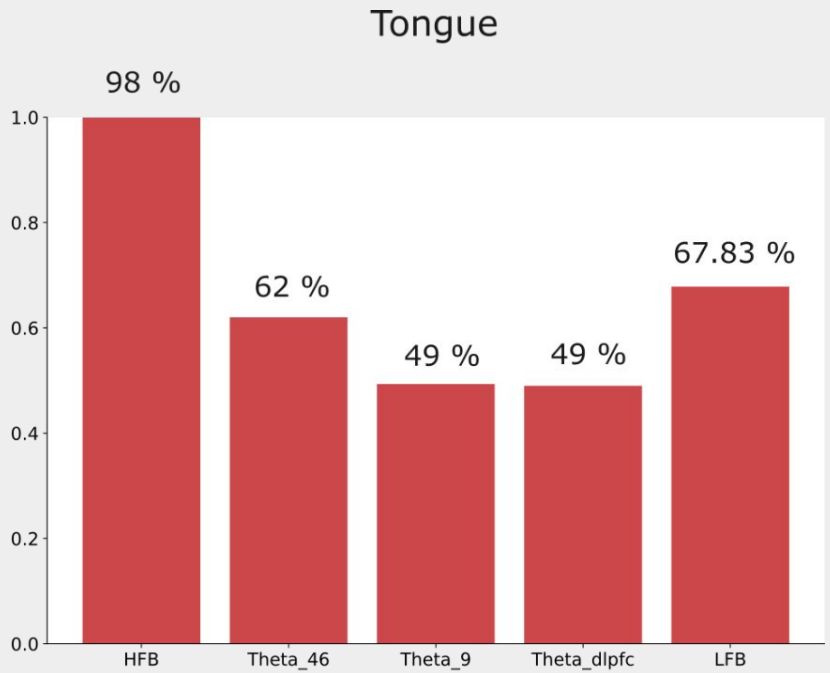
LFB-Motor





Results


Hand
Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
97.67 %
37.2 %
55 %
53.17 %
87.67 %
HFB
Theta_46
Theta_9
Theta_dlpfc
LFB


Tongue
1.0
0.8
0.6
0.4
0.2
0.0
98 %
62 %
49 %
49 %
67.83 %
HFB
Theta_46
Theta_9
Theta_dlpfc
LFB

Conclusions

Even though the connectivity between DLPFC and motor areas has been shown to have a major and even causal role in Motor Imagery, **our results show that the isolated theta band power activity of DLPFC is not a good feature to use to distinguish ME from MI.**

Limitation:

small sample size
(30 trials per condition)

Suggestion for further research:

Focus on the connectivity between DLPFC and motor areas, for example through Granger Causality, instead of the mere activity power of DLPFC.

References

- Miller, Kai J., Gerwin Schalk, Eberhard E. Fetz, Marcel Den Nijs, Jeffrey G. Ojemann, and Rajesh PN Rao. "Cortical activity during motor execution, motor imagery, and imagery-based online feedback." Proceedings of the National Academy of Sciences (2010): 200913697. doi: 10.1073/pnas.0913697107
- Lee, M., Yoon, J. G., & Lee, S. W. (2020). Predicting Motor Imagery Performance From Resting-State EEG Using Dynamic Causal Modeling. Frontiers in human neuroscience, 14, 321. https://doi.org/10.3389/fnhum.2020.00321