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Asymmetries in Cerebellar Activation during Finger Movements: A Functional Near-Infrared Spectroscopy Study

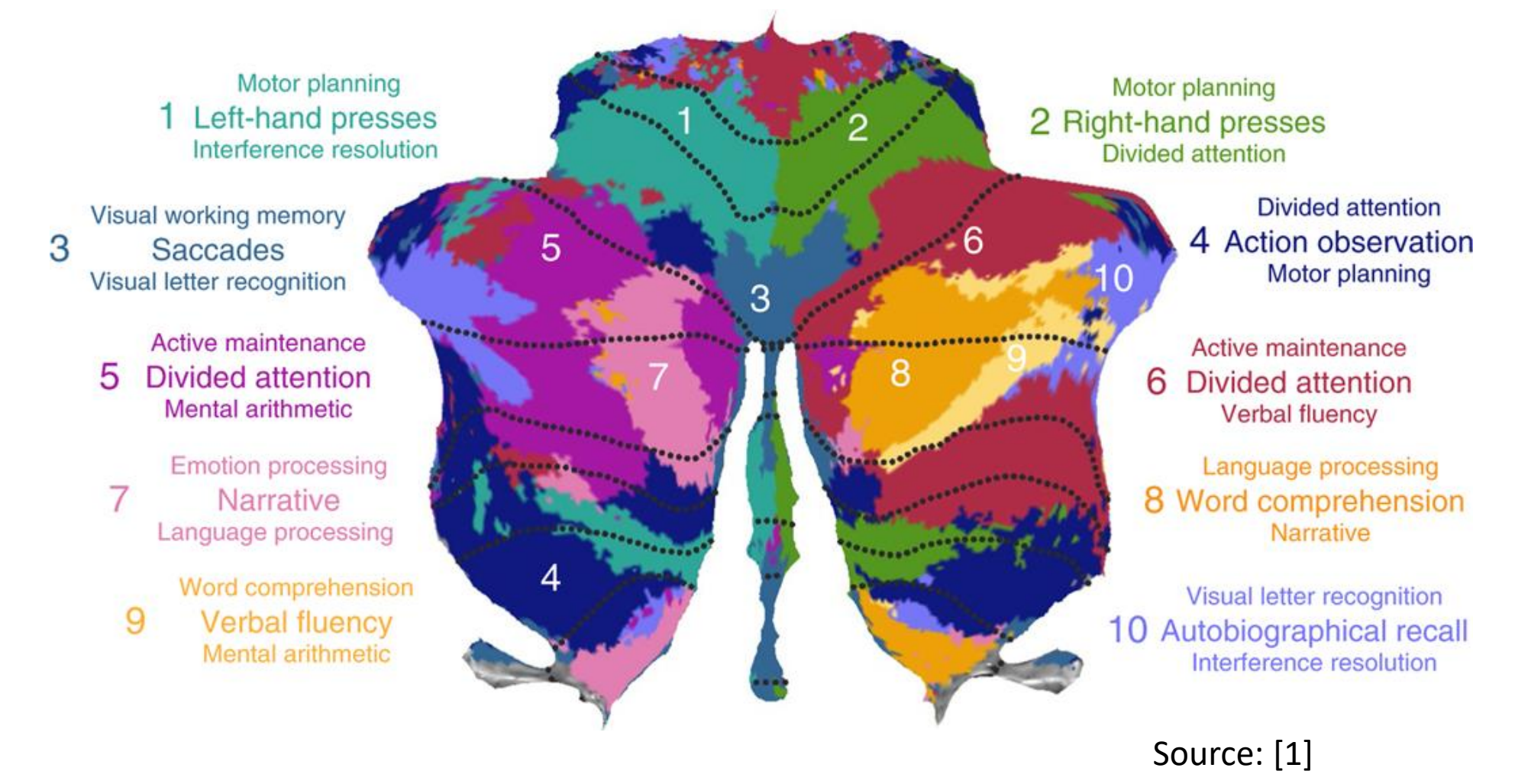
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INTRODUCTION

- Growing interest in unravelling cerebellar functions in the last decades
- Heterogeneous findings about cerebellar involvement in sensorimotor control
- Need for further analysis and new methods to investigate cerebellum with a focus on hemisphere specificity

