# Age differences in white matter: 3-way multimodal analysis.

Mendez A[1], Hefner M[2]; Calhoun V[4]; McAuley E[5]; Kramer A[6]; Burzynska AZ[3]

[1]Psychology department, [2]College of Engineering, [3]Human Develop. and Family Studies, Colorado State University; [4]Psychology and Neuroscience., Georgia State Univ., Atlanta, GA; [5]Univ. of Illinois at Urbana-Champaign, Urbana, IL; [6]Northeastern Univ., Boston, MA

## Introduction

- WM aging > "cortical disconnection" > cognitive decline
- WM aging studied predominantly with DTI, T2- and T1-WI
- Standard methods are sensitive to age differences but not specific to any pathology (e.g. demyelination)
- Each technique has limitations:
  - DTI: crossing fibers, water/membrane content
  - T1- and T2-WI: free water content, iron
- Inconsistent findings on age differences and correlations with cognition of brain function
- Multimodal fusion can help maximize information across modalities and identify biomarkers (Calhoun, 2016)
- Lack of symmetric voxel-wise data fusion studies on WM in healthy aging (Hsieh 2014).
- T1w/T2w suggested as an indirect proxy of myelin that can complement DTI.

## Study aim

Can we better define age differences in WM by leveraging information from different MRI types in multimodal fusion?

## Hypotheses

1) FA will be lower and MD higher in OA than YA
2) The three modalities will show joint age differences (i.e. multimodal ICs)

## Participants

- Young adults (YA): n=37, M=22yrs (Burzynska, 2017a)
- Older adults (OA): n=98, M=65yrs (Burzynska, 2017b)
- Cognitively normal (MMSE>27), community dwelling

## 3T Siemens MRI

- DTI, 30 dir., b-value=1000s/mm$^2$, 1.7mm for OA, 1.9mm for YA.
- Fractional anisotropy (FA) and mean diffusivity (MD) maps generated in FSL-DTD, nonlinear registration to MNI152
- T1-WI, MPRAGE, 0.9mm$^3$
- T2-WI, b=0 images from DTI
- T1w/T2w using MRTool in SPM12 (Ganzetti et al., 2014)

## mCCA+jICA multimodal fusion

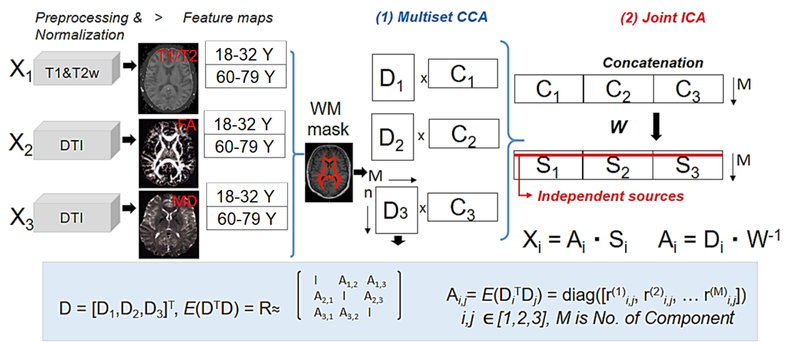


**Figure 1. Multimodal Canonical Correlation Analysis with Joint Independent Component Analysis (mCCA+jICA).** mCCA+jICA leverages the cross-information among N data types and allows to reveal relationships that cannot be detected by using a single modality. In other words, mCCA+jICA allows us to investigate whether certain group differences (here: age differences in WM) are shared or distinct across multiple MRI data types.

