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Abstract: We studied the ability and reproducibility of fNIRS to map the cortical motor areas. Simultaneously acquired fMRI was used as a reference and functional maps of both modalities were obtained from GLM analysis. NIRS results show satisfactory reproducibility but partial agreement with fMRI.

Introduction: Like fMRI, NIRS enables to study brain activity through cerebral hemodynamic variation. Also used for brain mapping, the NIRS technique remains challenging at the individual level due to intra-subject reproducibility issues [1]. This study aimed to evaluate NIRS test-retest reproducibility in comparison with fMRI in a motor paradigm.

Methods: Simultaneous NIRS and MRI data were acquired in 9 healthy adults according to a block design motor paradigm of the right hand. The motor task started with a 27" baseline period followed by four interleaved repetitions of 18" right hand grasping motions and 27" rest for a total duration of 3"45'. The NIRS acquisition, performed with a CW 8x8 optodes system (NIRScout NIRx) layout in twenty 3 cm-channels over the motor cortices of both hemispheres, was repeated twice, 6'30" apart. The first NIRS run matches a BOLD fMRI sequence (3T Siemens Prisma, 2.5x2.5x2.5mm^3, TR=1.5s) while the second NIRS run matches a pCASL perfusion sequence (6 mm-slices, 3.5x3.5 mm^2, TR=4.5s, LD/PLD=1500/1800ms). NIRS data processing was performed with the MNE-Python package [2] and consisted in data conversion to HbO_2/HbR concentration changes and bandpass filtering ([0.01-0.09] Hz). Statistical analysis was based on standard first and second level GLM with Bonferroni correction for multiple testing ($p < 0.05$ to be corrected for 20 channels) [3,4]. BOLD fMRI processing was performed using the Matlab/SPM12 software and consisted in motion correction, slice timing, co-registration to 3D T1w, spatial normalization to MNI space and smoothing (6 mm FWHM). Statistical maps at the individual and group levels were obtained from GLM analysis and thresholded at $p<0.05$ FWE-corrected at the cluster level.

Results: Results are presented for NIRS HbO_2 and BOLD fMRI data. At the individual level, NIRS show concordant activated channels between the 2 runs for 8 out of our 9 subjects. For all subjects, activation was found on the left hemisphere in agreement with BOLD fMRI whose activations were systematically localized in the right-hand motor area. However, 5 subjects show ipsilateral activations in NIRS that were not observed in BOLD. At the group level (see Fig. 1), the BOLD activation was localized on the left motor cortex only while NIRS show bilateral activations though with maximal responses on the contralateral side.

Conclusion: These preliminary results show reasonable NIRS inter-session spatial reproducibility as well as partial agreement with MRI results. Compared to BOLD, NIRS always yield co-lateralized activations but also ipsilateral ones as reported [5]. Future work will focus on a more quantitative evaluation framework, both spatially and temporally, and will include HbR assessment with a comparison to ASL data which may provide more insight on the specificities of the hemoglobin species. A co-registration of fNIRS data to MRI data would also provide increased anatomical specificity.

References: 1.Chen, 2020, Front. Neurosci, 14:724; 2.Gramfort, 2013, Front. Neurosci, 7:267; 3.Luke, 2021, Neurophotonics, 8(2):025008; 4.Pinti, 2019, Front. Neurosci, 12:505; 5.Leff, 2011, NeuroImage, 54(4):2922-2936.

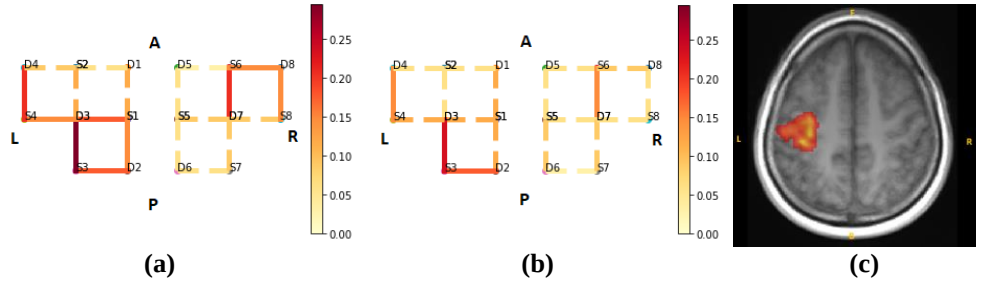

Figure 1: Group results on (a) NIRS session 1, (b) NIRS session 2. The color of NIRS channels encodes the GLM coefficients value. Solid lines indicate significant channels ($p<0.002$). (c) BOLD activation overlaid on the average 3D T1w in the MNI space.