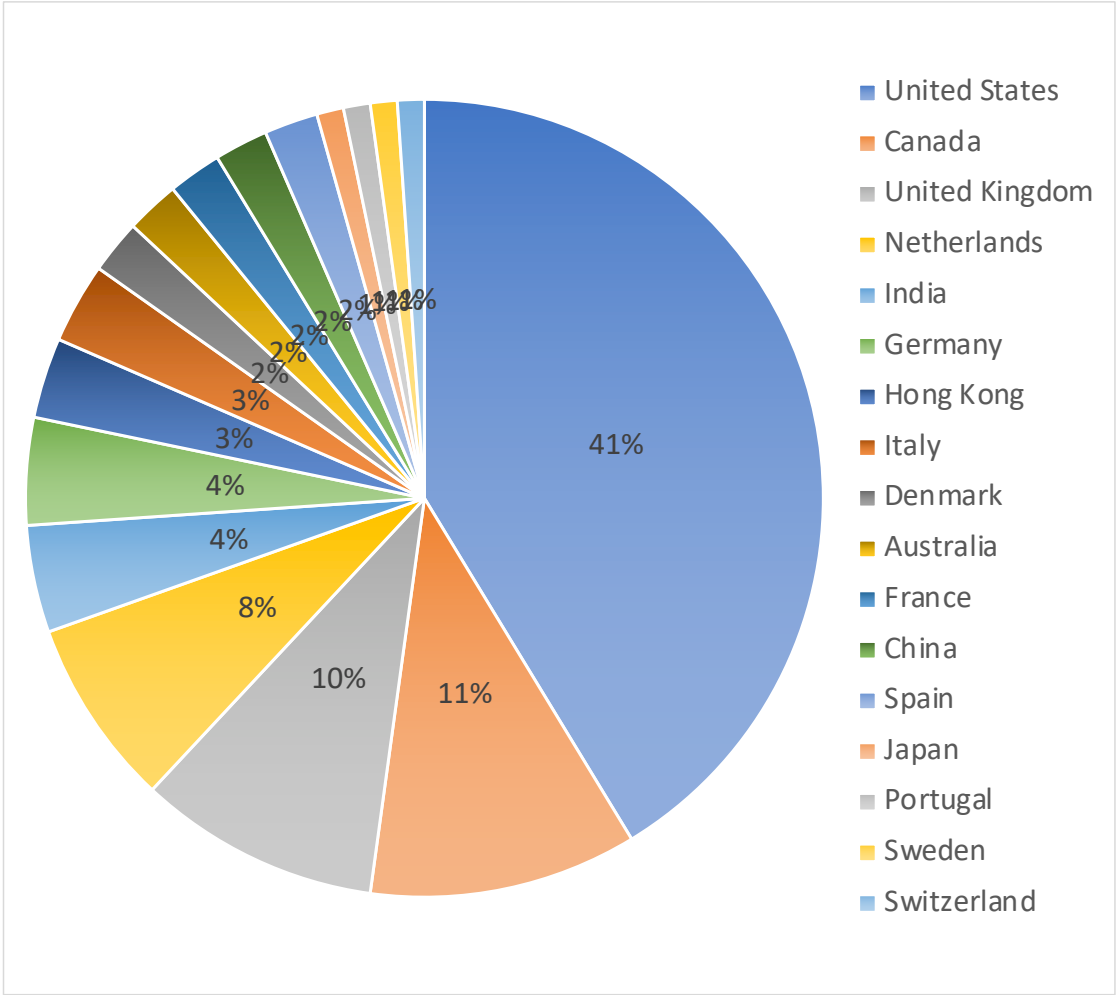
ISMRM 2020 Trainee Awards

ISMRM 2020 Trainee Awards

- A way to highlight the accomplishments of our trainee membership.
- The DSG committee solicited applications from trainees with abstract accepted as 1st author.
- Members of the DSG Committee (#9 in total) judged the abstracts and selected winners for the following categories:
  - Best Neuro Abstract accepted as Oral and Poster presentation
  - Best Body Abstract accepted as Oral and Poster presentation
  - Best Methods Abstract accepted as Oral and Poster presentation
  - Best Newcomer Abstract as Poster presentation

submissions

- 92 submissions
  - 58 digital posters
  - 34 oral presentations or power pitches
  - 17 newcomers (first time submission)