Calhoun et al. 2013, Sui et al. 2013

## Results

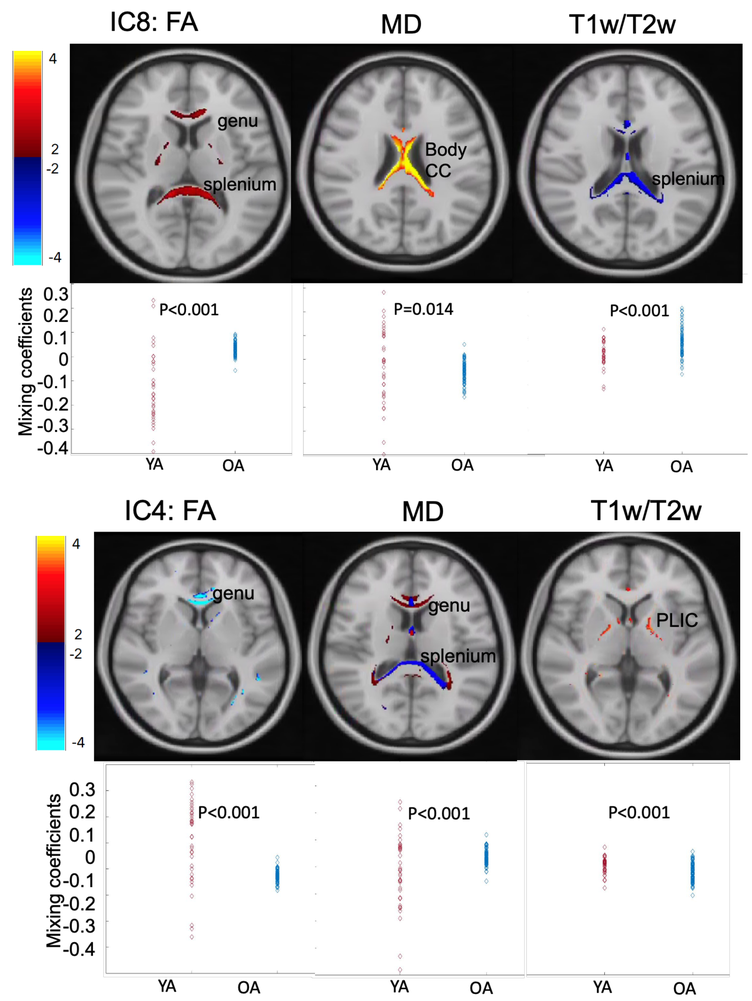


**Figure 2. Joint ICs representing age differences in WM between YA and OA at |Z| > 2.5.** Showing 2 out of 8 significant ICs. The positive Z-values (red regions) means YA>OA and the negative Z-values (blue regions) means YA<OA.

## Discussion

- We identified 7 modality-shared ICs, 1 modality-unique IC for T1/T2. Some ICs confirmed H1, but not all ICs showed expected DTI patterns (e.g., decreased FA in OA). We confirmed H2, but we observed complex spatial distribution of the independent sources.

## Future directions

- Correlate ICs with cognition, compare to FA only
- Test other multimodal models that focus on similarities among modalities

## Contact

Andrea Mendez Colmenares
Colorado State University
Email: andrea.mendez@colostate.edu

## References

1. Burzynska, A. Z., Preuschhof, C., Bäckman, L., Nyberg, L., Li, S. C., Lindenberger, U., & Heekeren, H. R. (2010). Age-related differences in white matter microstructure: region-specific patterns of diffusivity. Neuroimage, 49(3), 2104-2112.
2. Calhoun, V. D., & Sui, J. (2016). Multimodal fusion of brain imaging data: a key to finding the missing link (s) in complex mental illness. *Biological psychiatry: cognitive neuroscience and neuroimaging*, *1*(3), 230-244.
3. Ganzetti, M., Wenderoth, N., & Mantini, D. (2014). Whole brain myelin mapping using T1-and T2-weighted MR imaging data. Frontiers in human neuroscience, 8, 671.
4. Sui, J., He, H., Pearlson, G. D., Adali, T., Kiehl, K. A., Yu, Q., ... & Ho, B. C. (2013). Three-way (N-way) fusion of brain imaging data based on mCCA+ jICA and its application to discriminating schizophrenia. NeuroImage, 66, 119-132.