



# BioFIND MRI & MEG Data Insight

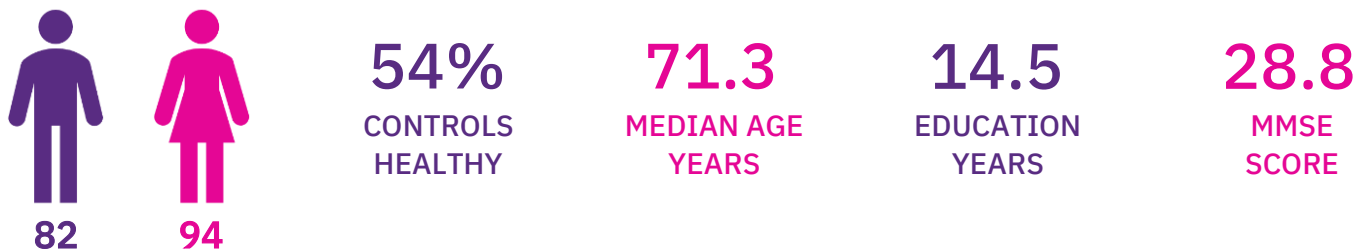
The Fox Investigation for New Discovery of Biomarkers (BioFIND) is an observational clinical study designed to discover and verify biomarkers of Parkinson's disease. As an extension to this dataset, 168 MEG datasets from dementia projects at the University of Cambridge and the Centre for Biomedical Technology in Madrid, were added. This brings a total of 324 participants, contributing 2-13 minutes of resting-state MEG and a T1-weighted structural MRI scan.

## Background

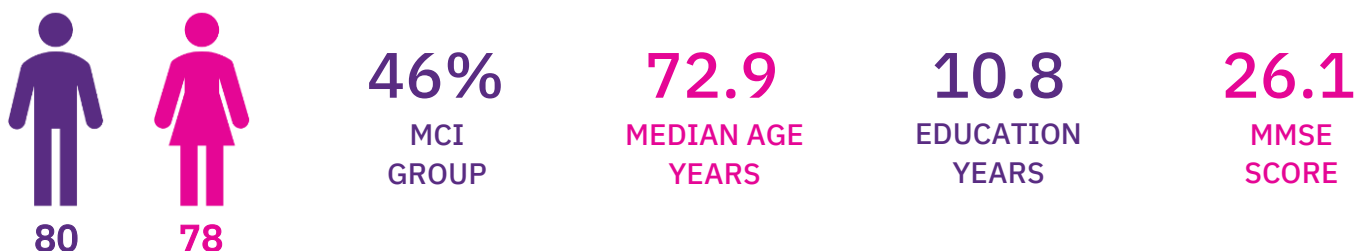
The 324 participants consist of 158 people with clinically diagnosed MCI and 166 controls, recorded at one of two sites: 1) the MRC Cognition & Brain Sciences Unit (CBU) at the University of Cambridge, and 2) the Laboratory of Cognitive and Computational Neuroscience at the Centre for Biomedical Technology (CTB), Madrid. The 68 MCI patients scanned at Cambridge were recruited from specialist memory clinics at Cambridge University Hospitals NHS Trust and the 91 controls were selected from the population derived CamCAN cohort of healthy people from the same geographic region. The 90 patients and the 75 controls from Madrid were recruited from the Neurology and Geriatric Departments of the University Hospital San Carlos.

## Data Characteristics

### Controls



### Mild Cognitive Impairment



## Resting-state MEG Protocol

The MEG data were recorded while participants were asked to keep their eyes closed, instructed to think of nothing specific, but not fall asleep. The duration of these recordings varied from 2 to 13 min, as seen in the table below. A Wilcoxon rank-sum test showed that the duration of the median MEG recording was longer in controls.

Data Characteristic	Groups		T/ $\chi^2$ -test
	Controls	MCI	T/ $\chi^2$ and p value
Recording Duration (seconds)	481.5	180	Z = 4.19 p < .001
Recording Hour (24h)	12.8	12.6	T = 1.13 p = 0.26
Recording Year (calendar)	2013.8	2012.4	T = 5.37 p < .001
Mean of head translation (mm)	1.9	2.3	T = -1.59 p = 0.11
SD of head translation (mm)	1.1	1.2	T = -1.03 p = 0.30
Number of bad epochs	4.1	4.7	T = -1.74 p = 0.08

MEG recordings were collected continuously at 1 kHz sample rate using an Elekta Neuromag Vectorview 306 MEG system (Helsinki, FI) at both CBU and CTB sites. The CBU MSR is made by Imedco and uses single layer mu-metal plates, while the Madrid MSR is made by Vaccumschmelze and has two layers. For the CBU, the average MSR noise level during tuning was 2.3 fT/sqrt(Hz); for the CTB, it was 2.8 fT/sqrt(Hz) until 2016, and 2.6 fT/sqrt(Hz) after 2016.

