Introduction of Magnetic Resonance Imaging (MRI) to LASI-DAD

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Outline


Motivation


Protocol


Data acquisition


Data processing


Data harmonization


Findings so far


Next steps

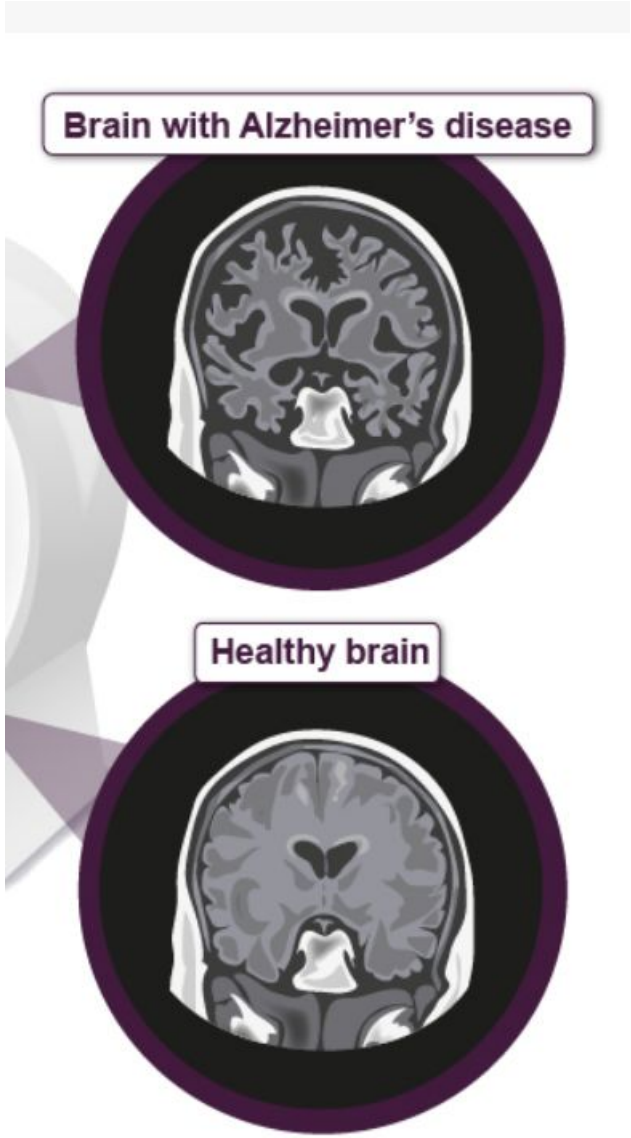
Why MRI?

Structural MRI is the most commonly used technique to identify brain atrophies related to AD

- Hippocampal atrophy (volumetric abnormality), entorhinal cortex, etc.

Functional MRI (fMRI) is used to observe activities in the brain

- Through resting state fMRI, brain networks are observed through changes in blood flow in the brain



ADNI-3 Protocol:

Exclusively on 3T scanner (32 channel head coil)

2xT1-weighted Scans
- 1 x 1 x 1 mm^3
- Multi-shot Imaging
- SENSE 2 Accelerated
- 8.0 ms TR / 3.7 ms TE

FLAIR
- 1 x 1 x 1 mm^3
- SENSE 2 Accelerated
- 4800 TR / 1650 TE

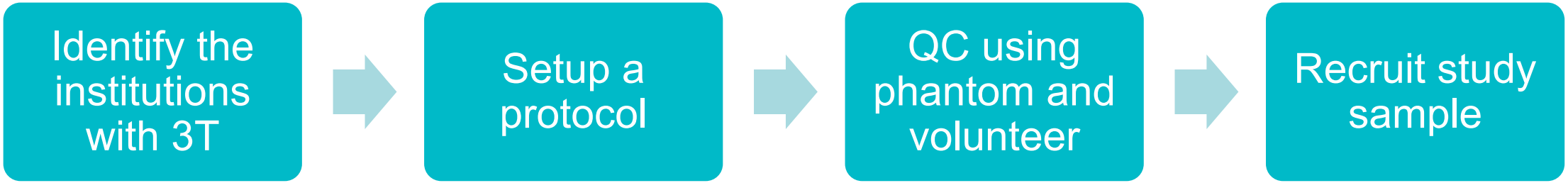
T2-High Resolution of Hippocampus
- 0.5 x 0.5 x 2 mm^3
- 3844 ms TR / 120 ms TE