Diffusion Study Group Award 2020 for

Best Diffusion Methods Abstract (Oral)

Merlin Fair

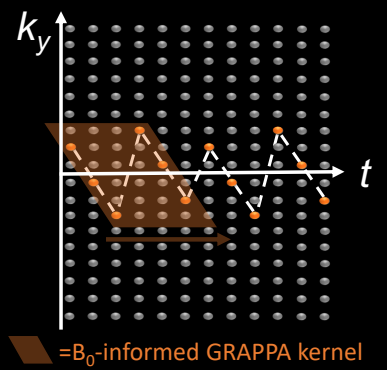
A. A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, United States

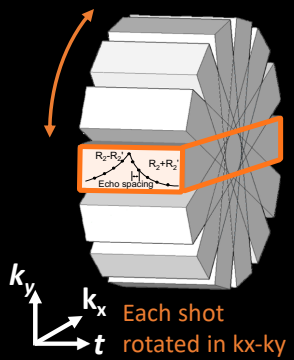
953: Diffusion-PEPTIDE: rapid distortion-free diffusion-relaxometry imaging

Diffusion-PEPTIDE: rapid distortion-free diffusion-relaxometry imaging – Fair et al. (#0953)

Martinos Center for Biomedical Imaging

PEPTIDE Sampling:

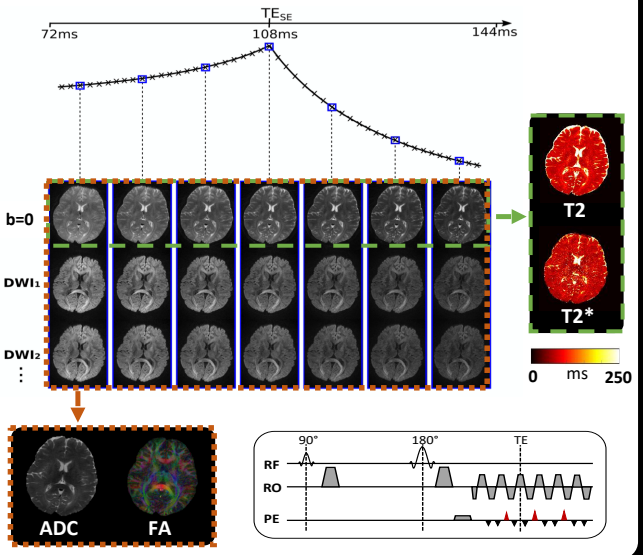




- Complete k-t space reconstructed
- Provides large time-series of multi-contrast images
- Each free from T2*blurring and B_0-inhom phase
- Incorporates self-navigation of phase and motion

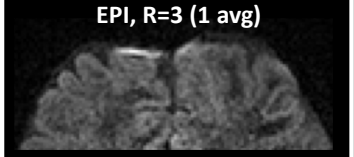
Echo Planar Time-resolved Imaging (EPTI) – Wang et al., MRM, 2019
Propeller EPTI with Dynamic Encoding (PEPTIDE) – Fair et al., MRM 2020

Diffusion-PEPTIDE:

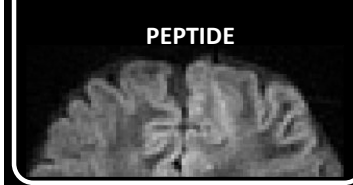


Distortion-free:

EPI, R=3 (1 avg)

