Exploring the Cerebellum with Functional Near-Infrared Imaging: A Preliminary Study

Giulia Rocco, Jerome Lebrun, Olivier Meste, Marie-Noële Magnié-Mauro

IEEE - ISBI 2021
International Symposium on Biomedical Imaging

Exploring the Cerebellum with functional Near-Infrared Imaging: a preliminary study

G. ROCCO [1], J. LEBRUN [1], M.N. MAGNIÉ-MAURO [2,3], O. MESTE [1]

[1] I3S Laboratory, [2] BCL Laboratory, [3] Centre Hospitalier Universitaire - Université Côte d'Azur, Nice, France

INTRODUCTION

Cerebellum

- Well-known role in **motor** co-ordination
- Involvement in **emotion** and **cognition**, but mechanisms still unclear

AIM

To examine the possibility to use a novel technique to study the cerebellar role in motor and cognitive processes as an alternative to functional Magnetic Resonance Imaging (fMRI), namely **functional Near-Infrared Spectroscopy** (**fNIRS**):

- ✓ Higher time resolution
- ✓ Low-cost and flexible

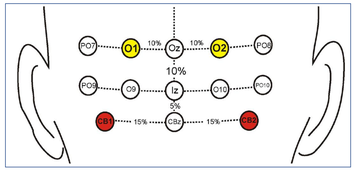
METHOD

Experimental protocol

One subject was sitting on a chair in a dark room performing a finger tapping task.

Data acquisition

The Artinis Oxymon III system was used, by setting the wavelengths at 763 and 858 nm with sampling rate at 50 Hz. Two channels were acquired with the optodes placement inspired by [1], where CB1 and CB2 positions were added to the 10/20 EEG system.



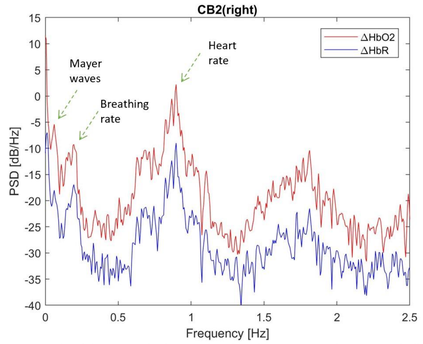
The added optodes, CB1 and CB2, are shown in the red circles. The proportion distances are with respect to the 10/20 system and used as reference for the placement.

RESULTS

Data quality assessment

The neurovascular coupling between the optodes and the scalp was verified by a frequency domain analysis. The Power Spectral Density of the signal was computed, where some components are visible as a proof of adequate coupling:

- Mayer waves
- Breathing rate
- Heart rate

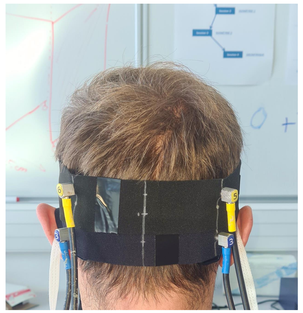


An example of the PSD of a fNIRS signal is shown. Several extra-cerebellar components are visible by indicating appropriate neurovascular coupling.

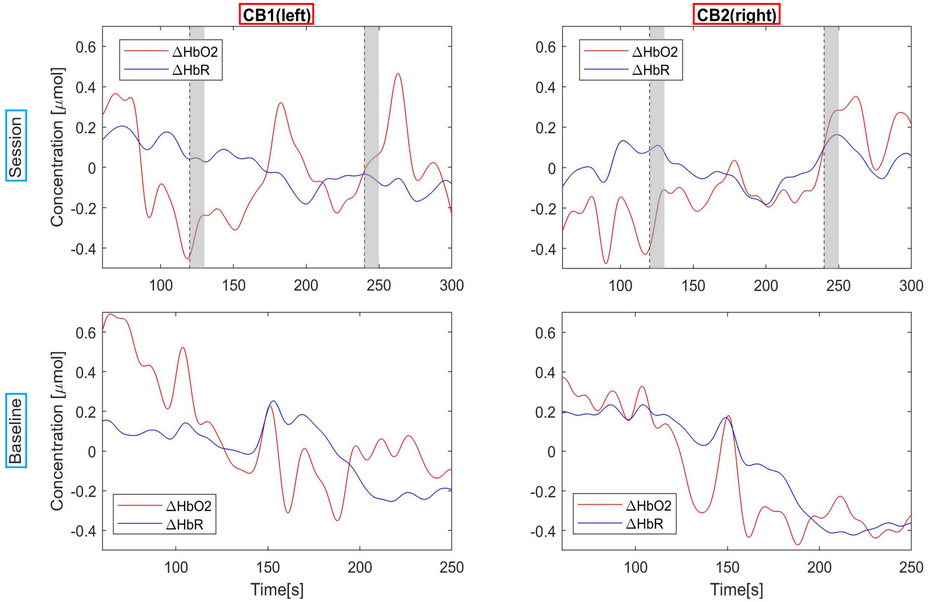
Data analysis

The measured light intensities were converted to local changes in oxygenated (ΔHbO2) and deoxygenated (ΔHbR) hemoglobin concentrations A band-pass FIR filter with order 1000 and cut-off frequencies 0.01 – 0.07 Hz was applied [2].

- Decrease of ΔHbO2 and ΔHbR in baseline
- Linear increase of ΔHbO2 during session with two peaks in both hemispheres after the left and the right finger tapping phases.



The experimental settings: light emitters (in yellow) and receivers (in blue) held by a headband.



At the top: fNIRS signals measured during the experimental session, respectively for CB1 and CB2. In both plots, the dashed areas represent respectively the duration of the left finger tapping and the right one. At the bottom: fNIRS signals measured during the baseline, respectively for CB1 and CB2

CONCLUSIONS

- fNIRS is able to discriminate between baseline condition and experimental session, detecting **hemodynamic changes** due to cerebellar activity (BOLD paradigm).
- The hemodynamic changes in fNIRS signal appear correlated to the subject's engagement in the task, thus stimulus-induced.
- This study pioneers a **novel** way of exploring the cerebellum and suggests **differences in its hemodynamic behavior** compared to the **brain**.
- Extended experimental sessions are planned to gain deeper insight.
- Coupling with other techniques, like EEG, is available and will be implemented in future analyses.

REFERENCES

[1] **Todd N.P., Govender S., and Colebatch J.G.** The human electrocerebellogram (ECeG) recorded non-invasively using scalp electrodes. *Neuroscience letters 2018; 682: 124-131.*

[2] **Pinti P., Tachtsidis I., Hamilton A., Hirsch J., Aichelburg C., Gilbert S., and Burgess P. W.** The present and future use of functional near-infrared spectroscopy (fNIRS) for cognitive neuroscience. *Annals of the New York Academy of Sciences 2020; 1464(1): 5.*

ACKNOWLEDGEMENTS

This project has received funding from Horizon 2020 COFUND programme "BoostUrCareer" under the Marie Sklodowska-Curie grant agreement no. 847581. We would like to thank LAHMESS - STAPS for supporting our experiments.

CONTACT INFORMATION

Mail: grocco@i3s.unice.fr