Lifespan quantitative MR images from 138 subjects, an open and spatially preprocessed dataset.

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Introduction

Quantitative MR Imaging (qMRI) techniques, e.g. derived from the "multiparametric mapping" protocol, provide high resolution, whole brain quantitative maps of brain tissue MR properties (Figure 1), which directly pertain to their underlying microstructure, such as axonal, myelin, iron and water concentrations [1]. These data are very relevant for the study of brain development and aging, as well as neurodegenerative diseases (Alzheimer's or Parkinson's disease, multiple sclerosis,…) [2,3], through "voxel-based quantification" (VBQ) and "voxel-based morphometry" (VBM) analyses [4,5].

This project had 2 objectives

Objective #1: describe the spatially pre-processed maps used in [6], about age-related brain microstructure differences.

Objective #2: share these data according to BIDS standard and its extensions to structural derivative data [7,8].

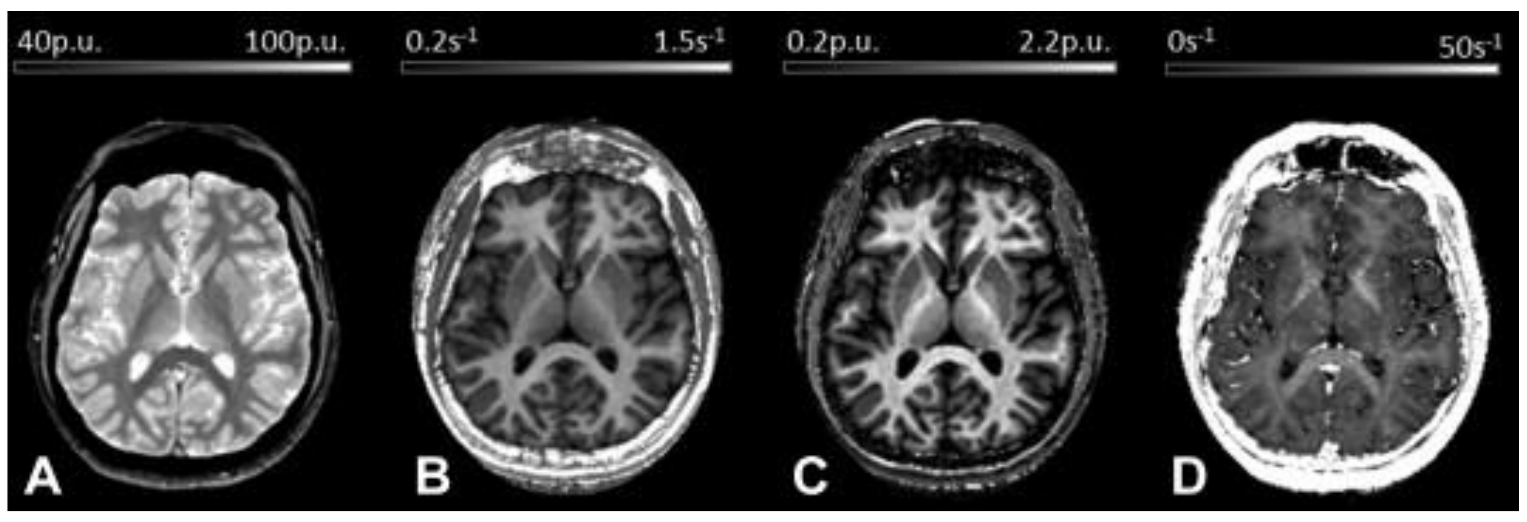

Figure 1. Example quantitative maps of an individual volunteer: effective proton density, `PD*` (A); longitudinal relaxation rate, `R1` (B); magnetization transfer, `MTsat` (C), and transverse relaxation rate, `R2*` (D). Adapted from [6]

Methods

Dataset demographics

- 138 (49M/89F) healthy participants;
- aged 19-75 years (mean 46.6, s.d. 21);
- age, sex, TIV, and scanner used collected in a table.

Quantitative MRI acquisition and processing (SPM8-VBQ)

- acquired on 2 different 3T whole body MR systems (69-69);
- `R1`, `R2*`, `PD`, and `MTsat` maps, reconstructed with a preliminary version of the hMRI [9] and VBQ [4] toolbox, see Figure 1;
- segmentation and DARTEL morphing to MNI space;
- tissue-weighted smoothing (GM & WM separately) with a 3mm FHWM isotropic kernel applied on the warped quantitative maps;
- standard 6 mm FWHM Gaussian kernel smoothing on the GM and WM modulated warped tissue maps;
- group level GM and WM masks creation from group averages.

Anonymization:

- random relabeling, from `S001` to `S138`;
- brain-masking of the quantitative maps.

