Comparison of Quantitative BOLD and MR Vascular Fingerprinting for Mapping Brain Oxygenation

Abstract 4094

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Declaration of Financial Interests or Relationships

Speaker Name: Linh Le and Greg Wheeler

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Introduction

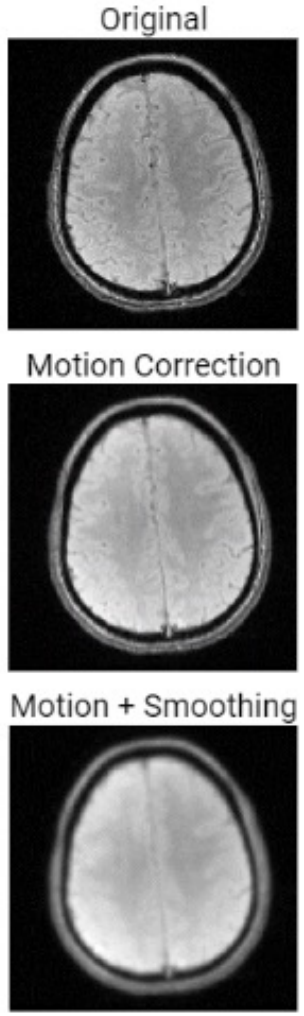
- Brain oxygenation measurements are important indicators for studies of brain physiology and pathologies
- Various MRI methods to measure brain oxygenation (i.e., oxygen extraction fraction) have been proposed, but have not been directly compared
- Quantitative BOLD (qBOLD) and magnetic resonance vascular fingerprinting (MRvF) represent promising approaches for mapping brain oxygenation on gradient and spin echo scans

Design and Objective

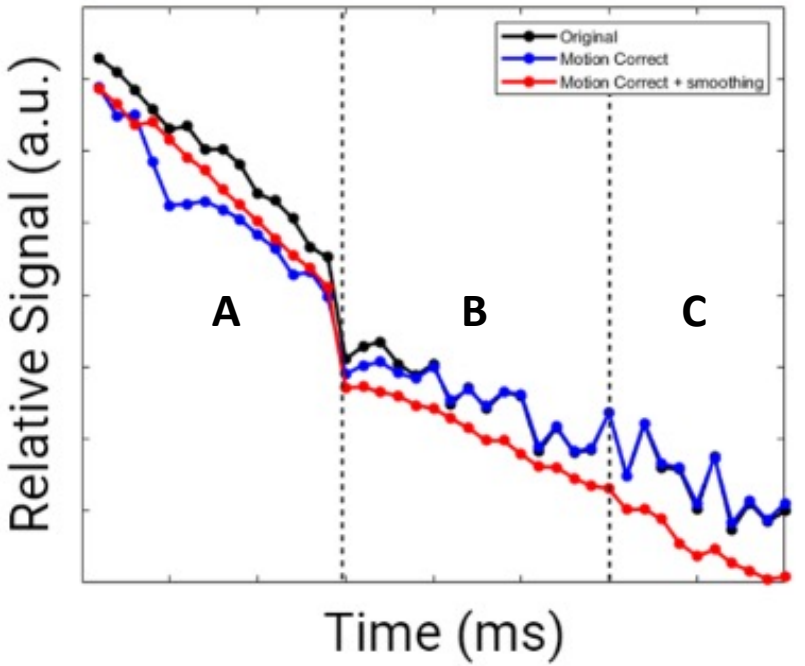
- 10 healthy, young (33±6 years) participants in this study
- 3 GESFIDE (Gradient-Echo Sampling of Free Induction Decay and Echo) scans were collected for each subject
  - 1 while breathing normal air (21% O_2)
  - 1 during induced hypoxia (14% O_2)
  - 1 during induced hyperoxia (100% O_2)
- Images had 1.5×1.5×2.5 mm^3 voxel size, 14 slices, and 40 TEs

We compared two approaches of quantitative brain oxygenation mapping using quantitative Blood-Oxygenation Level-Dependent (qBOLD) and magnetic resonance vascular fingerprinting (MRvF)