- DTI (Diffusion Tensor Imaging)
  - 2 x 2 x 2 mm^3
  - 64 Directions
  - 1000 max b-value

- SWI
  - 0.5 x 0.75 x 2 mm^3
  - 3D
  - 5 Echos

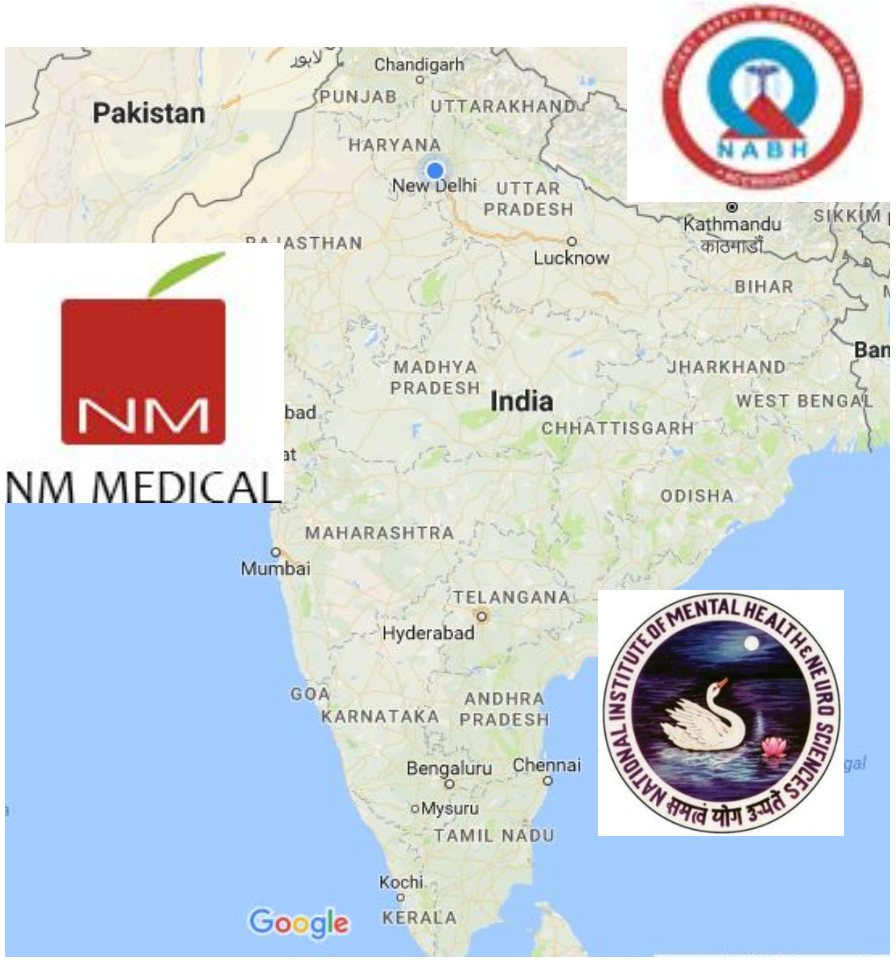
- RS- fMRI
  - 3 x 3 x 3 mm^3
  - 10 Minutes
  - SENSE 2 Accelerated
  - 2000 TR / 20 ms TE

