Physical Therapy and Human Movement Sciences, Feinberg School of Medicine

Neural dynamics based on multi-modal brain imaging: Potential in studying stroke

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Background

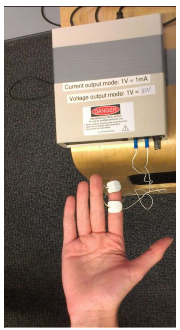
After stroke, motor recovery usually occurs with functional changes in the sensorimotor network rather than healing damaged brain areas. Clinical assessments and structural brain imaging techniques (CT/MRI) provide an overview of stroke severity and anatomical damages but cannot reveal the dynamic changes of brain function. Electroencephalography (EEG) as a non-invasive electrophysiological technique provides excellent temporal resolution to capture the dynamics of cortical activity. The state-of-the-art challenge of EEG is its limited spatial resolution. This study aims to introduce a computational tool based on the multimodal brain imaging to improve the spatial resolution of EEG for tracking the information flow inside the brain and its changes following a stroke.

Research Objectives

This study aims to introduce a computational tool based on the multimodal brain imaging to improve the spatial resolution of EEG for tracking the information flow inside the brain and its changes following a stroke.

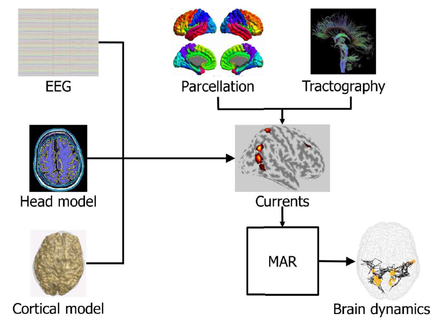
Methods

Experiment
- 10 patients vs. 8 health controls
- Structural MRI (T1-MRI)
- Diffusion weighted MRI (DWI)
- 62 channel EEG
- Somatosensory stimulation
  - Index finger: left vs. right
  - Monophasic anodal electrical pulse (400 µs)
  - Inter-stimulus interval 250-330 ms
  - Twice of sensory threshold

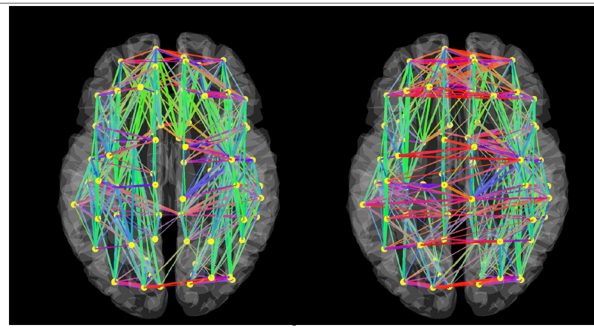


Data Processing
- EEG signal preprocessing
- Building head and cortical model
- EEG Source localization
- Neural fiber tracking
- Multivariate Auto-regressive model fitting

Diagram of source imaging processes

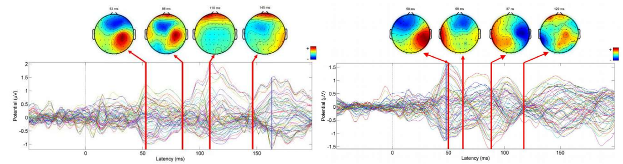


Anatomical brain connectivity based on DWI



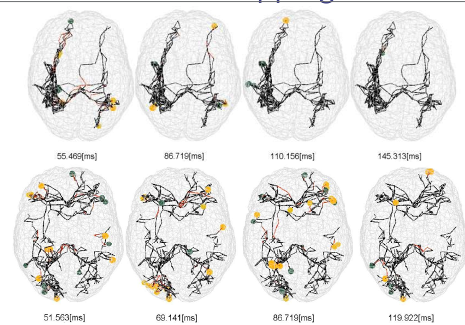
Anatomical brain connectivity of patient (left) and control (right) are derived by fiber tracking based on diffusion weighted imaging (DWI).

Butterfly plot and topography of EEG



Butterfly plot and topography of patient (left) and control (right).

Signal transmission mapping



Signal transmission mapping of patient (top) and control (bottom).

Conclusions

- Physiological + anatomical information leads to a precise modeling of brain dynamics
- A useful tool
  - to track signal propagation in the brain
  - to investigate neuroplasticity and compensatory network changes after stroke

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