Quantitative BOLD (qBOLD) Method

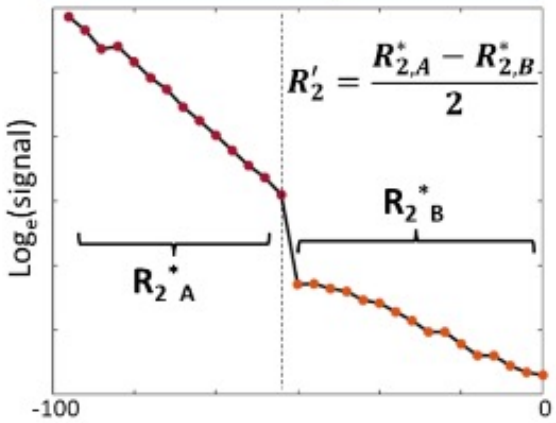


Voxel-wise Signal Evolution Extraction

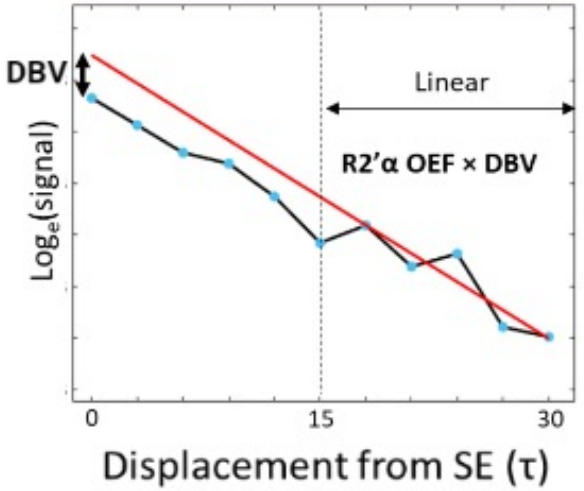


$$OEF = \frac{3 \times R_2'}{DBV \times \gamma \times 4\pi \times \Delta\chi_0 \times Hct \times B_0}$$

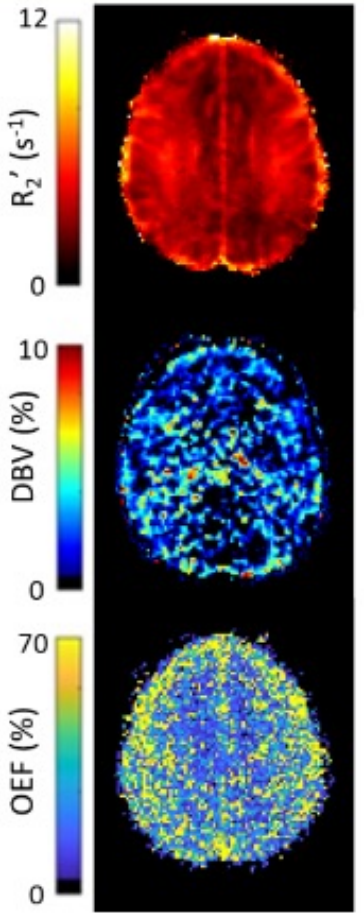
Quantify R2'



