Motor-Imagery Brain-Computer-Interfaces performances correlate with subject-specific frequency band characteristics

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INTRODUCTION

- Motor-Imagery based Brain Computer Interfaces (MI-BCIs)
  - are based on signals produced during **Motor-Imagery tasks**
  - require, to be efficiently controlled, the **acquisition of specific skills**, and thus a **dedicated user-training**
  - are systems that **need a calibration** for each user using **data driven** methods

SCIENTIFIC QUESTION

Data driven methods that are commonly use to calibrate the system often **ignore the human training and learning.**

Can those approaches reach optimal performances?

OBJECTIVES

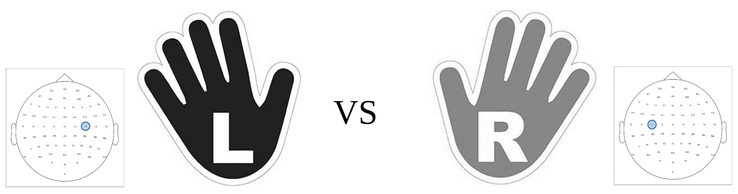
In this work, we want to study if there is a link between user performances and characteristics of one data driver method: **The frequency band selection algorithm [2].**

DATASET AND PROTOCOL

Dataset [1]

59 healthy MI-BCI naive subjects

Left and Right hand motor imagery



Experimental protocol:

Two calibration runs

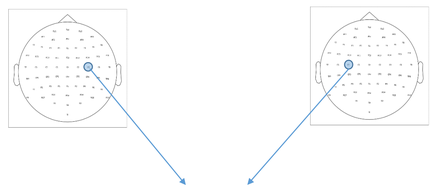
+

Four training runs

For each run: 20 trials/task

Calibration of the system

Frequency Band Selection



Most Discriminant Frequency Band (MDFB) in the α-β range[2]

To better discriminate which task the user is performing

α: 8-12 Hz β: 12-35 Hz

Available data for each subject

Mean online classification accuracy

MDFB **Mean value**

MDFB **Length**

Analyses

- Correlation between MDFB Mean value and classification accuracy
- Correlation between MDFB Length value and classification accuracy

