Propagation of epileptic spikes revealed by diffusion-based constrained MEG source reconstruction

AC Philippe(1), T Papadopoulos(1), C. Bénar(2), JM. Badier(2), M Clerc(1), R Deriche(1)

(1) Athena Project-Team, INRIA, Sophia Antipolis - Méditerrannée, France
(2) INSERM, UMR 751, Marseille, France

Goal: Study of the propagation of an epileptict spike.

Method: 1- cortex parcellation via structural information coming from diffusion MRI (dMRI)
2- MEG inverse problem on a parcellated source space
3- study of the propagation of an epileptic spike via the active parcels

Results on real data allowing to study the spatial propagation of an epileptic spike.

Preprocessing
1- Co-registration of the T1wMRI and dMRI
2- Surface meshes extraction
3- Computation of the leadfield matrix G

Surface meshes extraction
Computation of the leadfield matrix G
Co-registration of the T1wMRI and dMRI
Pre-clustering via Brodmann's atlas

5.1- Computation of the CP-based correlation matrix R
5.2- K-means algorithm on R

Study of the propagation of an epileptic spike

At each time sample, we want to determine the cortical areas at the origin of the activity. We call \( \mathcal{A}_t \) the set of these areas, for a time sample \( t \).

For each time sample \( t \), we compute the power \( \mathcal{P}_{p,t} \) of each area \( p \) on a sliding time window \( [t - \alpha, t + \alpha] \):

\[
\mathcal{P}_{p,t} = \frac{1}{2} \sum_{i=t-\alpha}^{t+\alpha} |s(p,i)|^2.
\]

\( \mathcal{A}_t = \{ p_a : \mathcal{P}_{p_a,t} > F \times \max(\mathcal{P}_{p,t}), \forall p \} \)

with \( F \) a percentage.

Results & Conclusion

- Almost the same parcels are activated for all epileptic spikes.
- The direction of propagation changes: from the back of the frontal lobe to the front or opposite direction.
- The time of activation of each parcel characterizes the spike.

Results on 3 epileptic spikes of a single subject.

- The parcellation allows an easier representation of source space.
- The method reveals differences between spikes (direction of propagation and time of activation of parcels).
- Future works will be to analyse the structural network supporting the propagation.

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