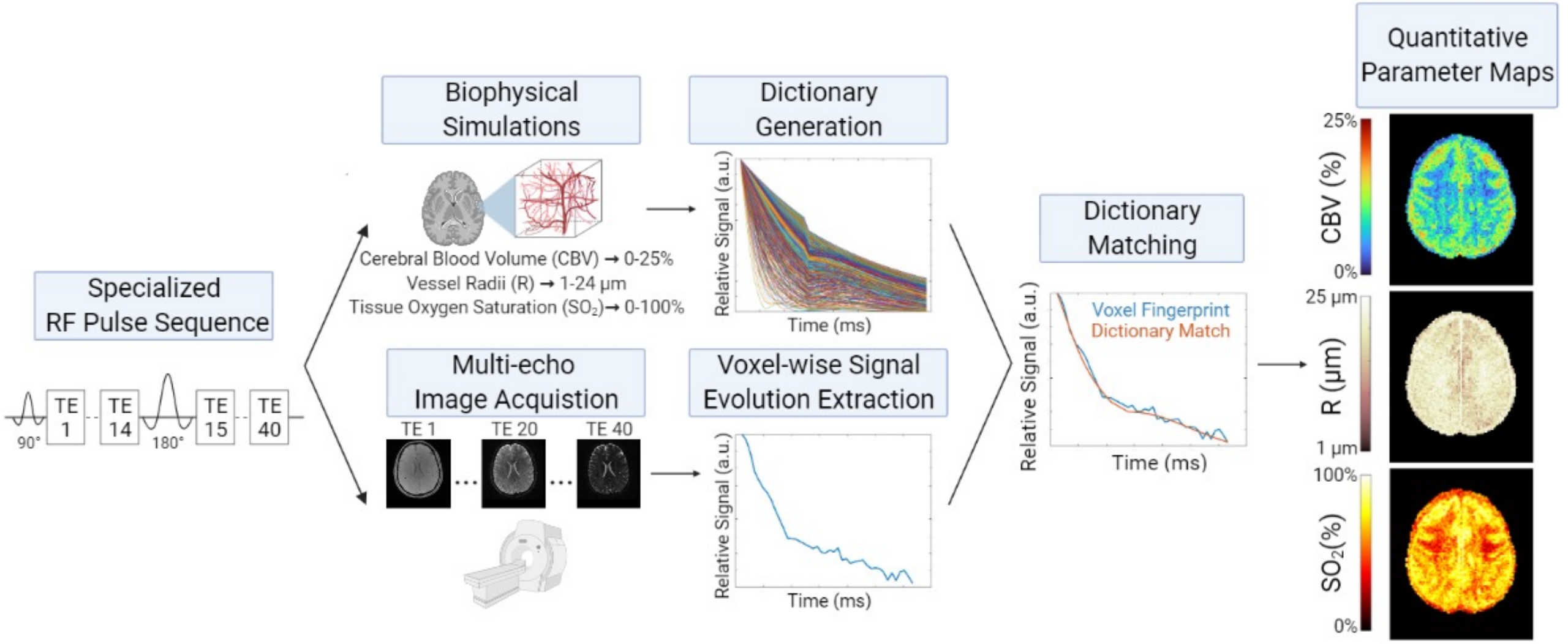
qBOLD Linear Model



Quantitative Parameter Maps



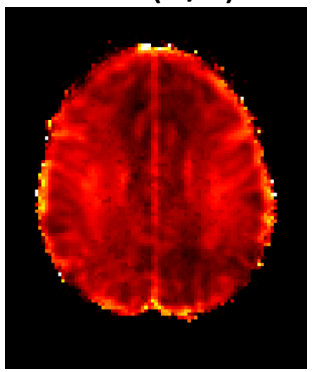
MR Vascular Fingerprinting (MRvF) Method



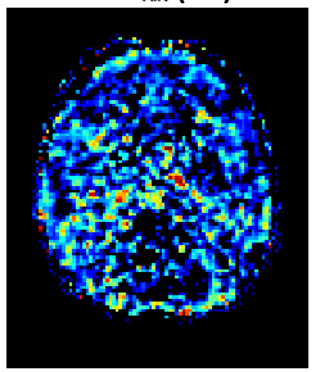
Summary of qBOLD vs MRvF Comparison

Quantitative BOLD

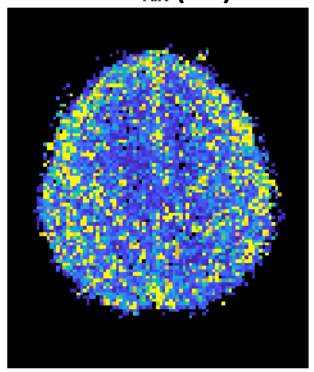
R2’ (1/s)