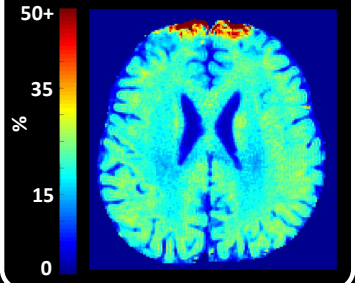


PEPTIDE

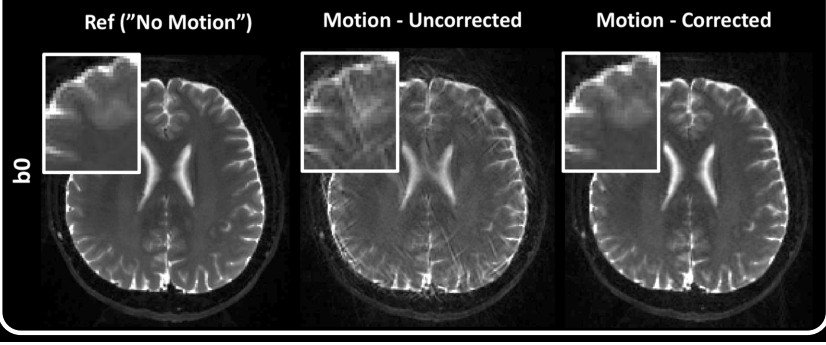


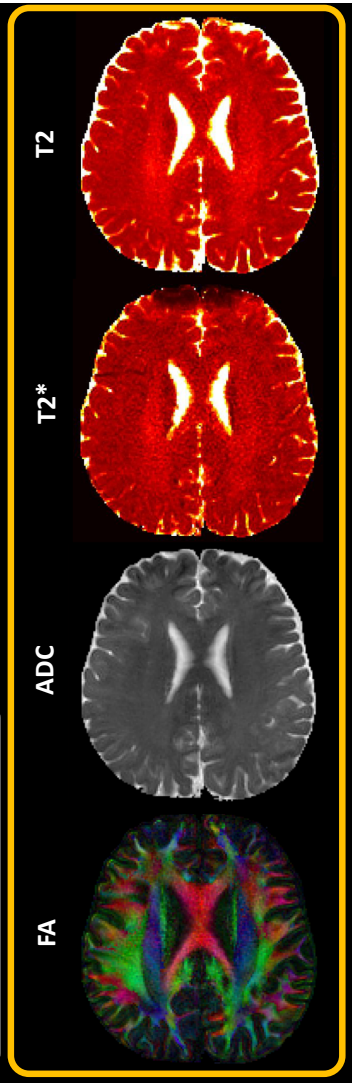
T*-blurring free:

EPI, R=3, T2* Resolution Loss



Motion-tolerant:





Diffusion Study Group Award 2020 for

Best Diffusion Methods Abstract (Poster)

Suheyla Cetin Karayumak

Psychiatry Neuroimaging Laboratory, Brigham and Women's Hospital, Harvard Medical School, United States

4379: Exploring the reliability of ComBat for multi-site diffusion MRI harmonization

ISMRM 2020 POSTER ID #4379

Exploring the reliability of ComBat for multi-site diffusion MRI data harmonization

Suheyla Cetin-Karayumak, Marek Kubicki, Yogesh Rathi

Department of Psychiatry, Brigham and Women's Hospital, Harvard Medical School, Boston MA

skarayumak@bwh.harvard.edu *@suheyla_cetin* *@Suheyla_Cetin_Karayumak*

NIH National Institute of Mental Health R01MH119222 (PI: Rathi, O'Donnell)

MOTIVATION

"*Harmonization*" (i.e., remove scanner specific effects) of multi-site diffusion MRI (dMRI) datasets can increase the statistical power of neuroimaging studies. Harmonization approaches can be categorized into two:

a. Pre-harmonization: Harmonization at the signal level

b. Post-harmonization: Pool diffusion measures, ComBAT

Two Important Questions for ComBAT:

1) *How much can ComBAT preserve effect-sizes (ES) of biological differences when used for harmonization?*

2) *What are the effects of using different software packages to estimate the diffusion tensor on the harmonization performance of ComBAT ?*

OBJECTIVE

This study aims to answer these questions (#1 and #2 above) by harmonizing fractional anisotropy (FA) across 5 sites using ComBAT.

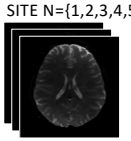
CONCLUSION

- ***We recommend being extra cautious using ComBAT while the bvalues, age range of the subjects, sample sizes across sites etc. are different.***
- ***Most importantly, we recommend not to combine dMRI measures processed with different software packages.***

METHODS

PRE-PROCESSING STEPS OF MULTI-SITE DMRI DATA:

SITE N={1,2,3,4,5}

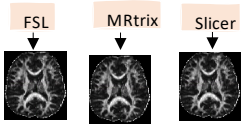


Eddy current and motion corrected dMRI data from 5 sites including 251 healthy controls and 291 schizophrenia patients

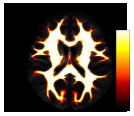
1) Diffusion tensor fitting with Ordinary least squares (OLS) fitting