Data Acquisition

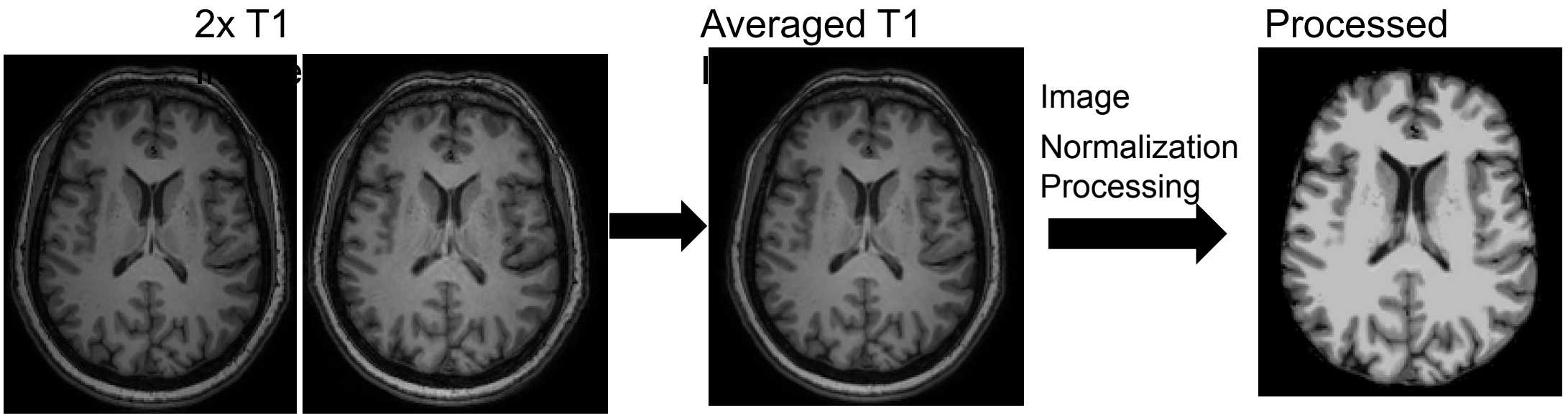


MRI sites

- National Institute of Mental Health and Neurosciences, Bangalore: *Phillips Ingenia*
- NM Medical, Mumbai: *Siemens Skyra*
- Institute of Neurosciences Kolkata, Kolkata: *Simens Skrya*



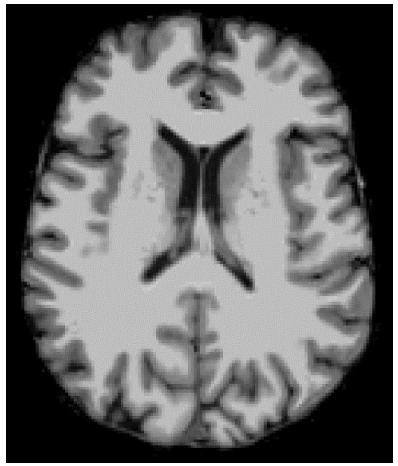
Data Processing



Voxel-based Parcellation & Segmenttion

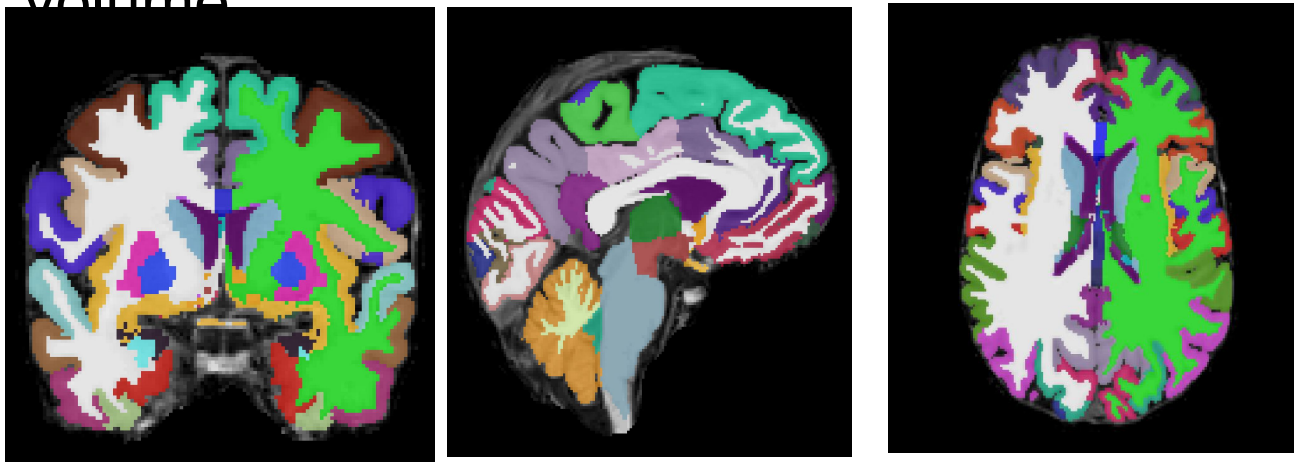
Main Output:

