

MGH/HST Athinoula A. Martinos Center for Biomedical Imaging



Language lateralization in patients with Tuberous Sclerosis Complex (TSC) using MEG and fMRI

Anne Gallagher^{1,2,3}, Naoaki Tanaka^{1,2}, Nao Suzuki¹, Liu Hesheng^{1,2}, Susana E. Camposano^{2,3}, Elizabeth A. Thiele^{2,3}, Steven M. Stuffelbeam^{1,2}

¹Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA

²Harvard Medical School, Boston

³Department of Neurology, Massachusetts General Hospital, Boston



TUBEROUS SCLEROSIS COMPLEX (TSC)

- Multisystem genetic disorder
- Brain Abnormalities include cortical tubers in at least 82% of patients¹
- Cortical tubers and their surrounding tissue can be epileptogenic²
- Nearly 90% of patients have epilepsy, and 2/3 of them are refractory to pharmacotherapy³
- Epilepsy surgery can be considered and requires a presurgical workup that may involve assessment of language lateralization



OBJECTIVES

- First study to investigate language lateralization in a group of TSC patients
- Compare MEG language results with fMRI data
- Explore cerebral reorganization in patients with multiple brain abnormalities and, in some cases, history of epilepsy

METHODS

15 patients with TSC (11 ♀; mean age 38.5 ± 9.1y; 12 Left-Handed; 7/15 with history of epilepsy; 5/7 now Sz free)

MEG: 306-channel MEG (VectorView, Elekta Neuromag)

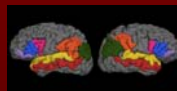
MRI/fMRI: 1.5T scanner (Avanto, Siemens)

Lexico-semantic decision task: Manual response to 160 abstract (ex: peace) or concrete (ex: car) sequentially and visually presented words

Analyzes: MEG pre-processing: NeuroMag package and homemade softwares; Minimum-norm estimates: MNE software (Hamalainen, 2006); 3D Brain reconstruction: Freesurfer (Fischl et al, 2001); BOLD fMRI: FSL (Smith, 2004)

Cerebral Regions of Interest:

- Inferior frontal gyrus
- Middle and superior temporal gyri
- Supramarginal and inferior parietal gyri



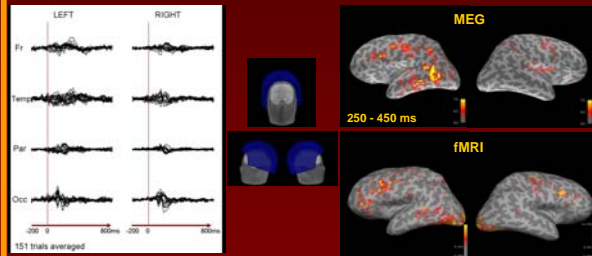
RESULTS

MEG/fMRI data comparison: 15/15 Patients concordance

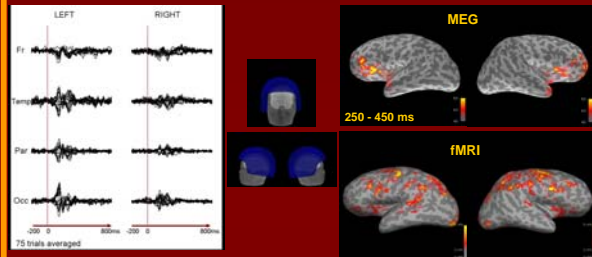
Patients	MEG	fMRI	Patients	MEG	fMRI
1	LEFT	LEFT	9	LEFT	LEFT
2	LEFT	LEFT	10	LEFT	LEFT
3	LEFT	LEFT	11	LEFT	LEFT
4	LEFT	LEFT	12	LEFT	LEFT
5	LEFT	LEFT	13	BILATERAL	BILATERAL
6	LEFT	LEFT	14	LEFT	LEFT
7	LEFT	LEFT	15	LEFT	LEFT
8	LEFT	LEFT			

ILLUSTRATIVE CASES...

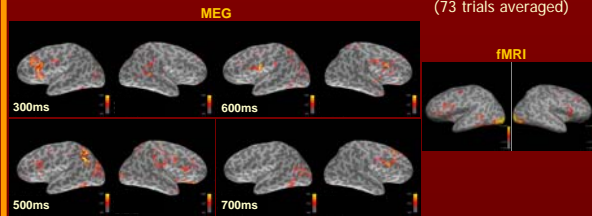
Patient #11: 43-y-o Lt-handed ♂ without history of epilepsy



Patient #13: 44-y-o Ambidextrous ♀ with history of epilepsy



Patient #10: 44-y-o Rt-handed ♀ without history of epilepsy (73 trials averaged)



DISCUSSION

- Conclusive results for the investigation of language lateralization in TSC patients are obtained using MEG
- A pattern of bilateral cerebral language representation is shown using MEG
- 100% concordance between MEG and fMRI results for language lateralization using a lexico-semantic decision task
- MEG provides temporal information that helps better understand cerebral activation during a lexico-semantic task
- Receptive language areas (Wernicke's area) are clearly shown with MEG to be involved during a lexico-semantic decision task in all patients. As previously reported⁴, fMRI detects poorly activation located in Wernicke's area, but is superior in detection of cerebral activity from frontal inferior region (Broca's area)

REFERENCES ¹Ridler et al. (2004). *J Child Neurol*, 19: 658-65. ²Major et al. (2009). *Epilepsia*, 50: 147-54. ³Crino et al. (2006). *New Engl J Med*, 355: 1345-56. ⁴Kamada et al. (2007). *Neurosurg*, 60:296-306.