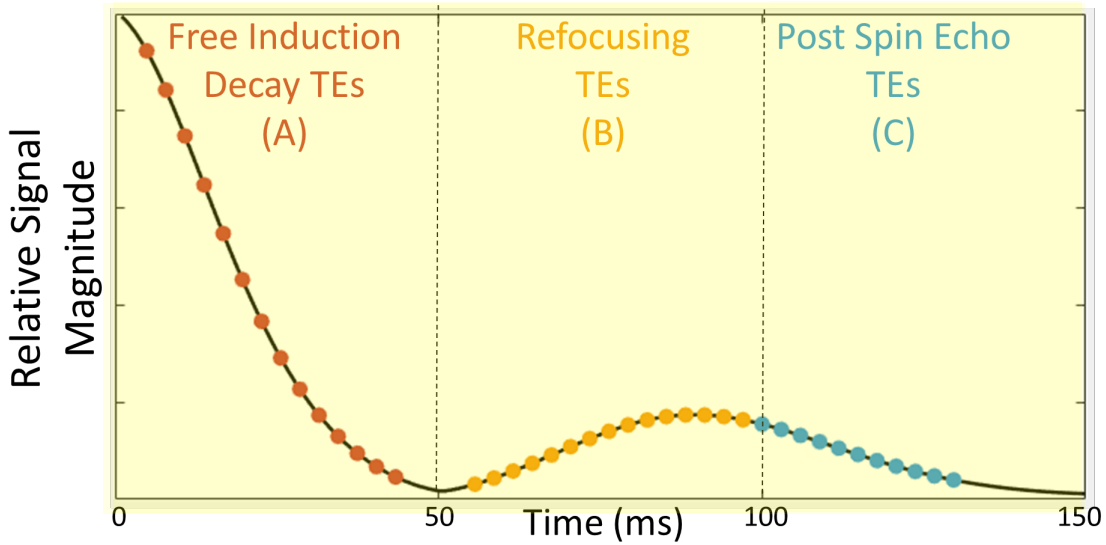


DBV (%)



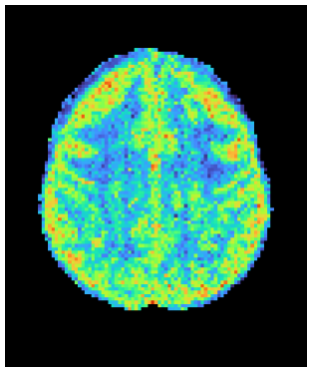
OEF (%)





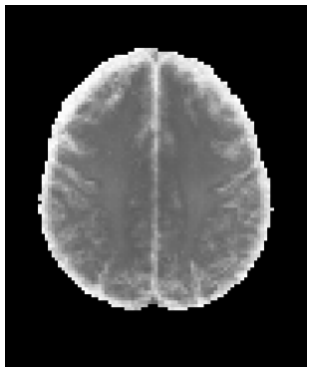
Magnetic Resonance Vascular Fingerprinting

CBV (%)



Radii (µm)

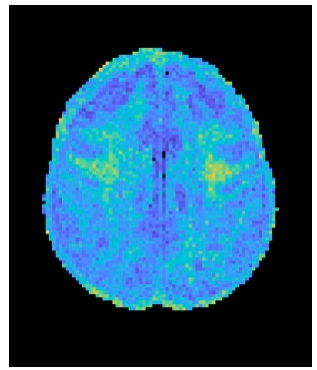
T2 (ms)