Numeric of each segmented region's volume

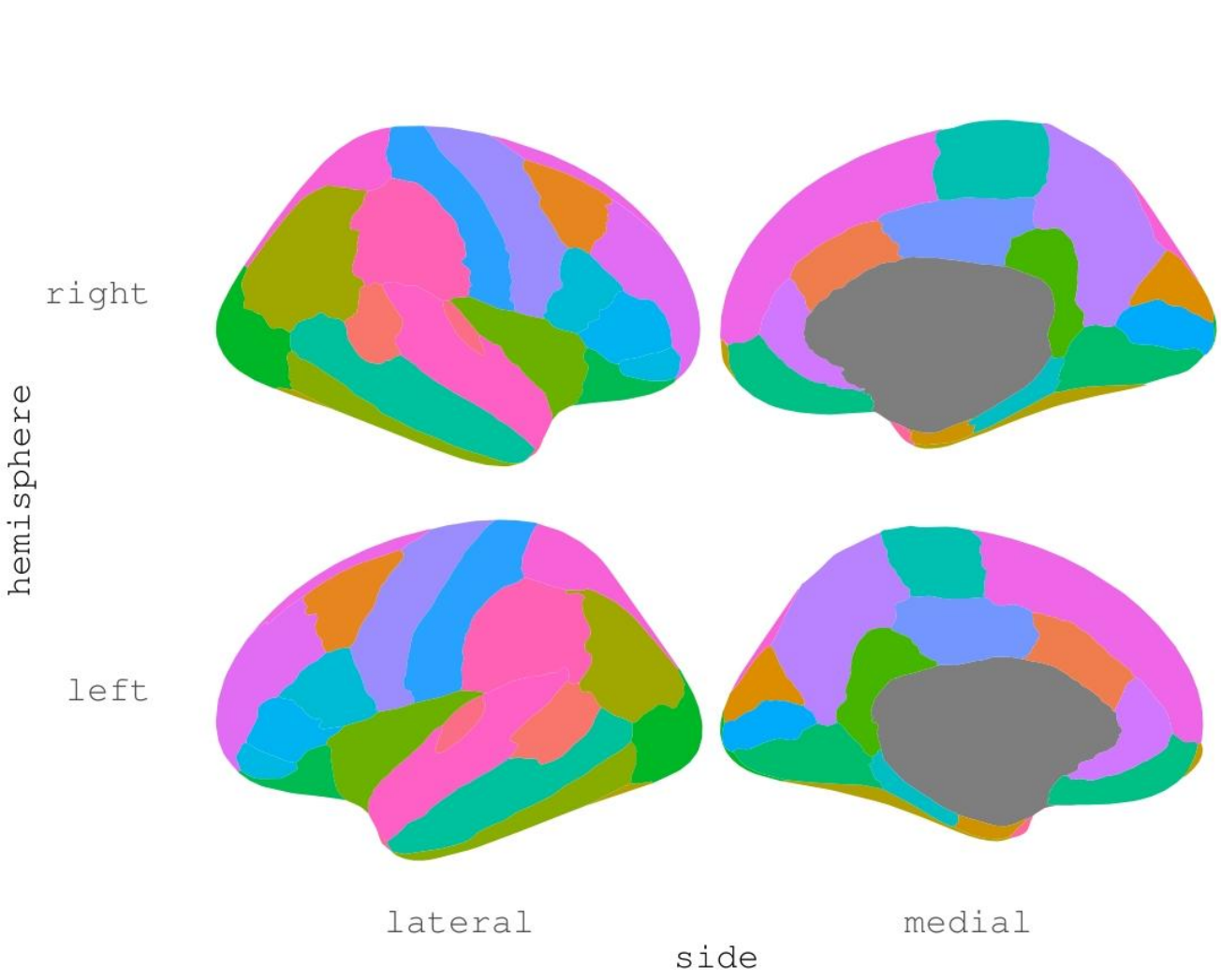


Processed Brain

FLAIR for Pial Surface



Volume & Thickness of Cortical ROIs (Region Of Interests)



