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## Impact of cerebral blood flow level on the fluctuations of resting-state BOLD fMRI in anesthetized rats

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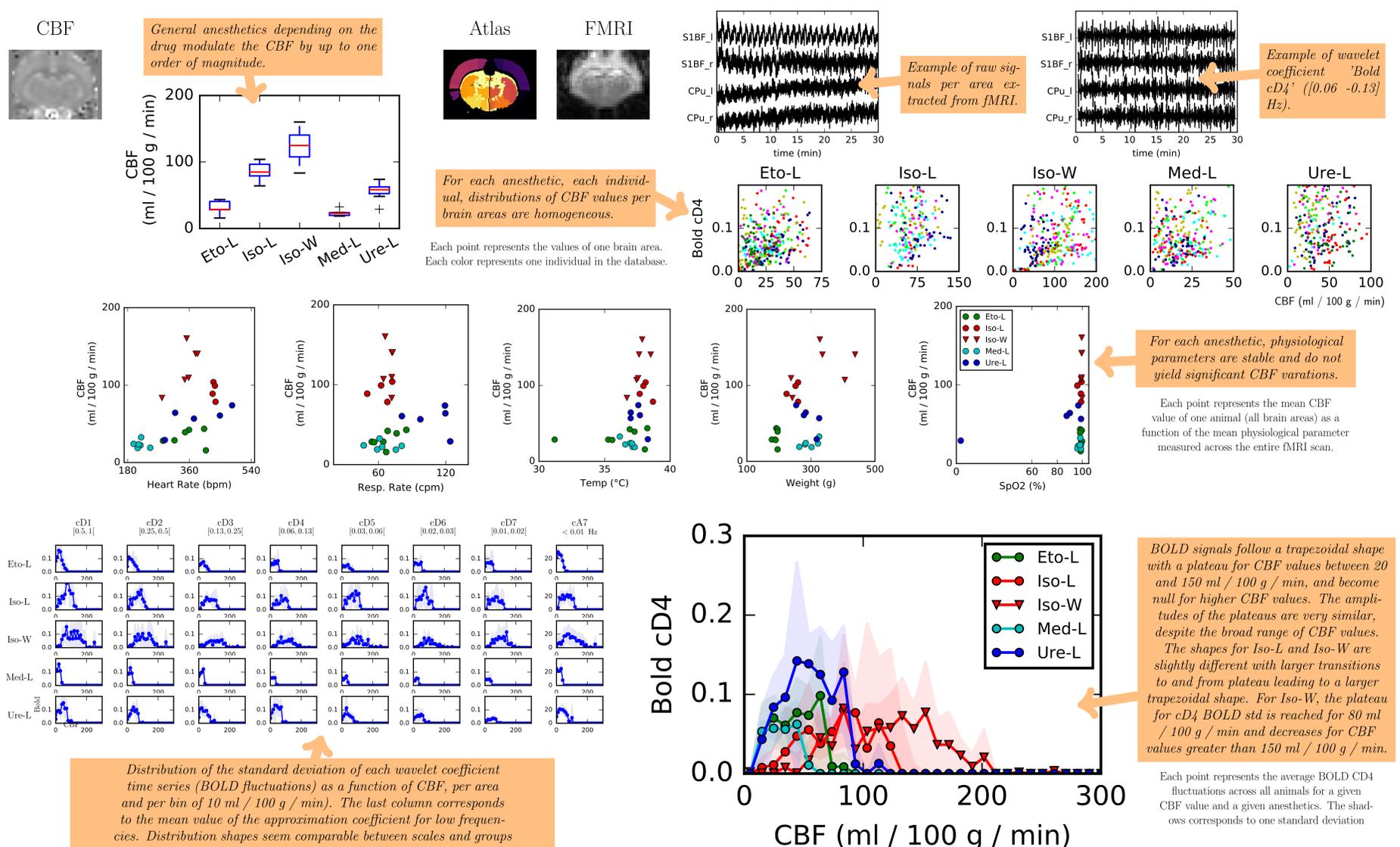
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## Abstract