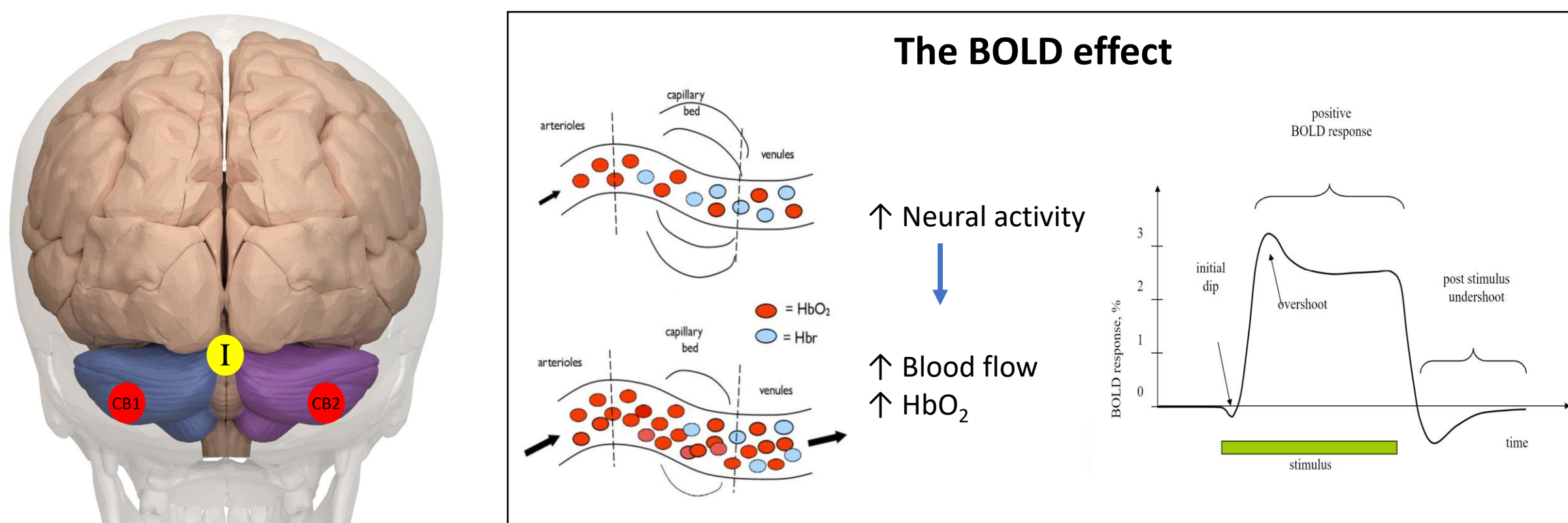
→ investigation of which **cerebellar hemisphere** displays **activation** during finger movement of the dominant and sub-dominant hand using **functional Near-Infrared Spectroscopy (fNIRS)**.