area

- banks superior temporal
- caudal anterior cingulate
- caudal middle frontal
- cuneus
- entorhinal
- frontal pole
- fusiform
- inferior parietal
- inferior temporal
- insula
- isthmus cingulate
- lateral occipital
- lateral orbitofrontal
- lingual
- medial orbito frontal
- middle temporal
- para central
- parahippocampal
- pars opercularis
- pars orbitalis
- pars triangularis
- pericalcarine
- post central
- posterior cingulate
- pre central
- precuneus
- rostral anterior cingulate
- rostral middle frontal
- superior frontal
- superior parietal
- superior temporal
- supramarginal
- temporal pole
- transverse temporal
- NA

Data Harmonization

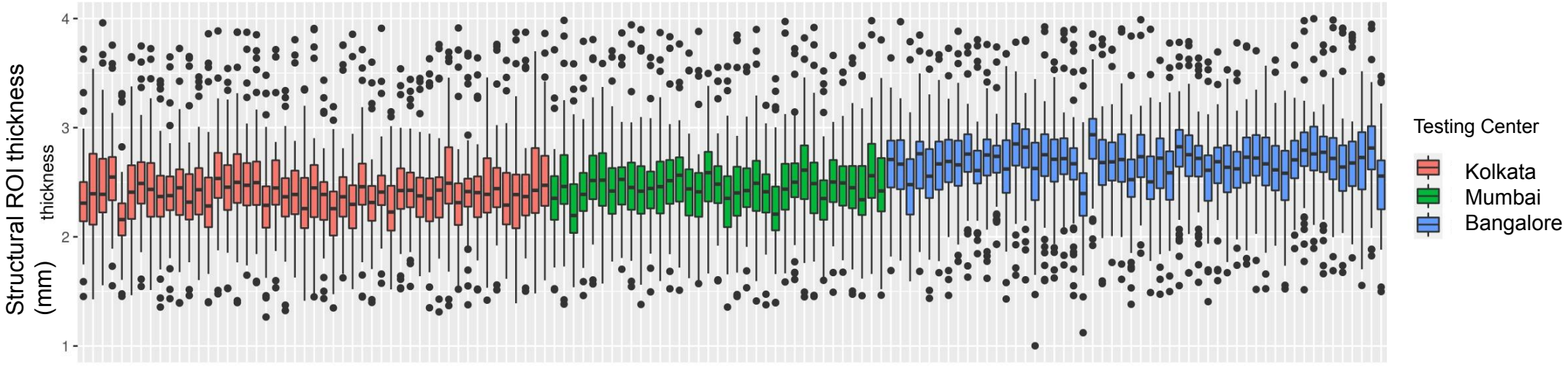
ComBat

- A popular batch-effect correction tool used in genomics
- Used for removing inter-site technical variability while preserving inter-site biological variability
- Estimates scanner-specific location and scale parameters, for each feature separately, and pools information across features using empirical Bayes to improve the estimation of those parameters

ComBat Parameters

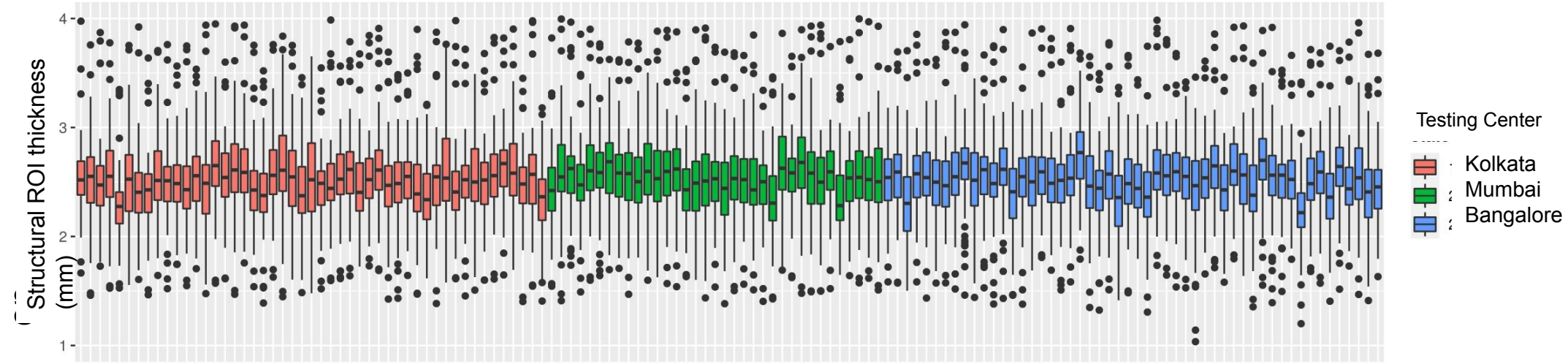
- Data matrix: Matrix of each participant's structural features (e.g., volumes and thicknesses of all sMRI ROIs)
- Batch ID: Vector specifying site/scanner ID for each participant (i.e., Bangalore, Mumbai, Kolkata)
- Biological Variables: Matrix specifying biological covariates that should be protected during the removal of scanner/site effects (e.g., age, sex, and disease status)