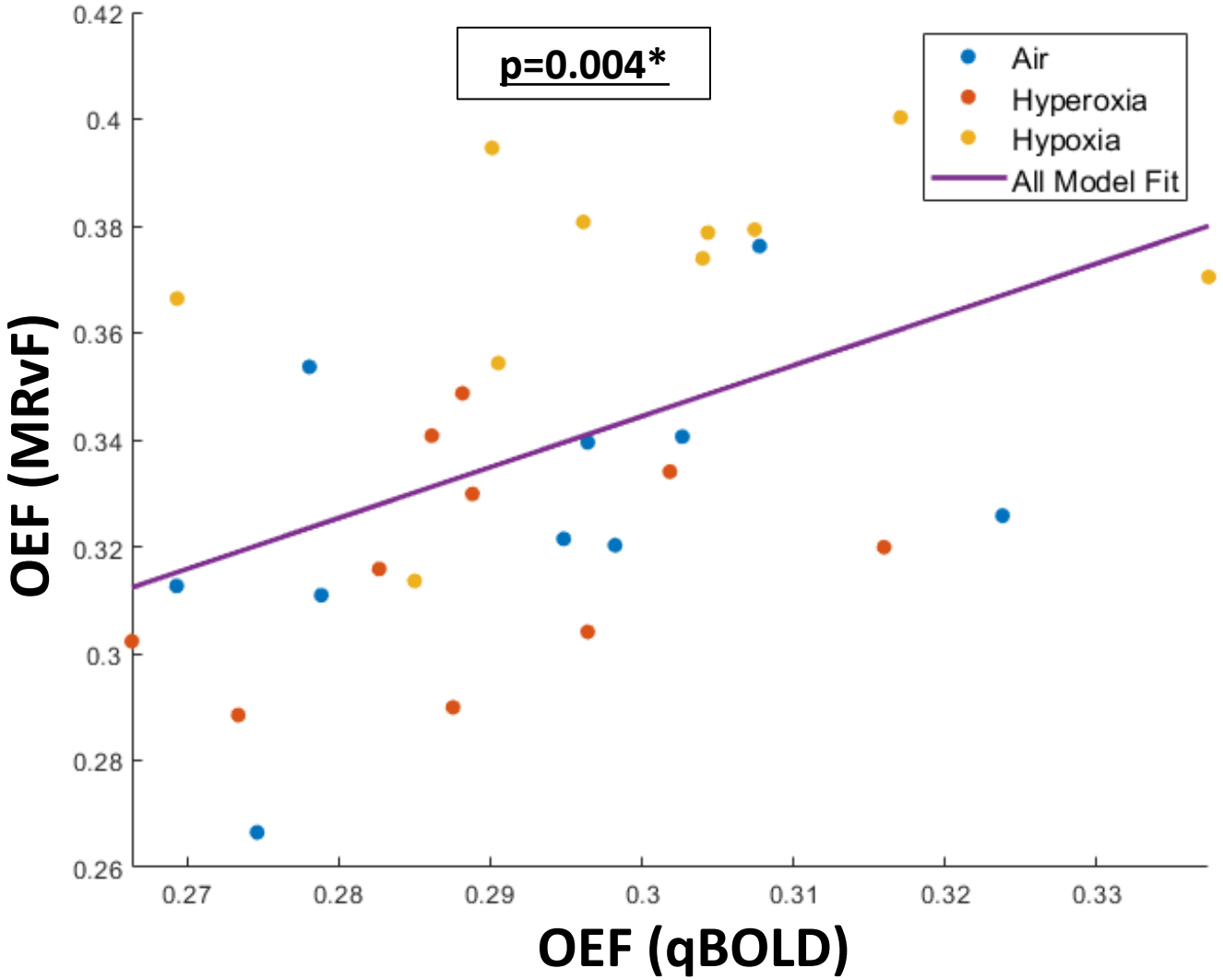
SO_2 (%)

$$OEF = \frac{(S_aO_2 - S_vO_2)}{S_aO_2}$$

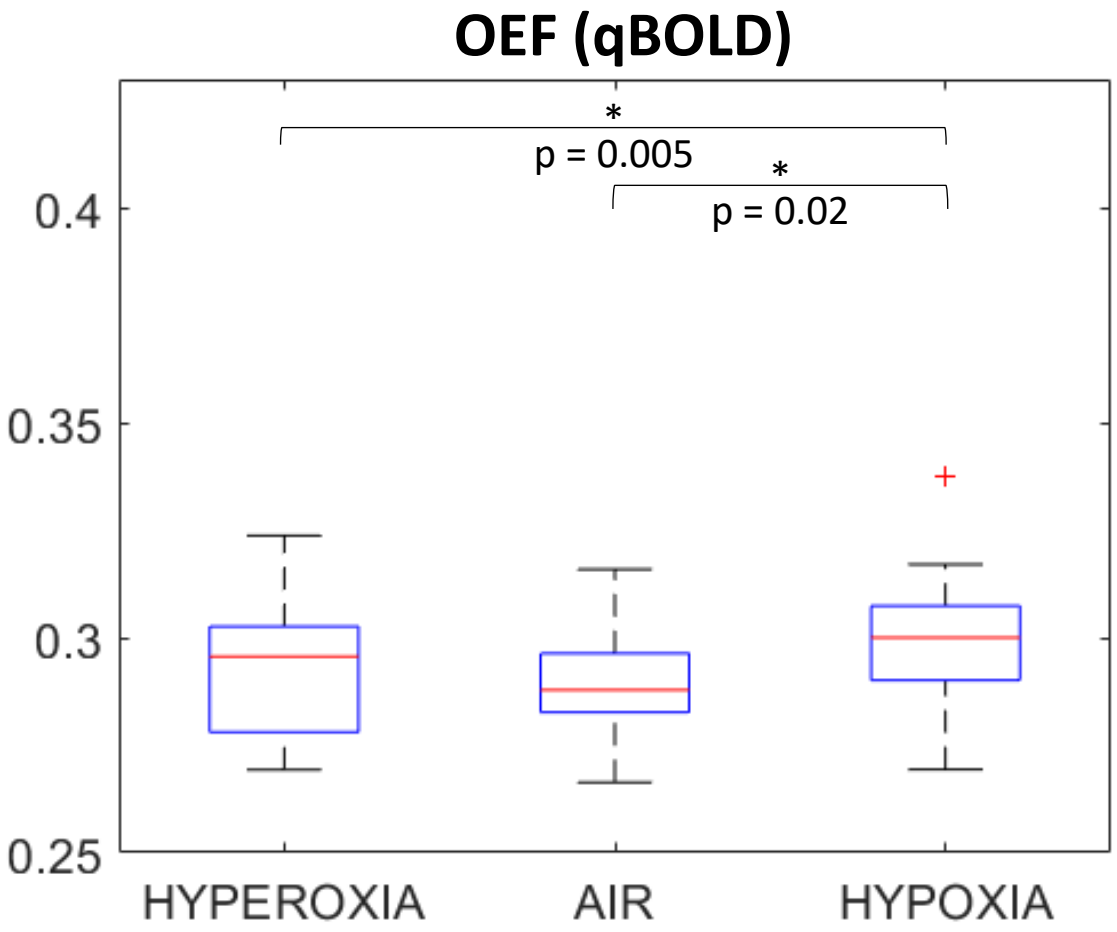
OEF (%)