The Blood Oxygen Level Dependent (BOLD) signal, used in resting-state functional Magnetic Resonance Imaging (fMRI), is tightly linked to Cerebral Blood Flow (CBF). This study evaluates the impact of the CBF on the low-frequencies BOLD fluctuations and on four physiological parameters during resting state in 5 groups of rats, Wistar (W) and Long-Evans (L) anesthetized with Isoflurane (Iso), Medetomidine (Med), Etomidate (Eto) and Urethane (Ure). It is shown that the CBF is not related to physiological parameters, and there exists a range of CBF values where the BOLD fluctuations are sufficiently high for being used in any other analysis.

## Results



## Discussion

**Discussion** For a large majority of anaesthetic agents, the amplitudes of the standard deviations of the resting state BOLD signals are not related to CBF. When applying wavelets, the fluctuations of the BOLD signals remain large. Wavelets have been shown to handle properly fractal properties of the BOLD signals as reported in [5], which is of particular interest in the context of brain connectivity. It is shown here that wavelet decompositions are not altering the BOLD standard deviation, especially at low frequencies usually used for preprocessing BOLD signal as in [5]. If all anesthetics show a trapezoidal shape of distribution with more or less transition steps, isoflurane seems to induce some relations with perfusion, especially for the Wistar strain. This is potentially due to the vasodilator effect of this molecule as noted in [6]. For large values of CBF, BOLD fluctuations are decreasing.

## Conclusion

For the anaesthetic agents evaluated in this study, dynamics of BOLD CD4 fluctuations per area are not related to CBF. However, isoflurane yields to reduced fluctuations of BOLD signals, for some brain areas with too low or too large values of CBF.

## Materials and Methods

**Groups:** 5 groups of rats were considered. One group of Wistar rats, anesthetized with isoflurane (1%, n=6), 4 groups of Long Evans rats anesthetized with isoflurane (1%, n=6), Urethane (n=7), Medetomidine (bolus of 0.24 mg/kg and infusion of 0.12 mg/kg/h; n=6), and Etomidate (bolus of 10 mg/kg and infusion, n=7).

**Data acquisition:** Rats were imaged at 9.4T with a volume transmit, 4-channel surface receive cross coil configuration (Paravision 6.0.1, Bruker, Ettlingen, Germany; IRMaGe Facility). After an anatomical T2w scan, cerebral blood flow (CBF) was mapped using pseudo continuous arterial spin labeling (pCASL) following inter-pulse phase optimization [7]. Then, resting state fMRI was performed with a single shot echo-planar imaging (TE=20 ms, TR=500 ms, spatial resolution 0.47x0.47x1.00 mm, 9 slices, 3600 repetitions, duration: 30min). Eventually, a second CBF map was acquired. Heart rate and breath rates were monitored throughout the entire procedure.

**Data processing:** Statistical Parametric Mapping program (SPM12, see 1) was used to co-register anatomical, CBF, and functional MRI data. CBF maps were obtained using homemade routines based on [2]. CBF values and rs-fMRI time courses were computed for each of the 51 parcels of an homemade rat brain atlas. Briefly, the atlas was obtained by fusing two existing atlases proposed in [3-4], and merging small regions. Mean CBF values were extracted by averaging the values obtained before and after the rs-fMRI acquisition. Each rs-fMRI time course was decomposed using a dyadic wavelet transform at different scales (detail or wavelet coefficients cD1 to cD7, in addition scaling or approximation coefficients (cA7) captures the polynomial trends contained in the signal. The 0.05-0.10 Hz frequency band, cD4, is the one generally evaluated in resting-state fMRI. Standard deviations (std) of the wavelet coefficients are computed for each area and each individual in each group for quantifying the fluctuations of the BOLD signals.

## References – Acknowledgements

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