pre-harmonizati



Participant at specific testing center

post-harmonizati

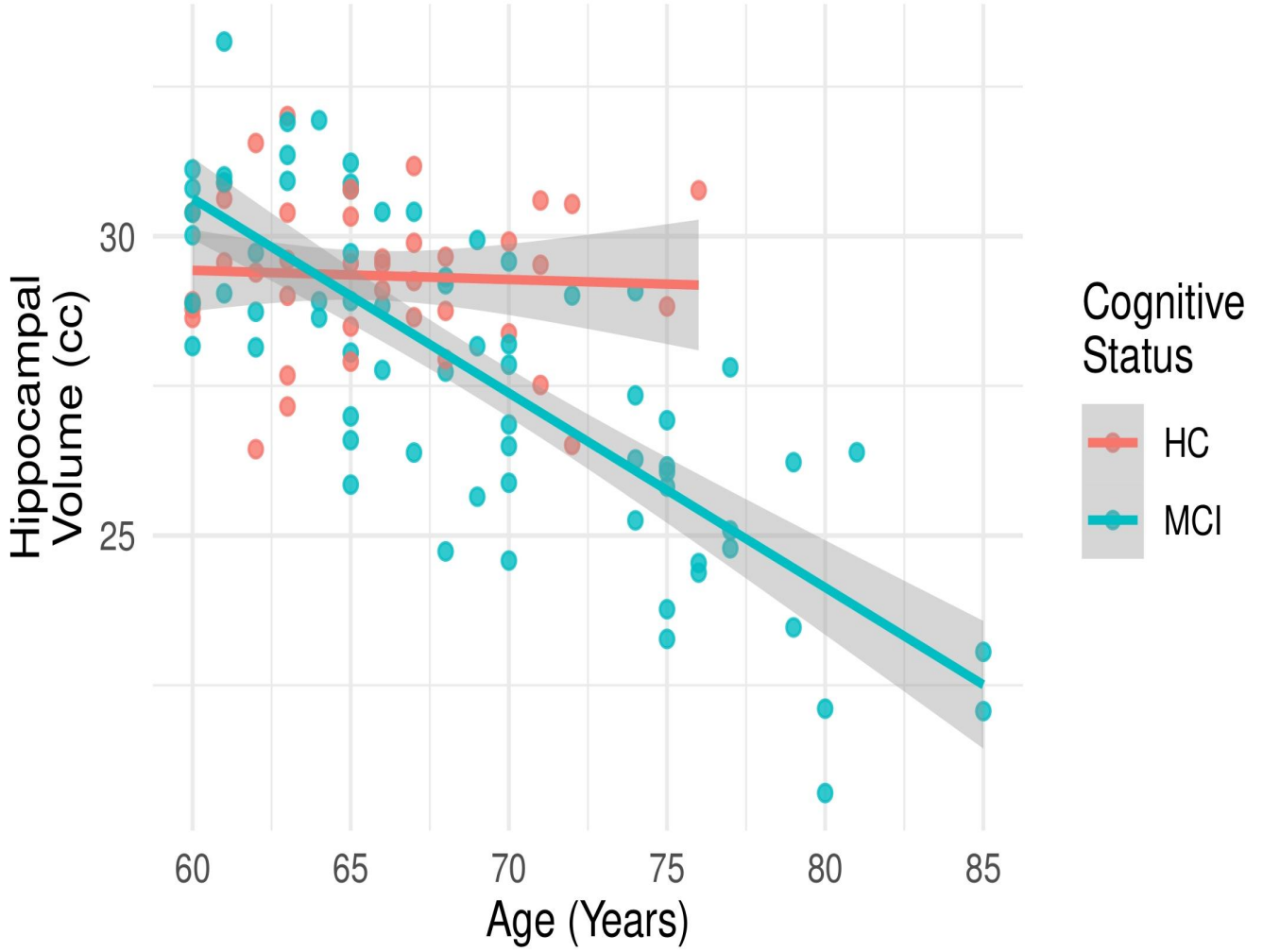


Participant at specific testing center

Findings

MCI – High Cognition (HC):
