Disentangling Blink Reflexes in Multiple Sclerosis with machine learning techniques

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PAST

Brainstem dysfunctions are common in Multiple Sclerosis (MS) and are a critical predictive factor for future disability[1]. Brainstem functionality can be explored with blink reflexes, i.e., subcortical responses consisting in a blink following peripheral stimulation. **Hand blink reflex (HBR)** [2,3], differently from other reflexes like the **trigeminofacial blink reflex (TBR)**[4], is modulated by the proximity of the stimulated hand to the face. Despite brainstem dysfunctions are very common in MS, HBR was never been investigated in people with MS (PwMS). Due to its sensitivity to a top-down modulation, the study of HBR in PwMS could allow investigating the activity of the cortico-bulbar circuits and provide information related to functionality of the corticalbrainstem pathways.

AIM: Main goal was to investigate HBR response, its relationship with the motor and associative cortical regions in PwMS with a relapsing-remitting multiple sclerosis course and its possible alteration due to the disease.

- 20 PwMS
- 20 Healthy Controls

Reflexes were recorded by means of two MP100 BIOPAC EMG channels from the orbicularis oculi muscles bilaterally.

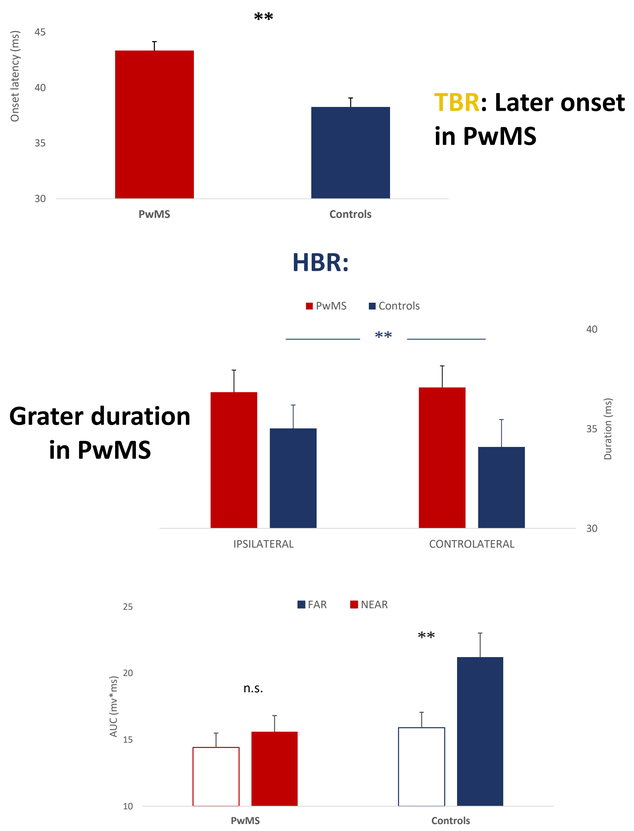
TBR

TBR was evoked by administering transcutaneous electrical stimuli to the supraorbital branch of the trigeminal nerve.

HBR

HBR was evoked by administering transcutaneous electrical stimuli to the median nerve.
HBR was elicited bilaterally in two conditions, NEAR and FAR, with the stimulated hand of the subject respectively near and far from the face.

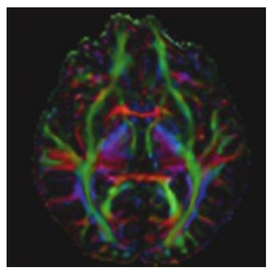
Results:

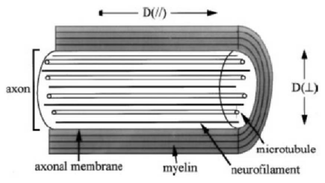


TBR: Later onset in PwMS

Grater duration in PwMS

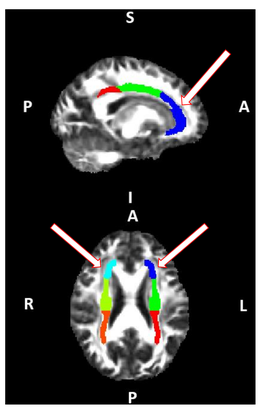
PwMS did not show the physiological HBR modulation related to the hand proximity to the body → possible alteration in the near-space representation.

