

Spontaneous fMRI-BOLD power spatial distribution: comparison between awake state and under isoflurane anesthesia in the rat

Wen-Ju Pan¹, Matthew Magnuson¹, Garth Thompson¹, and Shella Keilholz¹

¹Biomedical Engineering, Emory University/ Georgia Institute of Technology, Atlanta, GA, United States

Target audience Researchers using fMRI or functional connectivity in animal models.

Purpose The rat is the most common animal model for fMRI brain research. Anesthesia is typically used to prevent motion and minimize stress for the animal, but it alters baseline brain activity as compared to normal brain function in awake animals[1]. To examine the effects of isoflurane, we examined the spatial distribution of the spontaneous fMRI-BOLD power spectral densities across the brain [2] in both awake and isoflurane anesthetized rats.

Methods Five S-D rats, male 300-400g, were used in this study. The animals were trained daily for 8 consecutive days [3] to acclimate them to the restricted and noisy environment of the 9.4 T MRI (Bruker). A cradle and quadrature coil system (EkamImaging Inc., MA) specifically designed for awake animal imaging was used in this study. The resting-state fMRI scan sessions were first conducted under isoflurane (~1.5 %, mixed with room air, free breathing with nose cone) then in the awake state 30 min later (after isoflurane disconnection). During the fMRI scans, the rectal temperature was maintained at ~37.5° C by a temperature adjustable water circulating pad; respiratory rate was also monitored. The GE-EPI parameters include TR/TE=500ms/15ms, slice thickness/interval=2mm/2.1mm, 5 coronal slices, FOV=25.6mm, scan time = 8 min 20 sec for each resting-state scan. The fMRI data preprocessing included slice timing correction, motion correction, smoothing and detrending. The power spectral density of BOLD signal at each voxel in the brain was calculated, and the mean power within the low frequencies (0.01-0.1 Hz) for each voxel was mapped across brain. Each voxel in the BOLD based power maps was normalized to the whole brain mean power.

Results The differences of the BOLD power distribution were preliminarily compared between awake data and isoflurane data in 3 rats. ROI analyses were conducted (paired t-test) in the cingulate cortex (CG), primary somatosensory cortex (S1), secondary somatosensory (S2) and caudate putamen (CP). The results show regional BOLD power changed during anesthesia from awake condition, for example, the isoflurane increased BOLD power in S2 (significant), and CG and CP (trend, not significant); but potentially decreased S1 power (trend, not significant).

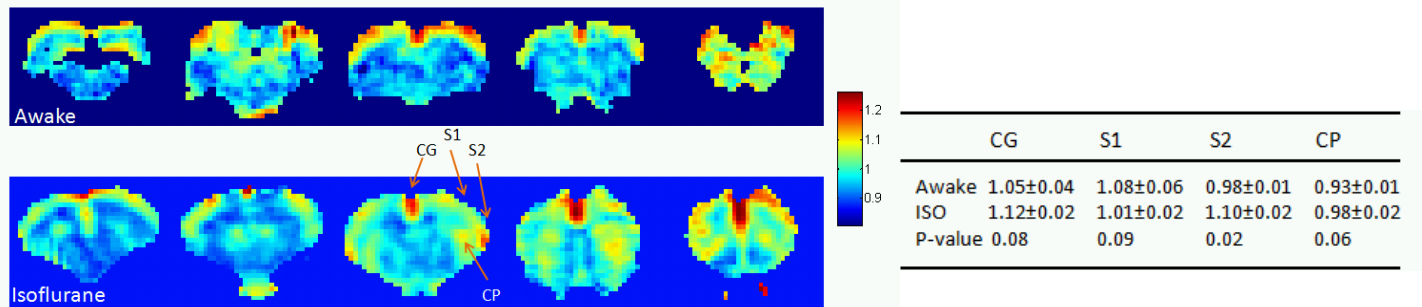


Fig.1 Power spectral density in spontaneous BOLD signals The representative data are showing between awake state (top) and under isoflurane (bottom).

Table.1 BOLD power comparisons from ROIs. ROI mean +/- SEM are listed. Paired t-tests were conducted between awake and isoflurane states.

Discussion/Conclusion The alternation in BOLD slow power in the anesthetic state might relate to impaired thalamocortical connectivity caused by the isoflurane [4]. The analysis on the BOLD power spectral density distribution may be potentially useful for mapping ongoing neural activity in brain. Further work, adding more subjects and incorporating neural electrophysiology are necessary for a full understanding of the effects of general anesthesia on brain activity.

References [1] Febo M. *Frontiers In Psychiatry*; [2] Pan, W-J, et al., *ISMRM 2011*; [3] King, J.A. et al. *Journal of neuroscience methods*; [4] White, N.S. and Alkire, M.T. *Neuroimage* (2003) 402-411.