-6.5%, t = -3.127, p < 0.01

MCI – Age Interaction:
-1.7% per year, t = -2.776, p < 0.01

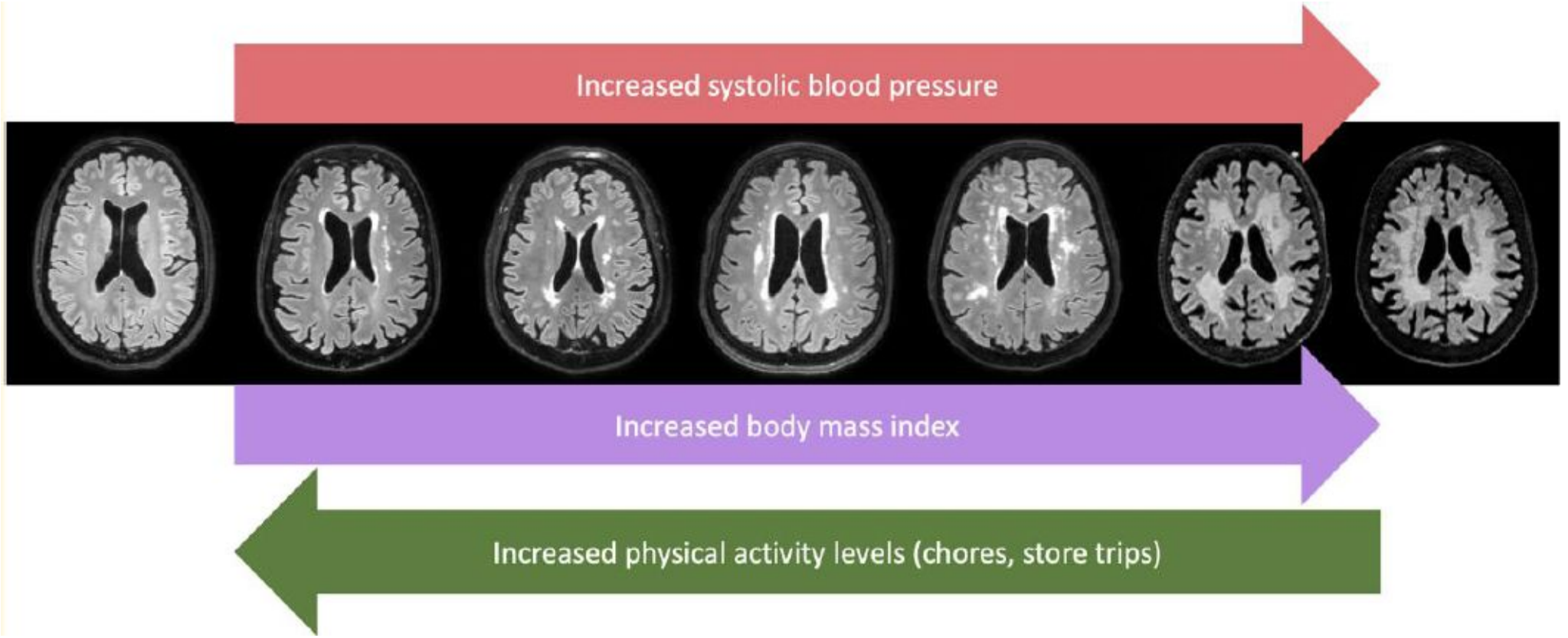


https://doi.org/10.1093/braincomms/fcad008 BRAIN COMMUNICATIONS 2023: Page 1 of 10 | 1