RESULTS

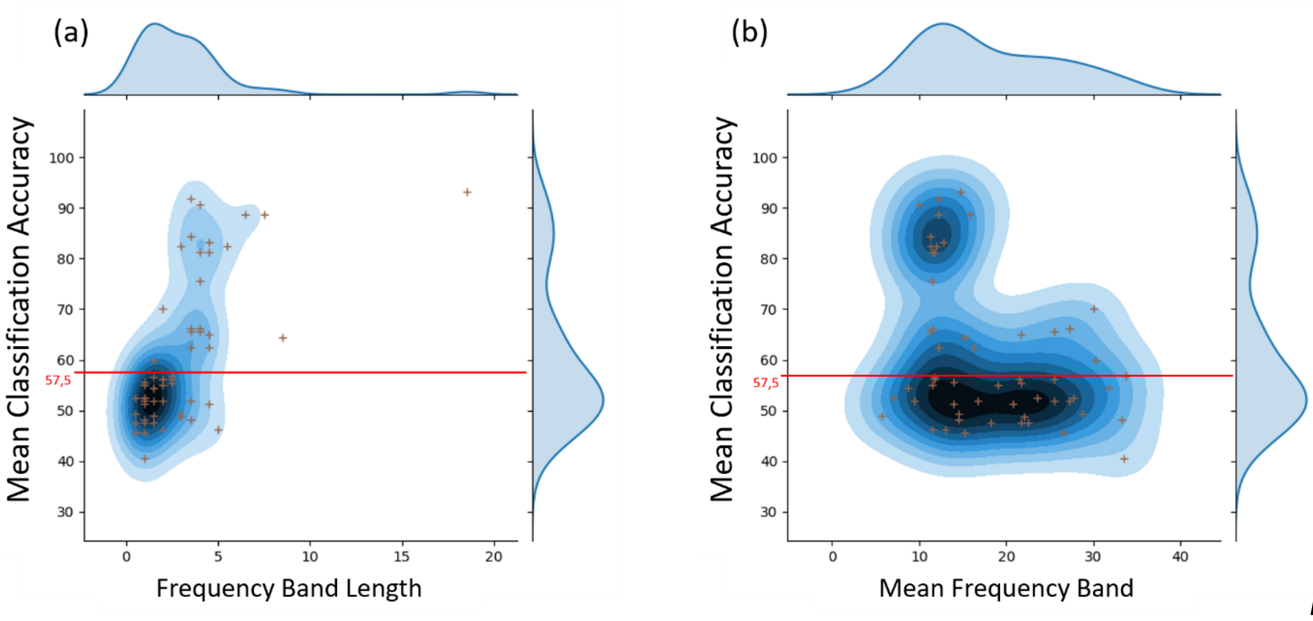


Figure 1. *Bivariate distribution of the frequency band length (a) and the mean frequency of the band (correlation: r=0.67, p<10^{-8})(b) with the mean classification accuracy (correlation: r=-0.34, p<.01). In red, the chance level for 2-classes, 80 trials per class and α=5%.*

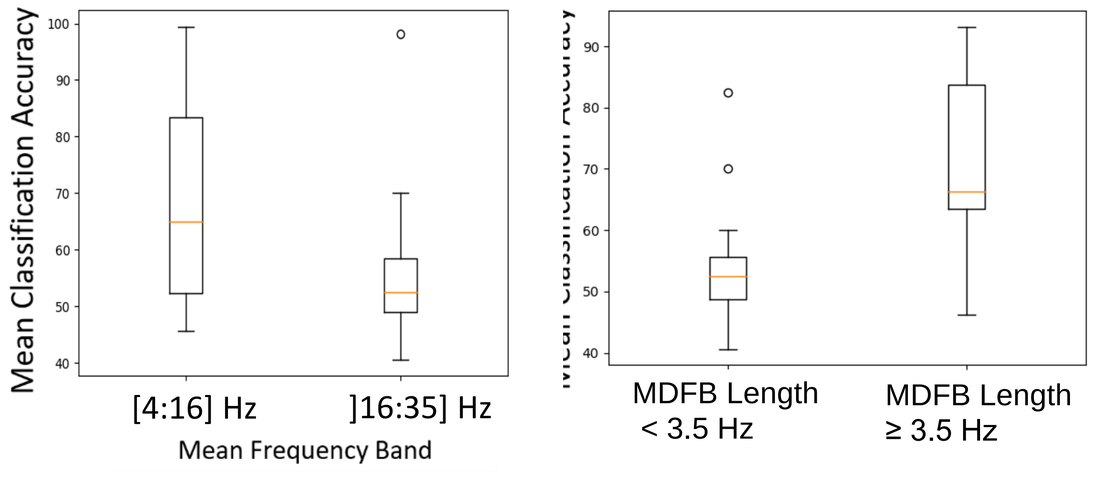


Figure 2. *Boxplot that show (a) a **significant difference** of the mediane of the two groups (MDFB Mean value in [4:16] or in]16:35] (Wilcoxon test: s=2.6, p<.05) and (b) a **significant difference** of the mediane of the two groups (MDFB Length <3.5 or MDFB Length ≥3.5 (Wilcoxon test: s=-4.4, p<10^{-5}) (thresholds were fixed visually using Figure 1. results)*

CONCLUSION AND FUTURE WORK

- **Online Performances correlate** with the characteristics of the selected most discriminant frequency band: MDFB **Mean value** and MDFB **Length.**
- Subjects with MDFB **Length** < 3.5 Hz seem to have difficulties controlling a BCI compared to subject with higher MDFB **Length**
- Subjects with a MDFB **Mean value** above 16 Hz (in β band) seem to have lower performances than subjects with a MDFB **Mean value** under 16 Hz (in α band)
- ? Could we use this MDFB to predict performances?
- ? Could putting constraints on the frequency band selection algorithm improve user performances?

REFERENCES

[1] Roc et. Al,. Would Motor-Imagery based BCI user training benefit from more women experimenters?", 8th Graz-Brain-Computer Interface Conference, 2019

[2] Blankertz et. Al, (2007). Optimizing spatial filters for robust EEG single-trial analysis, IEEE Signal processing magazine

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