2) Whole brain white matter and fiber bundles analysis in subject space

3) ComBAT harmonization



Fractional anisotropy (FA) maps



Whole brain white matter tissue atlas

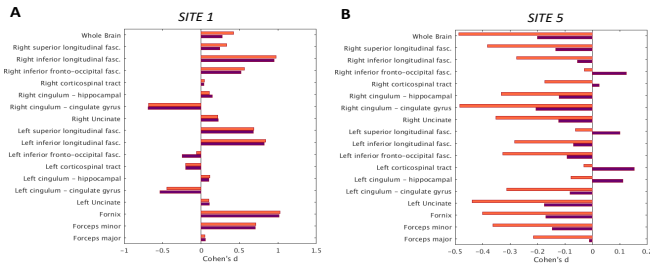
17 white matter major bundles from IIT probabilistic atlas

- Ran on 5 sites, using whole brain mean FA + 17 bundles mean FA
- Age, sex and diagnostic group are included as confounds to the harmonization

RESULTS

For identical preprocessing steps, ComBAT seems to still alter the inter-group differences in certain sites (e.g. flipping the direction of effect sizes).

Effect sizes between female and male healthy controls



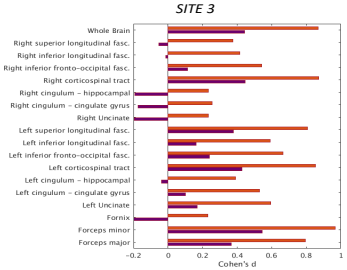
Before: Effect sizes between females and males before harmonization

After: Effect sizes between females and males after harmonization

Note: FSL was used to compute FA in each site

When DTI fitting software changes, ComBAT introduced drastic effects to the data.

Effect sizes between healthy controls and schizophrenia patients



Before: Effect sizes between controls and patients before harmonization

After: Effect sizes between controls and patients after harmonization

Note: different software was selected to compute FA in each site

Diffusion Study Group Award 2020 for

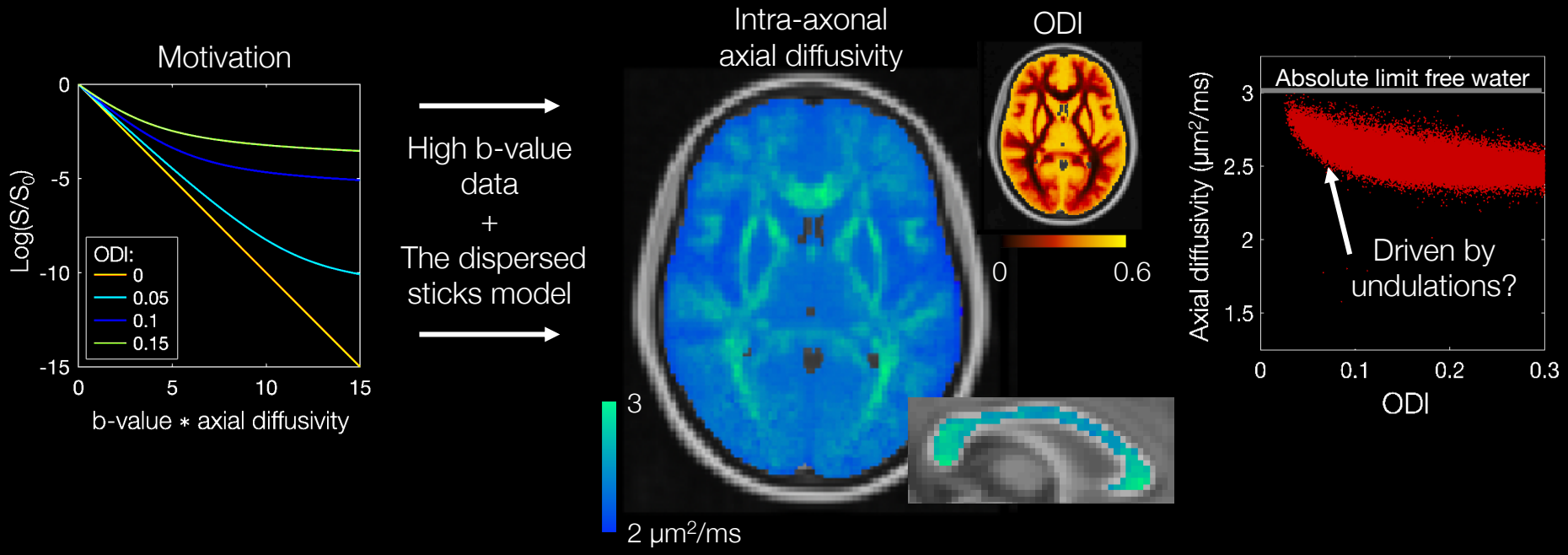
Best Diffusion Neuro Abstract (Oral)

