# Comparing Structural Covariance Regions in Humans and Chimpanzees

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## INTRODUCTION

- Grey matter (GM) structural covariance (SC) uncovers regions that share connectivity, genetic similarities, and/or development<sup>1</sup>
- Orthogonal Projective Non-Negative Matrix Factorisation (OPNMF)<sup>2</sup> creates datadriven SC regions with non-negative loadings improving interpretability and biological meaning to the components
- Aim: To present and compare OPNMF SC regions in humans and chimpanzees

# METHODS

# Chimpanzee (NCBR)<sup>3</sup>

CAT12 'chimpanzee preprocessing<sup>5</sup>

### **Post-Processing**:

- Modulated GM maps (mwp1\*)
- 2mm resolution
- Smooth 4mm FWHM
- QC N= 189, 9-50 y/o, 126 ♀
- 0.2 GM mask (Cortex & Basal Ganglia)

# Human (IXI)4 preprocessing

### **Post-Processing**:

- Modulated GM maps (mwp1\*)
- 3mm resolution
- Smooth 6mm FWHM
- QC − N= 480, 20-75 y/o, 262
- 0.2 GM mask (Cortex & Basal Ganglia)

### Mixed Sample: N=669

- IXI NCBR combined sample
- ↑ + ★★ · NCBR Non-linear deformation from
  - Juna (chimp) to MNI (human) space
  - IXI sample post-processing

### **OPNMF**: https://github.com/kaurao/opnmfR

- GM voxels X No. subjects input matrix
- Ranks 2 40 were investigated
- Permutation based rank selection<sup>6</sup> with bootstrapping (30) to determine change in Mean Reconstruction Error (MSE).
- Selection criteria were a plateau in MSE change across the 3 samples and a high inter-species Adjusted Rand Index (ARI).

### Comparison:

- Similarity of selected rank components were compared (ARI) to function connectivity networks (Yeo 17 networks)<sup>7</sup>.
- Present mean deformation (Juna MNI) of selected rank solution components.

# RESULTS **Reconstruction Error Change (MSE) over 30** Similarity of rank solutions across samples **Bootstraps** (mean±sd) 0.0 -18 Rank Solution 450K CORE HOURS 0.20 **ISE** Chimpanzee\_boots Chimpanzee perm IXI boots IXI<sup>\_</sup>perm Mixed boots Mixed\_perm 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 Ranks Ranks Rank 18 component-wise deformations **Yeo 17 Networks > 0.3 ARI in 18 rank component**

## DISCUSSION

Yeo 17 Networks<sup>7</sup>

- All 3 samples reveal a similar structure of reconstruction error change.
- Evolutionary deformations are captured within the 18 rank solution.

Somatomotor A (3)

Somatomotor B (4)

Limbic A & B (9,10)

Control C (11)

Temporal (14)

- The human rank solutions shows similarity to more higher-order networks as compared to the chimpanzee.
- The mixed sample contains SC features from both species and represents an extant greater ape (homo & Pan) parcellation.

**Small Juna - MNI** 

deformation

18 rank solution contains similar cross-species regions that may represent conserved structural organisation in human evolution

Large Juna - MNI

deformation

Alexander-Bloch A et al. Imaging structural co-variance between human brain regions. Nat Rev Neurosci. 2013 Sotiras A et al. Patterns of coordinated cortical remodeling during adolescence and their associations with functional specialization and

Chimpanzee brain morphometry utilizing standardized MRI preprocessing and macroanatomical annotations. Elife. 2020 Frigyesi A, Höglund M. Non-negative matrix factorization for the analysis of complex gene expression data: identification of clinically

Juna – MNI voxel-wise

deformations (jacobian)

Thomas Yeo BT et al. The organization of the human cerebral cortex estimated by intrinsic functional connectivity. J Neurophysiol. 2011

7 + 1