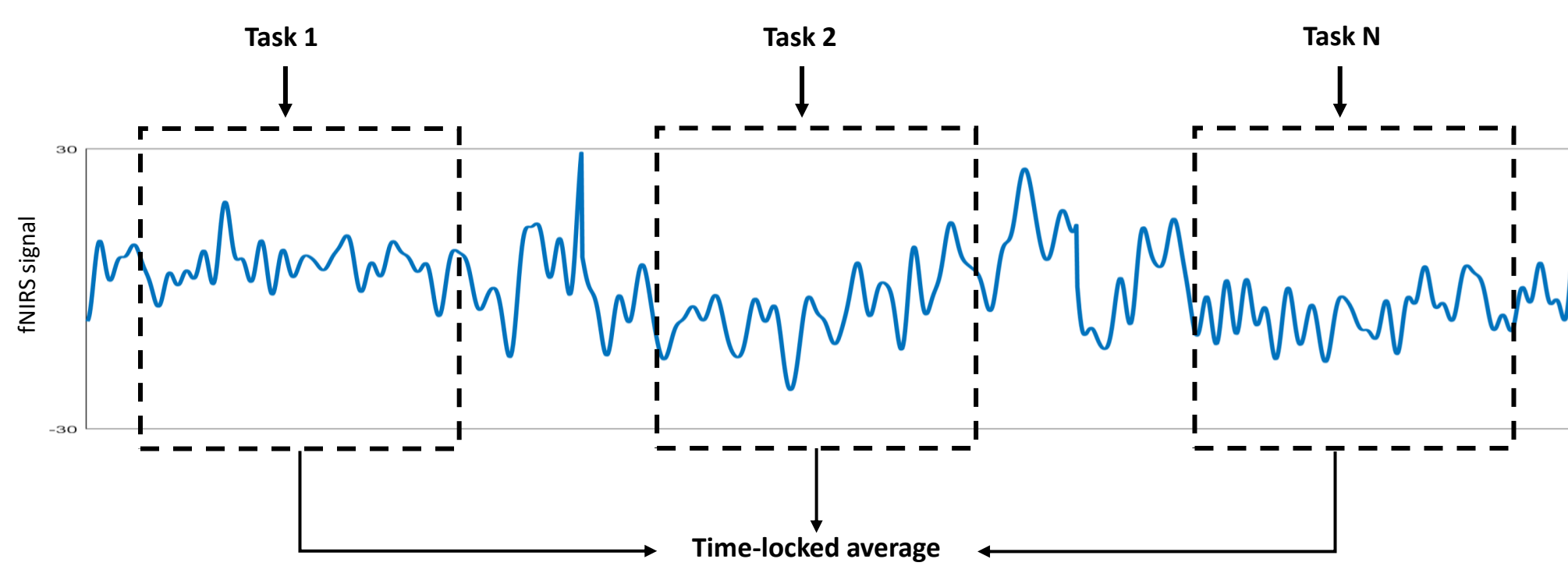
Source: [1]

METHOD

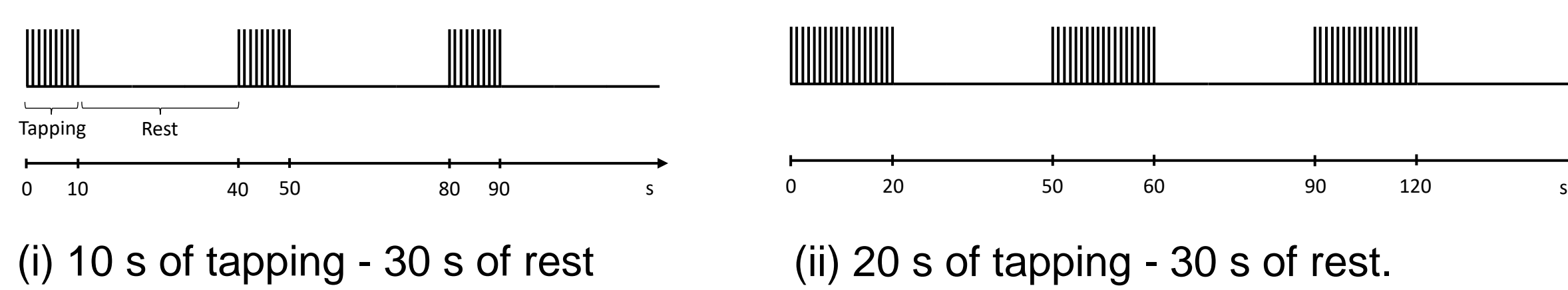
- fNIRS is an **optical technique** that allows to measure the changes in concentration of oxygenated (ΔHbO_2) and deoxygenated (ΔHbR) hemoglobin supposedly caused by neuronal activation.
- Two channels (source and detector) acquired, respectively on the left (CB1) and right (CB2) cerebellar hemisphere with source-detector distance at 3.5 cm to ensure an adequate depth to access the real cerebellar signal and to elude muscle and extracerebral activity.



