A reproducible, semi-automated pre-processing pipeline for ischemic stroke resting state fMRI data

Peter Goodin[1], Milanka Visser[1], Alistair Walsh[2], Andrew Bivard[1], Mark Parsons[1]

1. Melbourne Brain Centre @ RMH , Parkville, Victoria, Australia 2. LaTrobe University, Bundoora, Victoria, Australia

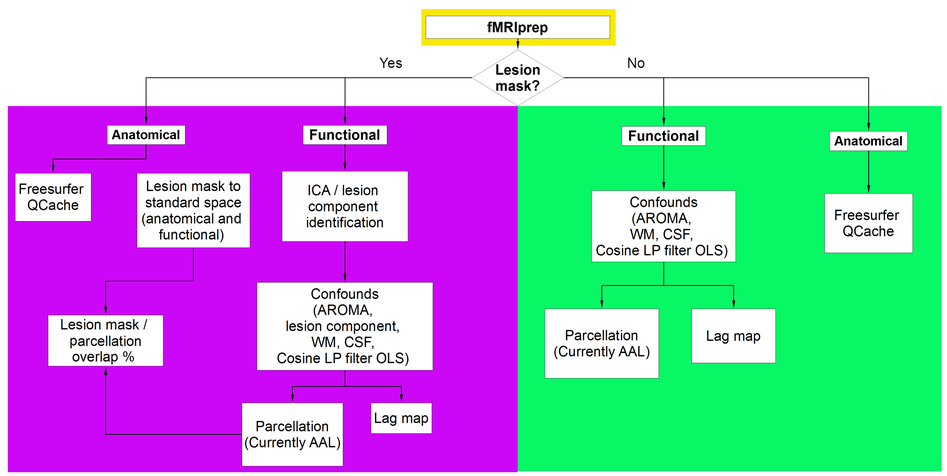
BACKGROUND

- Analysis of fMRI data makes assumptions regarding the general shape of the brain and vascular health.
- These assumptions regularly do not hold for data obtained from stroke patients.
- Restriction of blood flow leads to neuronal & glial damage and death.
- This can lead to structural deformation, changes in regional tissue ratios, alteration of vascular integrity & physiology.
- This significantly affects common anatomical preprocessing methods including skull stripping, tissue segmentation, coregistration and standardization.
- Vascular changes affect hemodynamic lags affecting both task and resting state fMRI analyses[1].
- Standard fMRI analysis packages (SPM, FSL, AFNI) can minimize structural issues (with additional parameters) but do not control for changes in hemodynamics.
- No standardized method of incorporating best practices[2] for stroke fMRI data is currently available.

PROJECT AIMS

- The pipeline aims to include current best practise recommendations for dealing with spatial and temporal artifacts due to stroke.
- The pipeline is built on the BIDS format and makes use of fMRIprep[3] and custom python functions.
- We aim for the pipeline to be easy to use, facilitate reproduceable and shareable output.

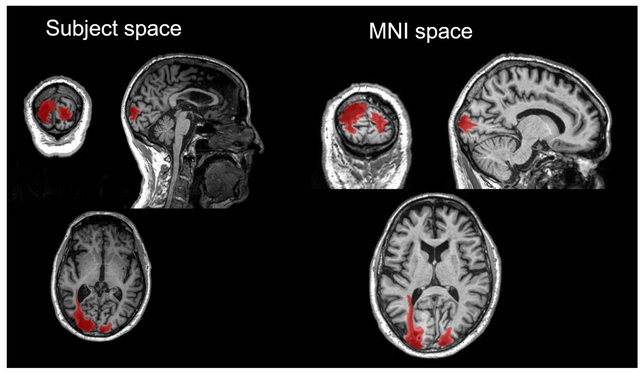
PIPELINE OVERVIEW



Note: ICA = Independent Component Analysis, WM = White matter, CSF = Cerebro-spinal Fluid, LP = Low pass, OLS = Ordinary Least Squares, AAL = Automatic Anatomical Labelling, AROMA = Automatic Removal of Motion Artifacts

OUTPUTS

Figure 1



- Figure 1 (left): Comparison of lesion mask in subject and MNI spaces in a single stroke patient.
- Figure 2 (bottom): Distribution and differences in resting state parcellation correlations between the stroke and standard pipelines for patient for single stroke patient.
- Figure 3 (right): Lag maps (MNI space) for stroke and control participants. White is lesion mask overlay.

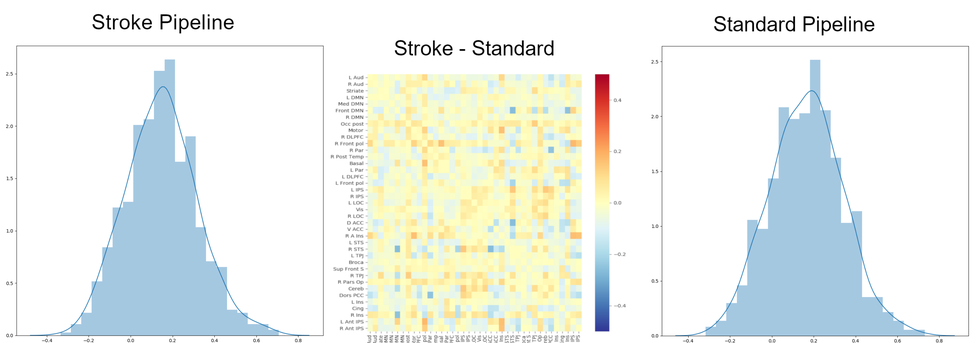


Figure 2

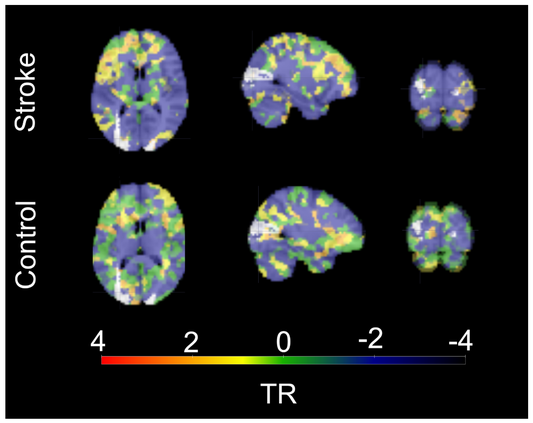


Figure 3

FUTURE ADDITIONS

- Make conversion from raw to BIDS format easy (integrated tool - Semi Automatic BIDS Restructurer (SABR)).
- Code optimization / incorporate other libraries.
  - eg. Nilearn for parcellation / resting state parcellation correlations calculation.
- Multi-run / session support (currently supports single run).
- Containerize for cross-system utilization (eg. Docker / Singularity).
- Automagic lesion masking.
- Collaboration.

REFERENCES

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2. Siegel, J. S., Shulman, G. L., & Corbetta, M. (2017). Measuring functional connectivity in stroke: Approaches and considerations. Journal of Cerebral Blood Flow & Metabolism, 37(8), 2665–2678. https://doi.org/10.1177/0271678X17709198

3. Yourganov, G., Fridriksson, J., Stark, B., & Rorden, C. (2018). Removal of artifacts from resting-state fMRI data in stroke. NeuroImage: Clinical, 17, 297–305. https://doi.org/10.1016/j.nicl.2017.10.027