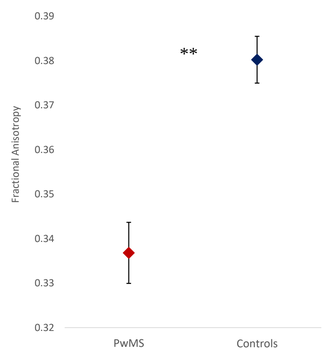




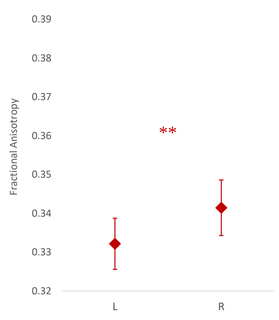
To investigate microstructural integrity of the cortico-brainstem pathway in association with reflexes features, participants underwent Diffusion Tensor Imaging (DTI: 3 Tesla, 64 non collinear directions; b=1000 s/mm^2).
By using FSL-FDT we obtained parametric maps of fractional anisotropy, mean diffusivity, axial diffusivity, and radial diffusivity. The mean value of each parameter was calculated on each scan as indication of tissue integrity in the whole white matter (**WM**) and in different white matter tracts, with special focus on the corona radiata (**CR** – **anterior, posterior** and **superior**), a bundle of ascending and descending fibers connecting the brainstem to the cerebral cortex.

Results:



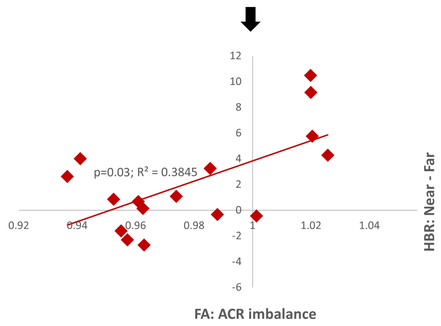


Lesser with matter integrity in PwMS

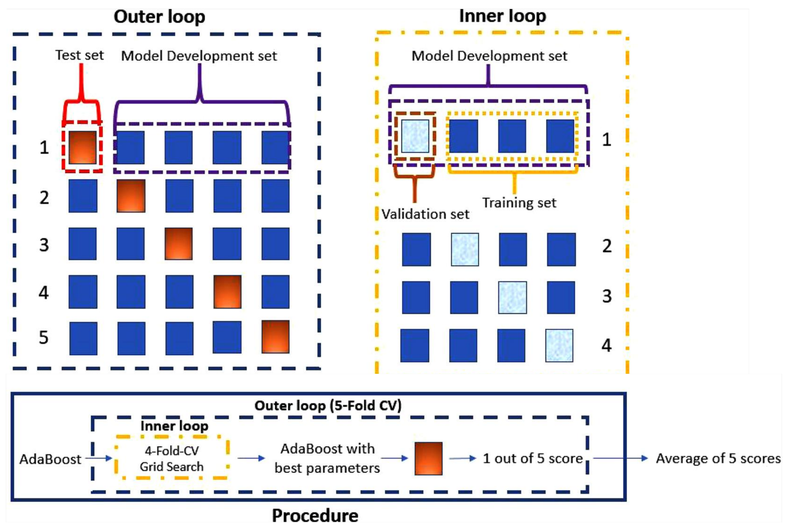


Higher imbalance in the PwMS showing less HBR modulation

➡ **Greater imbalance between left and right hemisphere** in PwMS



We explored neurophysiological data with Machine Learning (ML) techniques.
- Datasets based on HBR and TBR features.
- Dichotomic classification(PwMS/Control)
- Nested 5-fold-cross-validation procedure



Comparison between classifiers:

-Adaboost
-k-nearest neighbors
-Support Vector Machine
-Random Forest
-feedforward neural network (NN)

Results:

AdaBoost classifiers showed the highest accuracy for both datasets.

Class	Metrics	HBR	TBR
	Accuracy [%]	86.7	73.3
PwMS	Recall [%]	88.3	71.7
	Precision [%]	91.0	82.7
	F1-Score [%]	89.6	76.8
Control	Recall [%]	83.3	76.7
	Precision [%]	88.3	74.7
	F1-Score [%]	85.8	75.7

$$\text{Accuracy\%: } \frac{true\ positive + true\ negative}{N} \cdot 100 \qquad \text{Precision: } \frac{true\ positive}{true\ positive + false\ positive}$$

$$\text{F1-Score: } \frac{2 \cdot Recall \cdot Precision}{Recall + Precision} \qquad \text{Recall: } \frac{true\ positive}{true\ positive + false\ negative}$$

Machine learning for exploring neurophysiological functionality in multiple sclerosis based on trigeminal and hand blink reflexes.[5]

PRESENT

FUTURE

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DESCRIBE specific alteration of HBR in PwMS with ML in relation with clinical parameters on 100 PwMS and 100 Controls.

Extract the most relevant features of the reflex and virtually **REPLICATE** subject responses .

MONITOR patient's response after 18 months, with the goal to identify biomarkers reflecting pathology.

Bibliography

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