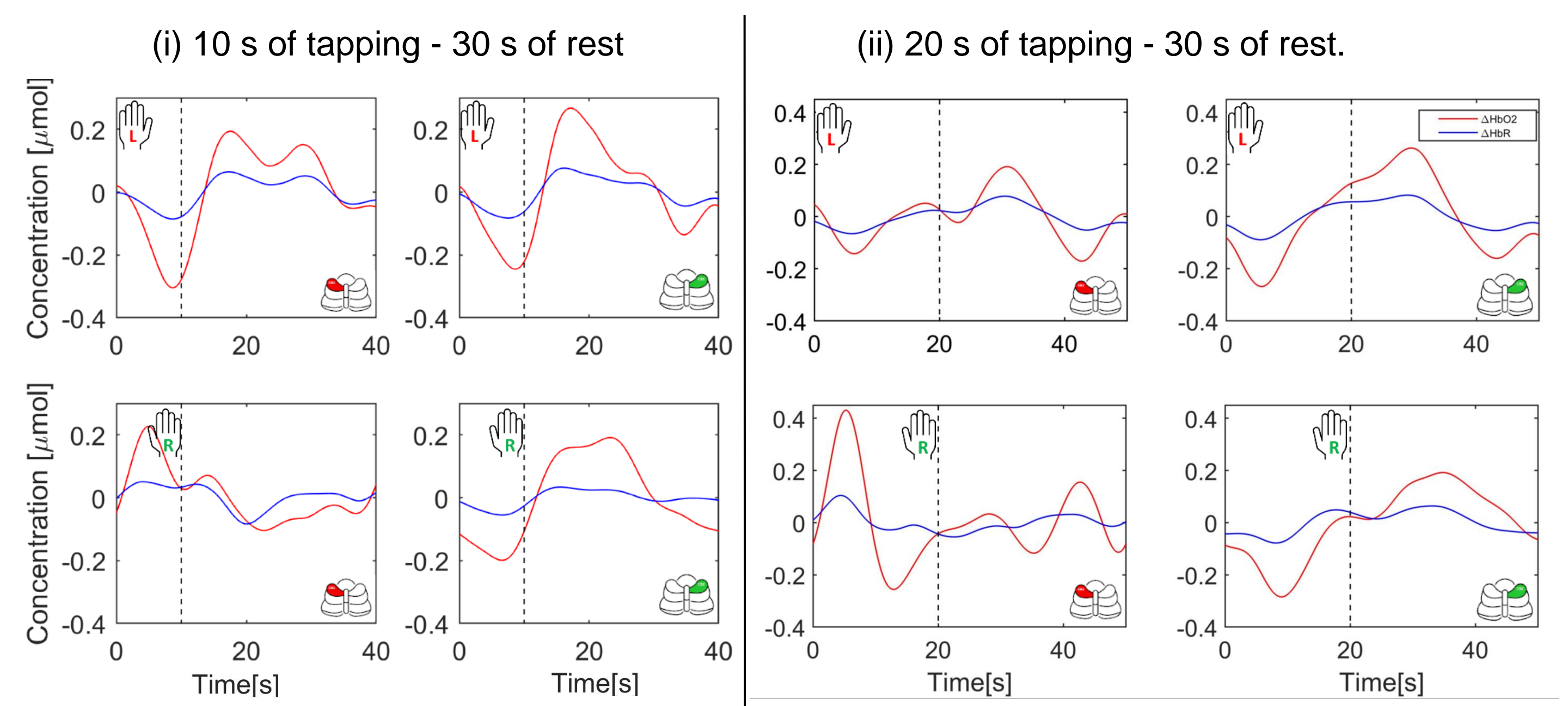
- Recording of the blood oxygenation level dependent (**BOLD**) effect: neural activation is associated with an increase in local arterial vasodilation, which leads in turn to a regional increase in cerebral blood flow and volume and thus oxygenation.
- One healthy subject performed a **finger tapping** task: 6 repetitive blocks (task + rest) respectively for the left and right hand.



