A study on the link between source-based spectral metrics and BOLD signal at rest.

I. Mazzonetto\textsuperscript{1,2}, E. Ambrosini\textsuperscript{1}, A. Bertoldo\textsuperscript{2}, A. Vallesi\textsuperscript{1}

\textsuperscript{1}Department of Neuroscience and \textsuperscript{2}Department of Information Engineering, University of Padova, Padova, Italy

**Background:** Simultaneous acquisition of resting state EEG and fMRI data is a state-of-the-art approach to investigate spontaneous neuronal activity. Previous studies have shown that changes in BOLD activity are associated with changes in specific spectral metrics at the scalp level. However, possible spatial dependencies between EEG and BOLD signals and between different spectral metrics have been neglected so far. To fill this gap, we employed a novel analytical approach by performing spectral analyses on the source-based electrophysiological oscillations estimated at the cortical level and computing the $\beta/\alpha$ power ratio to quantify brain dynamics at rest. We then correlated these electrophysiological measures with BOLD activity simultaneously recorded from the same regions at rest.

**Methods:** Simultaneous EEG-fMRI resting-state data were acquired with a 3T MRI scanner in 20 healthy participants. Continuous EEG data were corrected for gradient, ballistocardiographic, and ocular artifacts. Cortical source of the rsEEG signals were estimated with the depth-weighted minimum norm estimation approach. The Destrieux atlas was used to parcellate the cortical surface in anatomical ROIs. Then, based on the electrophysiological activity reconstructed within each of these ROIs, we calculated different rsEEG spectral measures, including power in $\alpha$ and $\beta$ bands, as well as the $\beta/\alpha$ power ratio in time windows corresponding to the TR. The fMRI data underwent standard preprocessing and for each anatomical ROI we calculated the mean BOLD signal. Pearson correlation between BOLD and $\beta/\alpha$ time series were computed to assess EEG-fMRI relationship.

**Results:** The analyses revealed that the pattern of resting-state BOLD signal fluctuations within specific brain regions was characterized by specific source-based rsEEG spectral signatures involving the combination of different electrophysiological rhythms. In particular, we found that the $\alpha$ power extracted from occipital cortical sources was significantly related to a suppression of the BOLD signal, mostly in the parietal and frontal cortical regions forming the right-lateralized ventral attention network. Moreover, significant negative correlations were observed between the source-based rsEEG $\beta/\alpha$ power ratio and the BOLD signal in a number of cortical regions, including the medial PPC/precuneus and the angular gyrus/temporo-parietal junction bilaterally, and a portion in the left DLPFC, which take part in the so-called default mode network.

**Conclusions:** We combined resting-state EEG and fMRI to study the dynamic functional organization of the brain. Taken together, our findings extend previous resting-state studies by showing that the cortical activity spontaneously fluctuates according to spatiotemporal patterns related to specific spectral metrics. They also show that the estimation of these spectral metrics at the cortical level is a useful approach for joint resting-state EEG/fMRI analyses. (Funding: ERC grant #313692).