BRAIN COMMUNICATIONS

Investigating the factors that explain white matter hyperintensity load in older Indians

Leon Aksman,[1] Kirsten Lynch,[1] Arthur Toga,[1] Aparajit Ballav Dey[2] and Jinkook Lee[3]



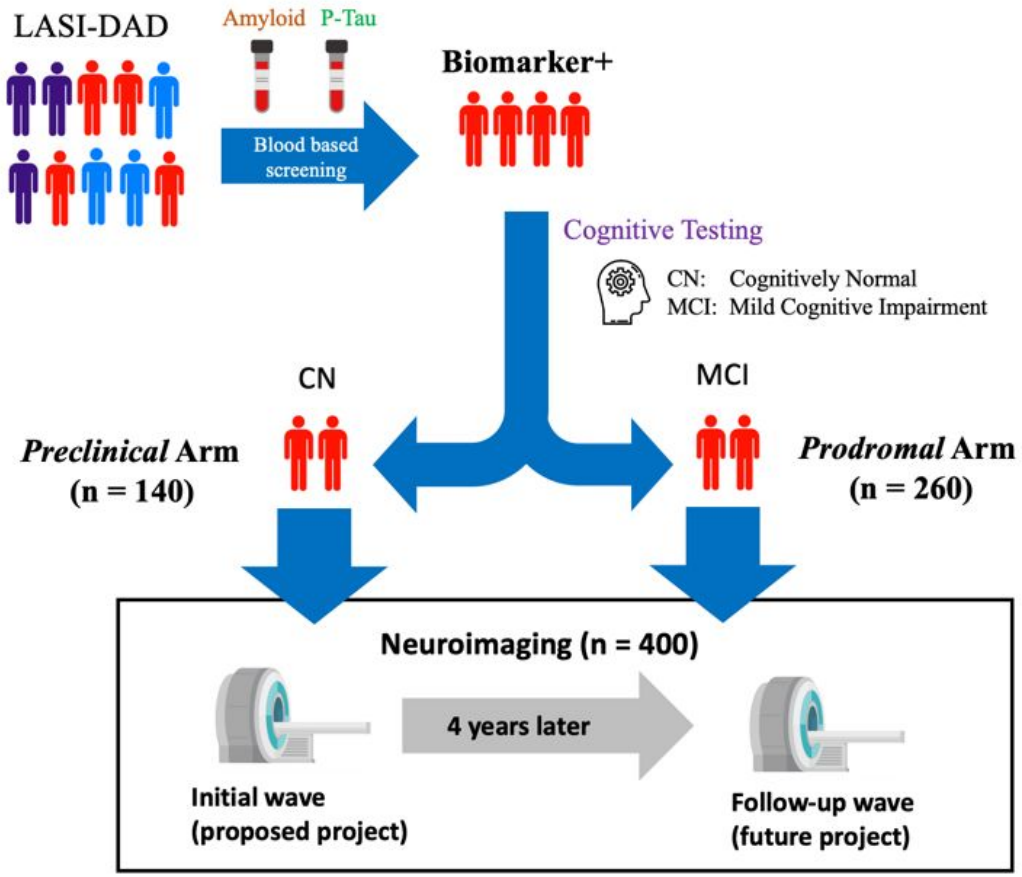


Figure A1: Overview of study design

Next steps

- Streamline the protocol to 40 min:
  - T1-weighted: brain structure
  - T2-weighted: perivascular spaces
  - T2 FLAIR: cerebrovascular pathology
  - DTI: brain connectivity
- Geographic expansion
  - More 3T scanner (32 channel head coil) available!
- Target sample of 600
  1. Power to investigate the effect of socioeconomic, environmental and late-life health measures on both the preclinical and prodromal phases of AD (N=400)
  2. Power to to empirically characterize cognitive reserve in a diverse population that largely lacks formal education and identify modifiable mid-to-later life factors that may promote cognitive reserve (+N=200)

Thank You!

NIH/NIA 2R01AG051125, 1U01AG064948

Brenton Keller, Art Toga, Jorge Jovicich, John John, Himanshu Joshi, Leon Aksman, A.B. Dey