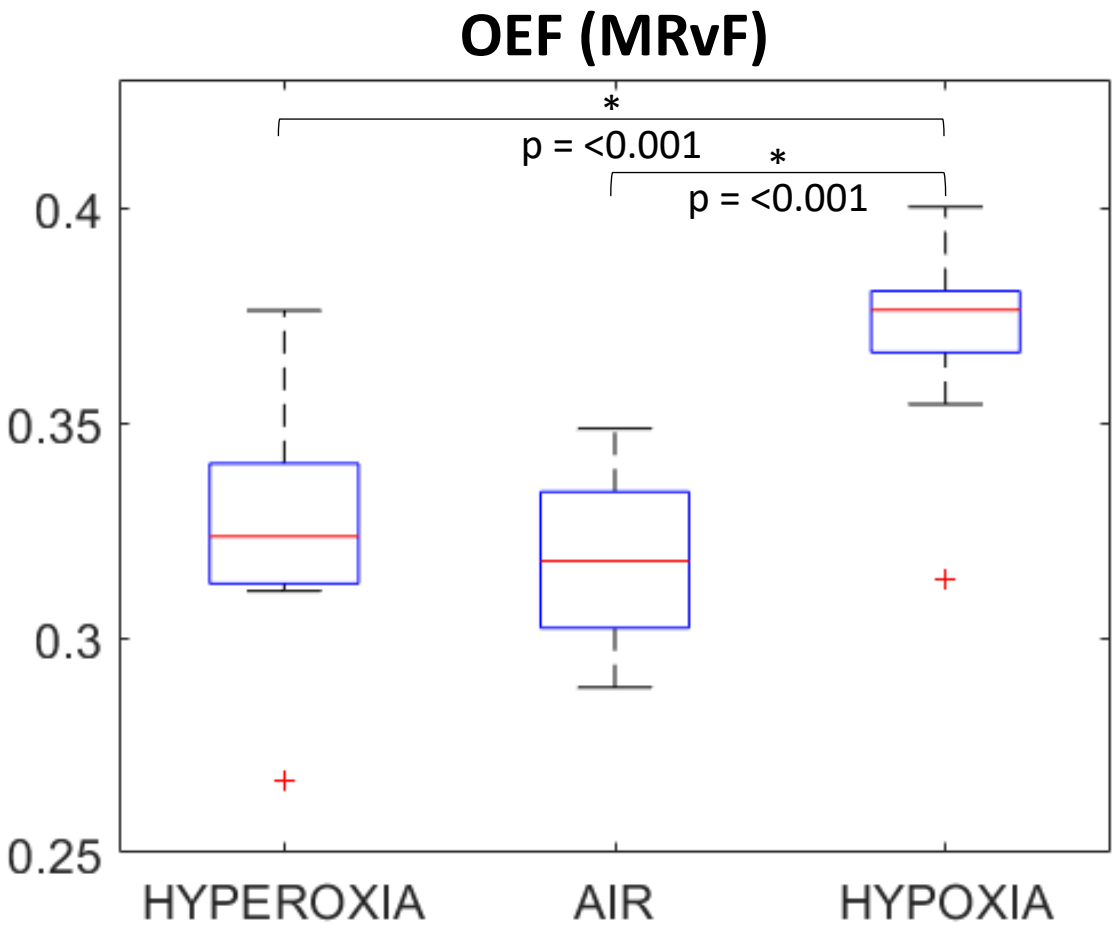


OEF Calculated: qBOLD vs. MRvF



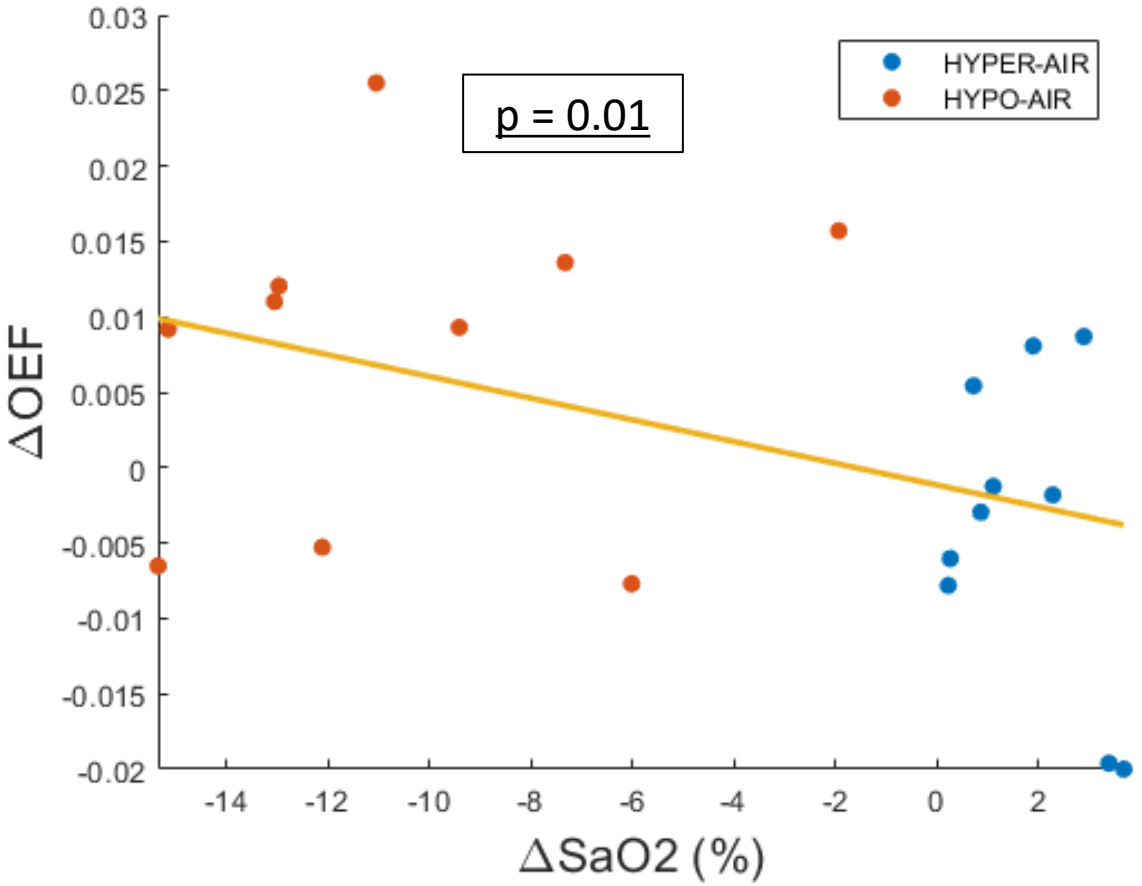
Change in Gray Matter OEF During Hypoxia and Hyperoxia Using qBOLD vs. MRvF