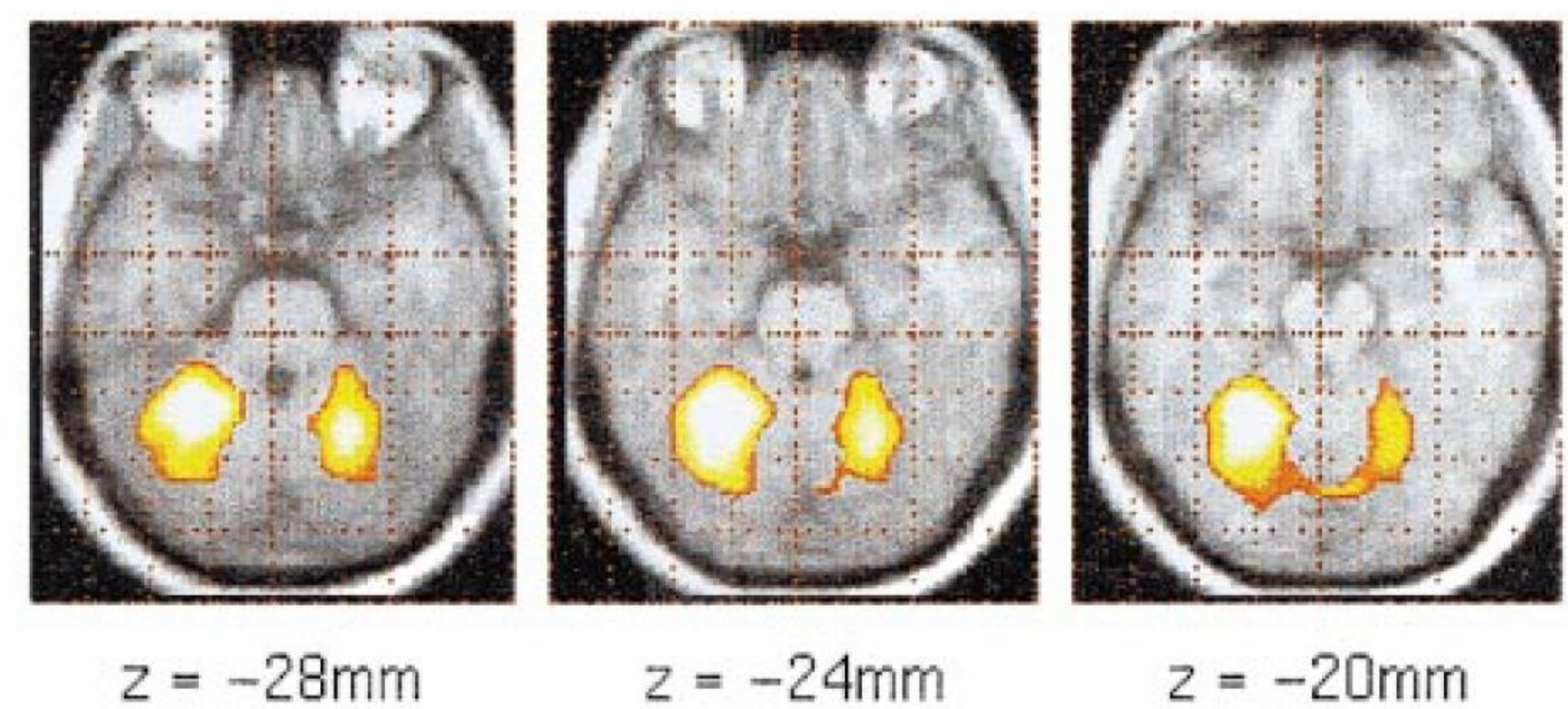
- The task was repeated twice for each hand changing the activity periods:



RESULTS



- Similar hemodynamic response observed ipsilaterally and contralaterally for both protocols (10 s vs 20 s activity).
- Involvement of the dominant hemisphere (right-handed subject) even during the sub-dominant hand movement (validated with a left-handed subject) [2].
- A finer analysis shows higher synchronization of the right hemisphere for left hand movement in according with previous fMRI studies [3]:
 - Ipsilateral activation with the dominant hand movement
 - With movements of the subdominant hand BOLD signal increases ipsilaterally and also contralaterally. This raised the hypothesis of a dual layer processing



Source: [3]

CONCLUSIONS

- fNIRS proved to be a bona fide alternative technique to capture cerebellar hemodynamics in a non-clinical setting.
- The observed asymmetries in cerebellar activation agree with previous fMRI studies [3].
- They suggest the existence of different layer of controls from the cerebellum in the two hemispheres: one for precise movements and the other for repetitive ones.
- Extended experiments are planned in the future to study motor and cognitive functions in a multimodal setting with EEG recordings.
- This work paves the ground towards the implementation of a new diagnostic tool to interpret patterns of cerebellar activation.

REFERENCES

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