Amy Howard
FMRIB Centre, University of Oxford, Oxford, United Kingdom

730: Estimating intra-axonal axial diffusivity with diffusion MRI in the presence of fibre orientation dispersion

Estimating intra-axonal axial diffusivity in the presence of fibre orientation dispersion

AMY HOWARD, RICK LANGE, JEROEN MOLLINK, MICHIEL COTTAAR, KARLA MILLER* & SAAD JBABDI* *EQUAL CONTRIBUTION



AMY.HOWARD@DTC.OX.AC.UK | MANY THANKS TO MARK DRAKESMITH, DEREK JONES & CUBRIC CARDIFF FOR PROVIDING DATA

Diffusion Study Group Award 2020 for

Best Diffusion Neuro Abstract (Poster)

Emilie McKinnon, PhD
Center for Biomedical Imaging, Medical University of South Carolina, United States

4627: Power-law fits for the direction-averaged diffusion MRI signal: a potential marker for white matter maturation in non-feeding infants

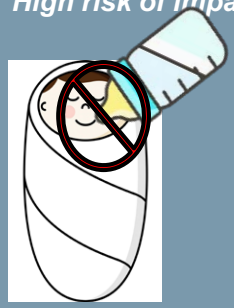
2806: dMRI Power-law fits - a marker for white matter maturation in neonates

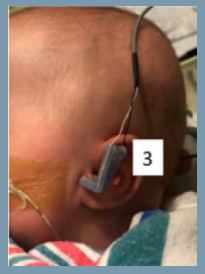
mckinnon@musc.edu

MOTIVATION

Preterm infants (<37 weeks GA)

High risk of impaired motor skills





Increase sensitivity by studying high b-value behavior?

$$\frac{\bar{S}}{S_0} = C \cdot \left(\frac{b_1}{b}\right)^{\alpha} \longrightarrow \alpha = \frac{\ln(\frac{\bar{S}_4}{\bar{S}_6})}{\ln(\frac{b_6}{b_4})}$$

METHODS

12 infants

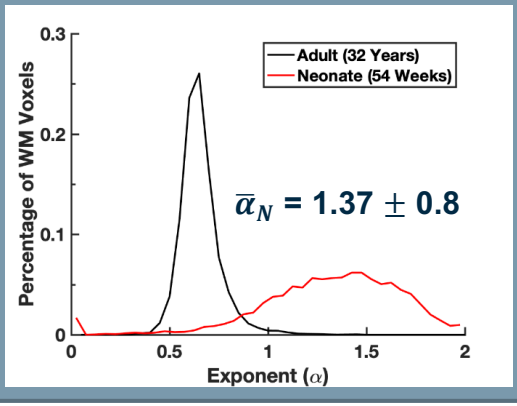
$\overline{GA}$ = 32 ± 5.3 weeks

GA= 38 – 54 weeks

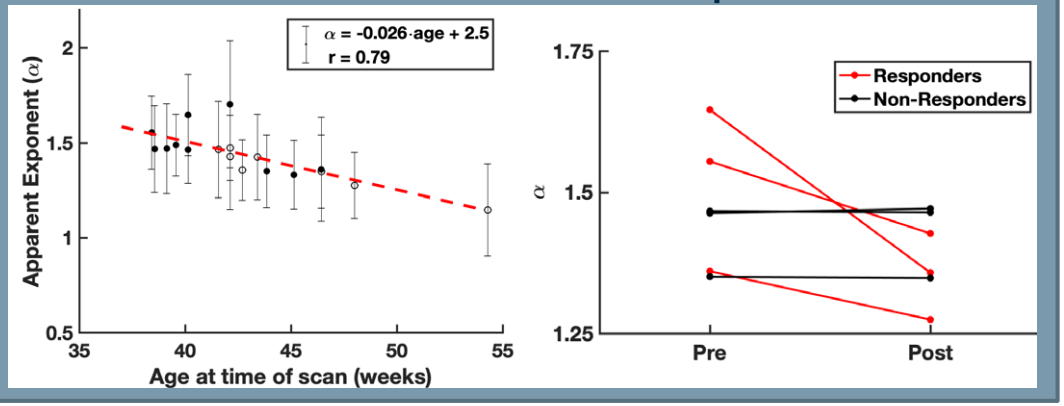
23 ± 13

Siemens Prisma Acquisition Parameters	
Diffusion Weighting (mm²/s)	0, 1000, 2000, 4000, 6000
Gradient Directions	64