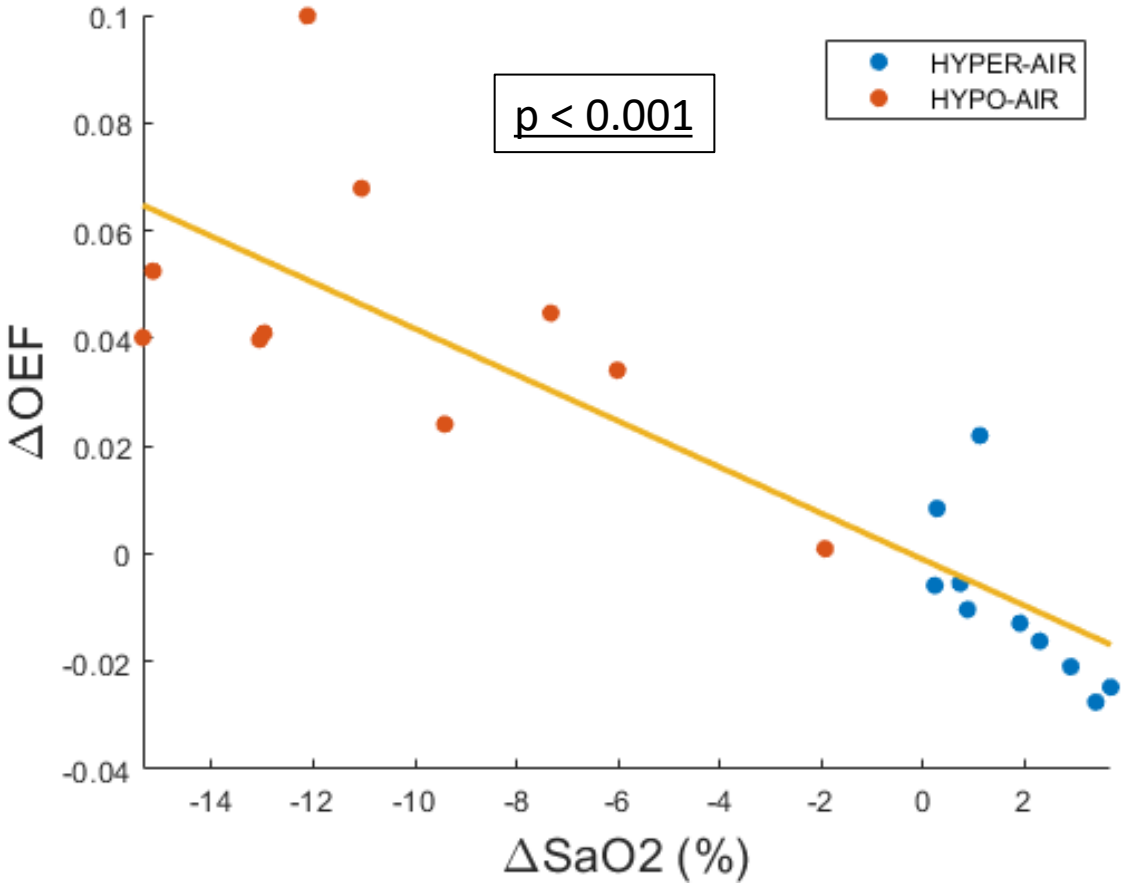


Relationship Between OEF Changes and Arterial Blood Oxygen Changes During Hypoxia and Hyperoxia

qBOLD



MRvF



Discussion and Conclusions

- Brain OEF measurements from both qBOLD and MRvF provide sensitivity to physiological changes across hypoxic and hyperoxic oxygen inhalation conditions

- OEF maps from MRvF visually showed improved reconstruction and larger changes during different gas conditions
  - ➢Robustness of fingerprint matching to noise

- Future studies will utilize these models to assess oxygenation changes in conditions that affect neurovascular physiology

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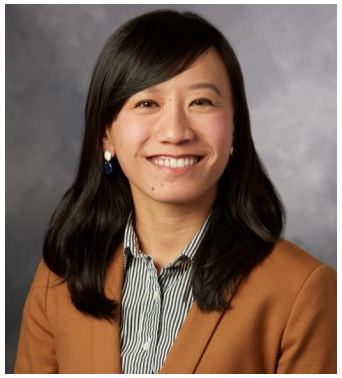

Professor Audrey P. Fan

Fan's Lab

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