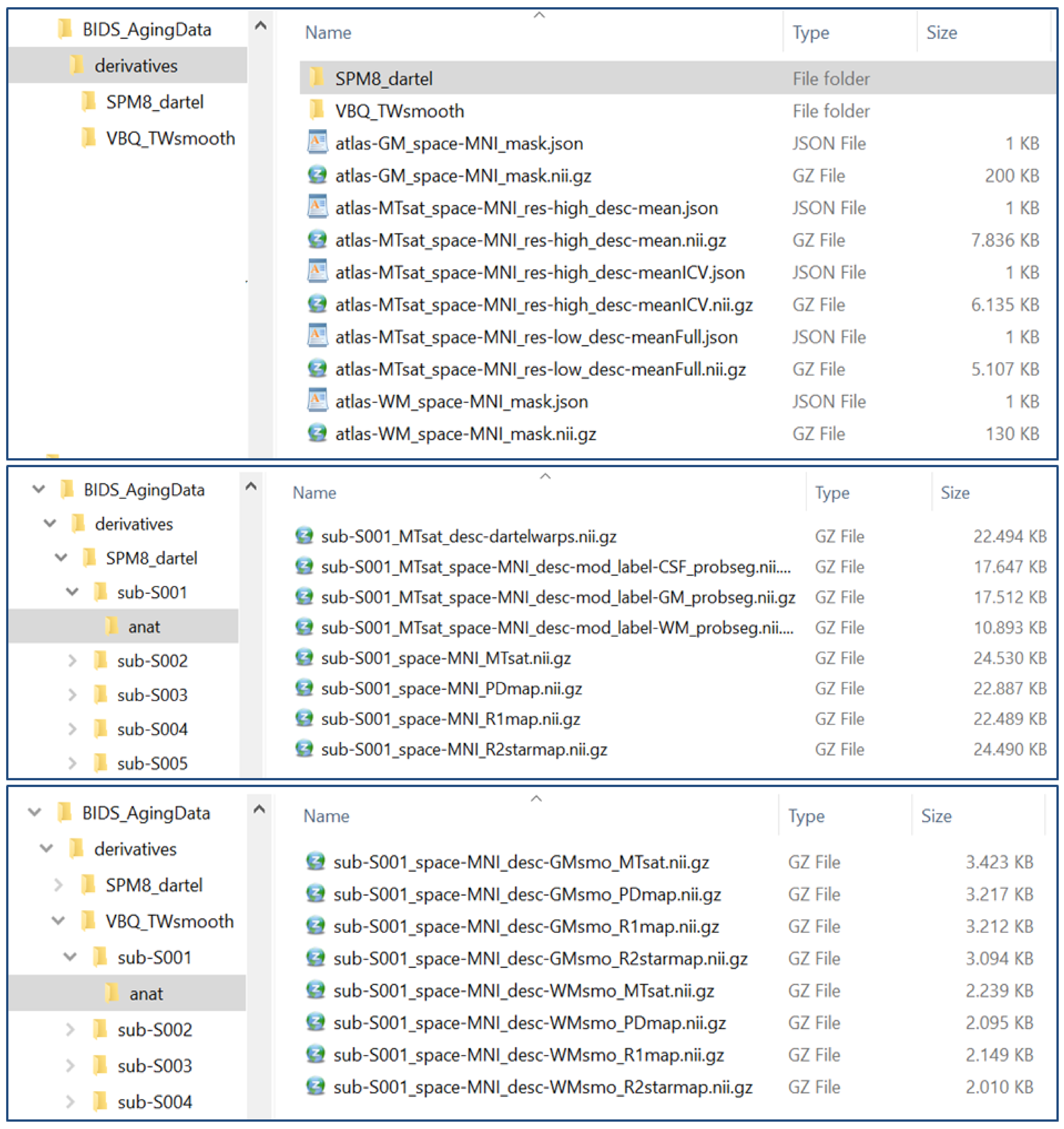

Figure 2. Derivative data structure and example file naming of a single subject. *Top.* Main `SPM8_dartel` and `VBQ_TWsmooth` derivative folders and top-level files, with GM/WM masks and mean `MTsat` maps. *Middle.* `SPM8_dartel` derivatives with the warped quantitative maps and tissue maps, plus deformation field. *Bottom.* `VBQ_TWsmooth` derivatives with the warped quantitative maps after tissue-weighted smoothing for the GM and WM separately.

Results

Data organization, see Figure 2:

- Top `derivatives` folder → GM and WM masks (for SPM analysis), and mean `MTsat` maps (for display purpose);
- `SPM8_dartel` folder → 8 images per participant, i.e. 4 quantitative maps, GM/WM/CSF tissue maps, & deformation field;
- `VBQ_TWsmooth` folder → 8 images per participant, i.e. GM/WM-weighted smoothing of 4 quantitative maps;

Data availability: https://openneuro.org/datasets/ds005851

Discussion

So far, few MPM datasets have been made publicly available, for example [10,11]. This dataset nicely complements Callaghan et al., 2014 [6], allowing anyone to reproduce the results for educational purposes or reanalyze the data differently. The qMRI data could also be used as a reference, thanks to their quantitative nature, for other studies. Finally, the dataset will permit other researchers to experiment with qMRI data processing, e.g. tissue-weighted smoothing, and explore new statistical approaches, e.g. a "multivariate SPM" analysis over multiple quantitative maps [12].

References & acknowledgments

References:

[1] Weiskopf, N. et al. (2015), Curr. Opin. Neurol. [2] Moallemian, S. et al. (2023), Neurobiology of Aging. [3] Vandeleene, N. et al. (2023), Brain and Behavior. [4] Draganski, B. et al. (2011), NeuroImage. [5] Ashburner, J. & Friston, K. J. (2000), NeuroImage. [6] Callaghan, M. F. et al. (2014), Neurobiology of Aging. [7] Karakuzu, A. et al. (2022), Scientific Data. [8] BIDS Extension Proposals (BEPs), BEP011 and BEP038. [9] Tabelow, K. et al. (2019), NeuroImage. [10] Callaghan, M. F. et al. (2019), Data in Brief. [11] Clark, I. A. & Maguire, E. A. (2023), Scientific Data. [12] Moallemian, S. et al. (2023), medRXiv.

Acknowledgments:

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