The VectorView system includes two orthogonal planar gradiometers and one magnetometer at each of 102 locations around the head. For many but not all participants, bipolar electrodes were used to record the electro-oculogram (EOG), for vertical and/or horizontal eye movements, as well as the electro-cardiogram (ECG). When present, these correspond to EEG channels EEG061 (HEOG), EEG062 (VEOG) and EEG063 (ECG). For a smaller subset of CBU participants, an additional 70 channels of nose-referenced, unipolar EEG were recorded.

To monitor head position throughout the scan, head position indicator (HPI) coils were attached to the scalp and detected by the MEG machine (energized at frequencies above 150 Hz in CTB and above 300Hz in CBU). Prior to the scan, a Fastrak digitizer was used to record locations of the HPI coils, in addition to three anatomical fiducials, for the Nasion, Left and Right Peri-Auricular points (LPA and RPA, respectively), plus approximately 100 points across the scalp (to help coregistration with the MRI). For CBU data, the LPA and RPA refer to pre-auricular points; for CTB data, the LPA and RPA refer to a point anterior to the tragus.

## MRI Protocol

T1-weighted MRIs for participants tested at the CBU were acquired on either a Siemens 3T TIM TRIO or Prisma using a magnetization prepared rapid gradient echo (MP-RAGE) pulse sequence. The T1-weighted MRI for participants tested at the CTB were acquired on a General Electric 1.5 Tesla MRI using a high-resolution antenna with a homogenization PURE filter.

# Data Structure

The data structure of BioFIND conforms to BIDS formatting, where MRI and MEG data is located in participant folders. The main BioFIND directory includes three folders: Code, MCIControls and TravelBrains. The code folder contains the data processing code from the BioFIND paper for the MRI and MEG data. This code can be used to replicate the processing done by the BioFIND paper.

## MCIControls

The 'MCIControls' directory includes 324 separate sub-directories, one per participant, coded 'sub-Sub' followed by four digits for the unique participant number, matching a 'participants.tsv' file. The participants file mentioned, is included in the MCIControls folder and contains the database of participants with their sex, age, MMSE, education years and recording information for the MEG data. This file has an accompanying JSON sidecar file which describes the data in the TSV file. You will also find a README file which contains the CamCAN IDs of the control participants in case both datasets are being used to analyse data.

- MCIControls/
  - derivatives/
  - sub-emptyroom/
  - sub-Sub0001/
  - ...
  - sub-Sub0324/
    - dataset\_description.JSON
    - participants.JSON
    - participants.TSV
    - README

There is also a derivatives folder which contains max-filtered MEG data for each of the participants. This means that this data has been de-noised using Signal Space Separation (SSS), implemented through MaxFilter.

A sphere was fit to the digitised head points, excluding points on the nose, and the coordinates of the centre of that sphere were passed to MaxFilter. MaxFilter was then called twice: first, just to detect bad channels in each data buffer (using MaxFilter's "autobad" option), and to estimate head position every second (using MaxFilter's "headpos" option).

The sub-emptyroom folder contains MEG data to capture the environmental and system noise.