RESULTS



Posterior limb of the internal capsule



Diffusion Study Group Award 2020 for

Best Diffusion Body Abstract (Oral)

Matthew Birkbeck

Newcastle University, Newcastle upon Tyne, United Kingdom

346: Non Invasive Imaging of Human Motor Units

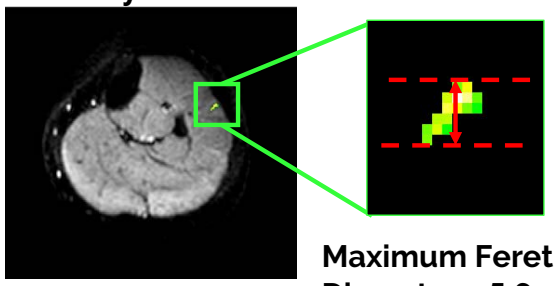
Applications of Motor Unit MRI (MUMRI)

Sarcopenia

Neuromuscular disease in which motor units degenerate & increase in size causing muscle weakness

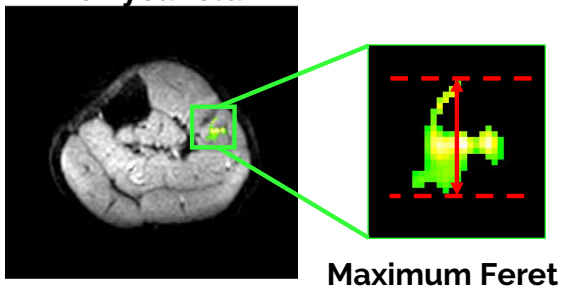
MUMRI to detect differences in motor unit size between different age groups

32 year old

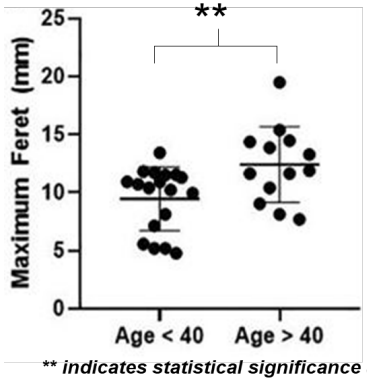


Maximum Feret Diameter = 5.6 mm

54 year old



Maximum Feret Diameter = 11.9 mm



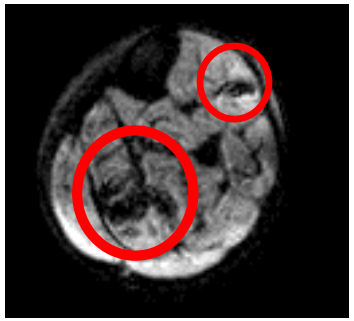
*** indicates statistical significance at p = 0.01*

Amyotrophic Lateral Sclerosis

Neuromuscular condition hallmarked by fasciculation: spontaneous activation of motor units

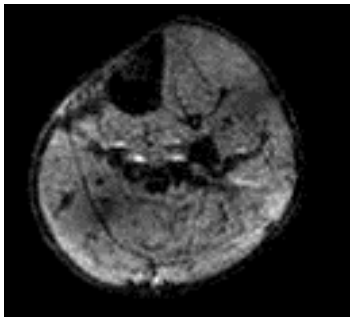
MUMRI to detect fasciculation between patients & healthy volunteers

Patient with ALS



99 per minute (range 26 - 161)

Healthy volunteer



8 per minute (range 4 - 10)

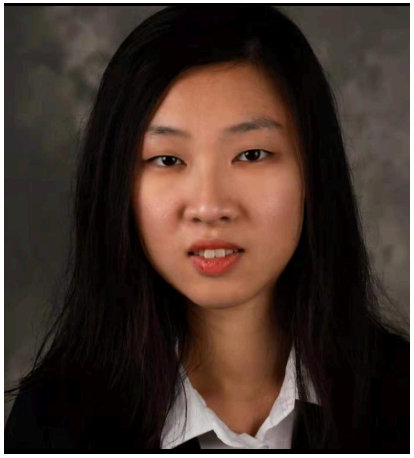
To Date:

MUMRI has detected statistically significant changes in: fasciculation in ALS[1] & motor unit morphology associated with age[2]. MUMRI is a promising tool for use in Neuromuscular disorders

1) Whittaker et al. Ann. Neuro. 9999: 1-5, 2019 2) Birkbeck et al. Clin. Neurophys. 131: 1399-1406, 2020

Diffusion Study Group Award 2020 for

Best Diffusion Body Abstract (Poster)



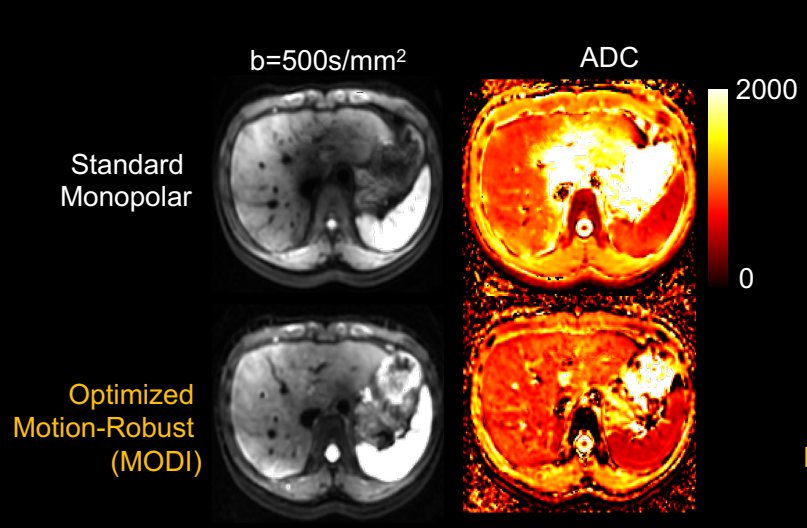
Ruiqi Geng
Department of Radiology, University of Wisconsin-Madison, United States

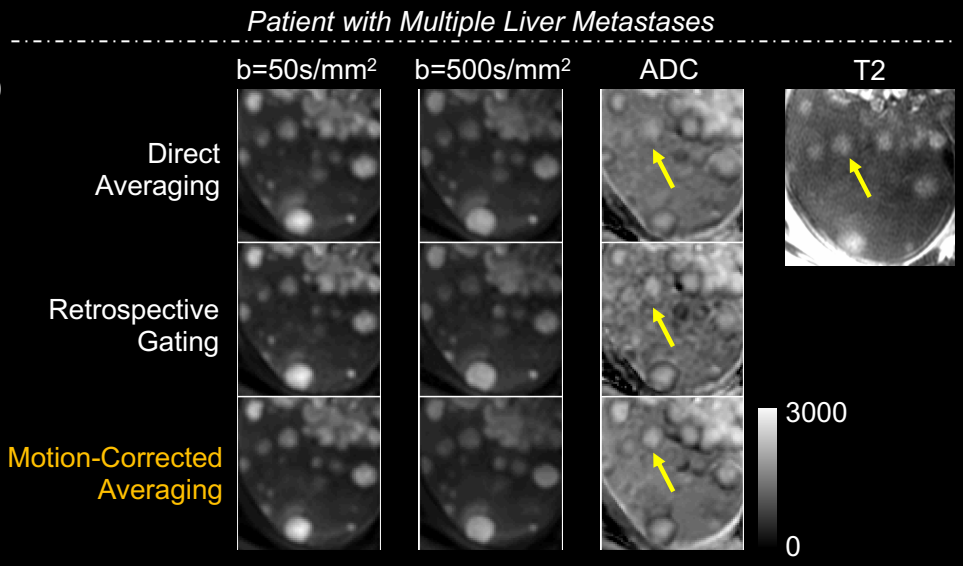
2470: Liver Diffusion MRI using Optimized Gradient Waveforms, Free-Breathing Acquisitions, and Motion-Corrected Averaging: Validation in Patients