## Subject directories

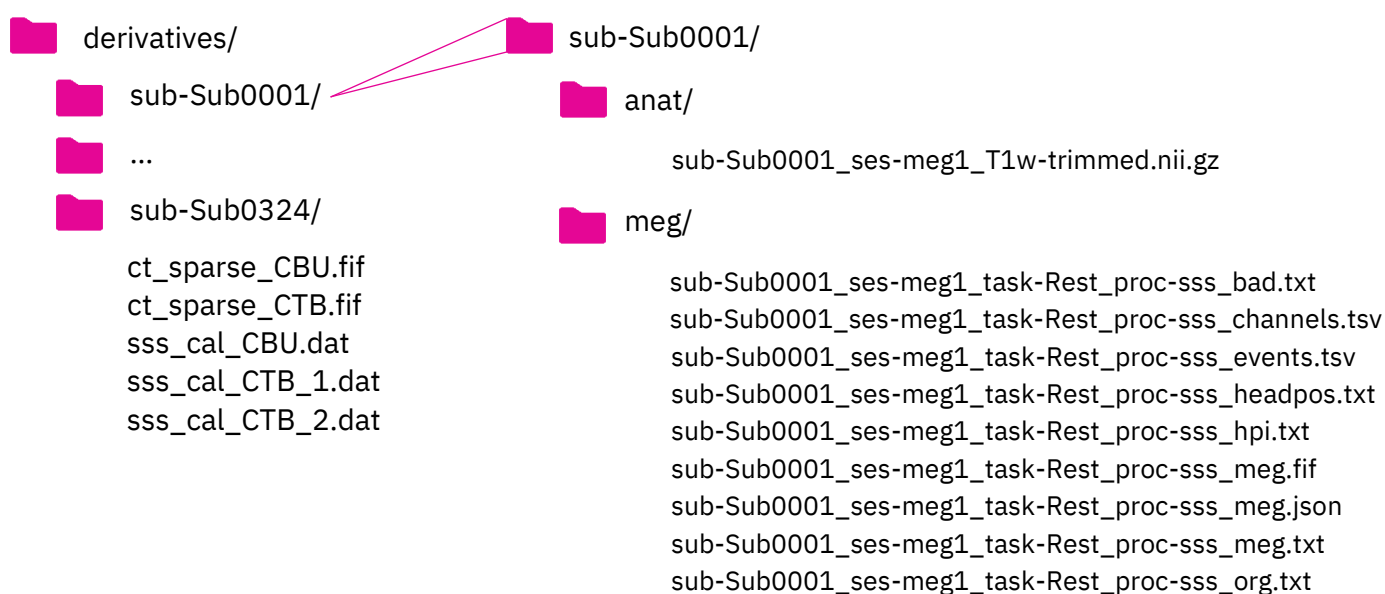
- sub-Sub-0001/
  - ses-meg1
    - anat/
      - sub-Sub0001\_ses-meg1\_T1w.JSON
      - sub-Sub0001\_ses-meg1\_T1w.nii.gz
    - meg/
      - sub-Sub0001\_ses-meg1\_task-Rest\_channels.TSV
      - sub-Sub0001\_ses-meg1\_task-Rest\_coordsystem.JSON
      - sub-Sub0001\_ses-meg1\_task-Rest\_events.TSV
      - sub-Sub0001\_ses-meg1\_task-Rest\_meg.fif
      - sub-Sub0001\_ses-meg1\_task-Rest\_meg.JSON

The MRI data is located in the ‘anat’ folder as NIFTI images. These images have been defaced using FreeSurfer and are accompanied by a JSON sidecar which contains meta-data such as the anatomical MRI coordinate system. In particular, for MEG coregistration, the manually defined MRI indices for the Nasion, Left Peri-Auricular (LPA) and Right Peri-Auricular (RPA) fiducials. These points are also included as images in the MCIControls directory folder.

The MEG data is located in the ‘meg’ folder as FIFF files, containing data from all MEG channels and additional EEG, EOG, ECG and several other channels. There is also accompanying sidecars including:

- channels.tsv (listing all channels present in the data),
- coordsystem.json (containing information about the coordinate system, measurement units and head coil coordinates),
- events.tsv (specifying the duration of the recording),
- and meg.json (information about the MEG acquisition parameters).

## Derivatives directories



The derivatives folder contains processed data for all participants. Within the ‘anat’ folder, there is the T1-weighted image which has been trimmed instead of defaced. This means that the nose is included which is useful for MRI-MEG coregistration.

The ‘meg’ folder contains:

File suffix	Description
-sss_bad.txt	MEG channels determined as “bad” for each 10 s segment of the data (and subsequently corrected by MaxFilter)
-sss_headpos.txt	The location of the centre of the head every 1 s in quaternions, capturing head motion throughout the scan. The mean and standard deviation of head motion (relative to the initial location) have been extracted and put in the ‘participants.tsv’ file.
-sss_hpi.txt	The 3D locations (in MEG space) of the digitized headpoints
-sss_meg.fif	Maxfiltered version of the data
-sss_meg.txt	
-sss_org.txt	coordinate of the centre of a sphere (in MEG space, relative to [0 0 0] as the origin of the helmet) fit to the above headpoints (after excluding points on the nose)

Finally, the TravelBrains directory in the main BioFIND folder, contains scans from 7 people from both scanner to highlight the importance of differences between scanners/recording sites.