#2470 – DWI of the Liver with Optimized Gradient Waveforms, Free-Breathing Acquisitions, and Motion-Corrected Averaging

Technical Impacts:

- Cardiac motion → Optimized gradient waveforms
- Respiration → Motion-corrected averaging (NLM)





Potential Clinical Impacts:

- Validation in patients with liver metastases → better assessment of lesions
- Non-gated free-breathing methods with fixed, predictable scan time → improved comfort & workflow

Geng R, Zhang Y, Muhler M, Starekova J, Hernando D *University of Wisconsin-Madison*

Diffusion Study Group Award 2020 for

Best Diffusion Newcomer Abstract (Poster)

Daniel Djayakarsana

Physical Sciences, Sunnybrook Research Institute, Toronto, Canada

4428: Using stimulated echo diffusion MRI to elucidate cellular changes during cell death

4428 - Using stimulated echo diffusion MRI to elucidate cellular changes during cell death

Medical Biophysics
UNIVERSITY OF TORONTO

D. Djayakarsana, G.J. Czarnota, C. Bailey

Sunnybrook
HEALTH SCIENCES CENTRE

Motivation

- Cancer treatments induce microstructural changes, including membrane permeability
- Diffusion MRI with longer diffusion times may have the potential to differentiate treatment response outcomes

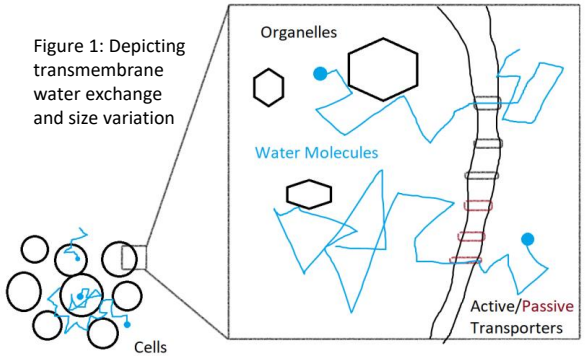


Figure 1: Depicting transmembrane water exchange and size variation

- Longer diffusion times (~50-1000 ms) can be achieved with stimulated echoes (DTI-STEAM-EPI)

Results

Model used is an in vitro AML-5 cell line with a control and an apoptotic group

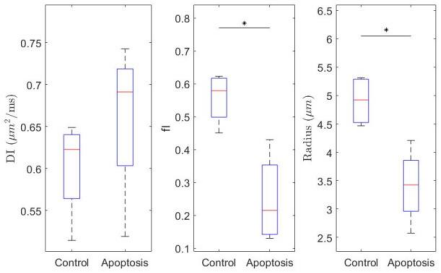
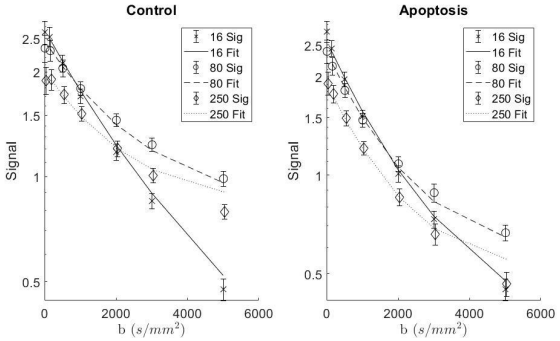


Figure 2: Ball-sphere fitting. DI is intracellular diffusivity, fI is intracellular volume fraction, radius is the cell radius. DI is the only NS. 0.05 threshold. N=4

Figure 3: Ball-sphere fits for a single dataset. 7 fits total, but only 3 are shown. Note poor fitting at higher gradient separation (250 ms)



Highlights

- The chosen ball-sphere (Camino) fitting does not include varying sizes or water exchange
- **Control** values are consistent with literature and microscopy
- **Apoptosis** has varying cell sizes and increased water exchange based on literature, the current ball-sphere fit may be biased towards smaller cells
- Fits for the simple ball-sphere are not ideal, which could be due to water exchange and size variations (sample of fits in Fig. 3)

Future Work

- Modeling and investigating the mathematical theory in detail
- Include water exchange and distributions of cell sizes (Xu et al. 843)
- Applying Nilsson et al. framework for time-dependent diffusion (Oral 718)

Congratulations!!