

Preprocessing of fMRI data

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pierre_bellec

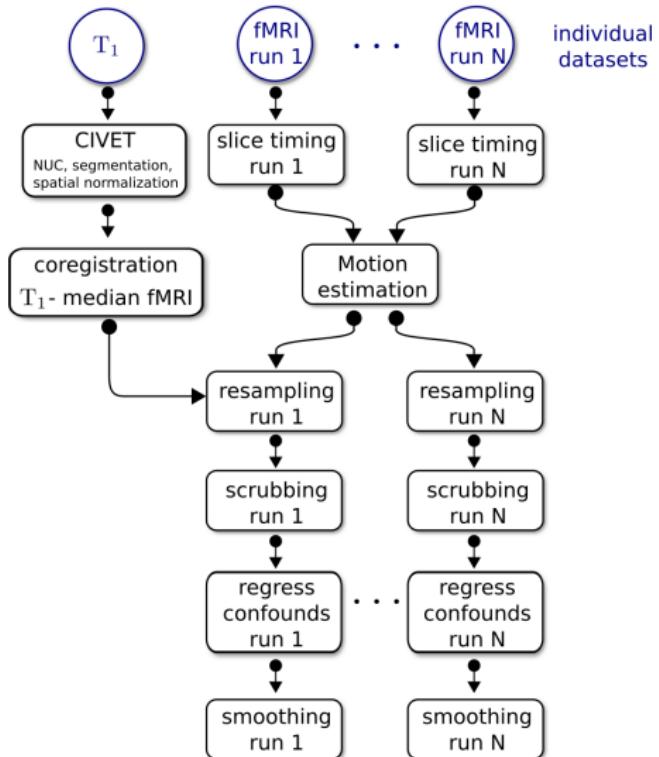


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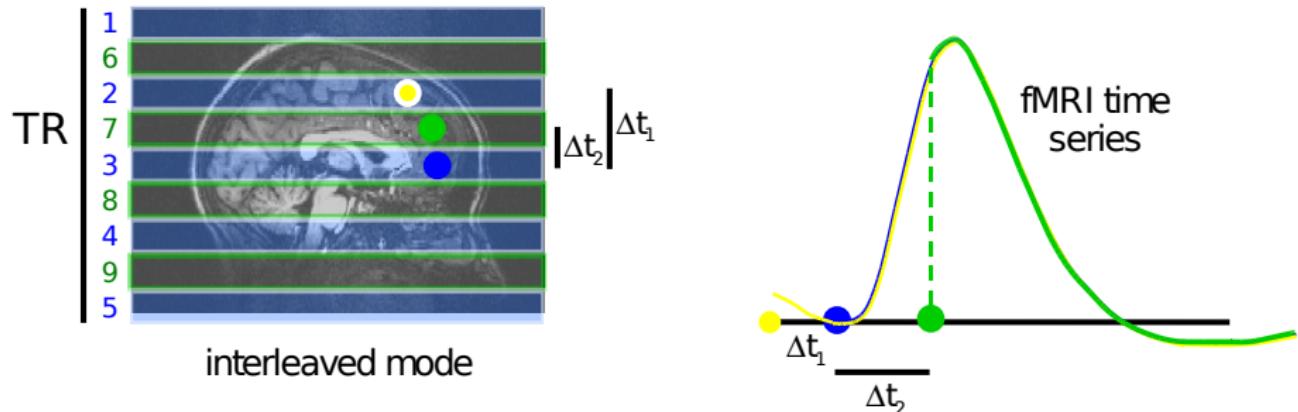
CRIUGM, DIRO, UdM



Flowchart of the NIAK fMRI preprocessing pipeline



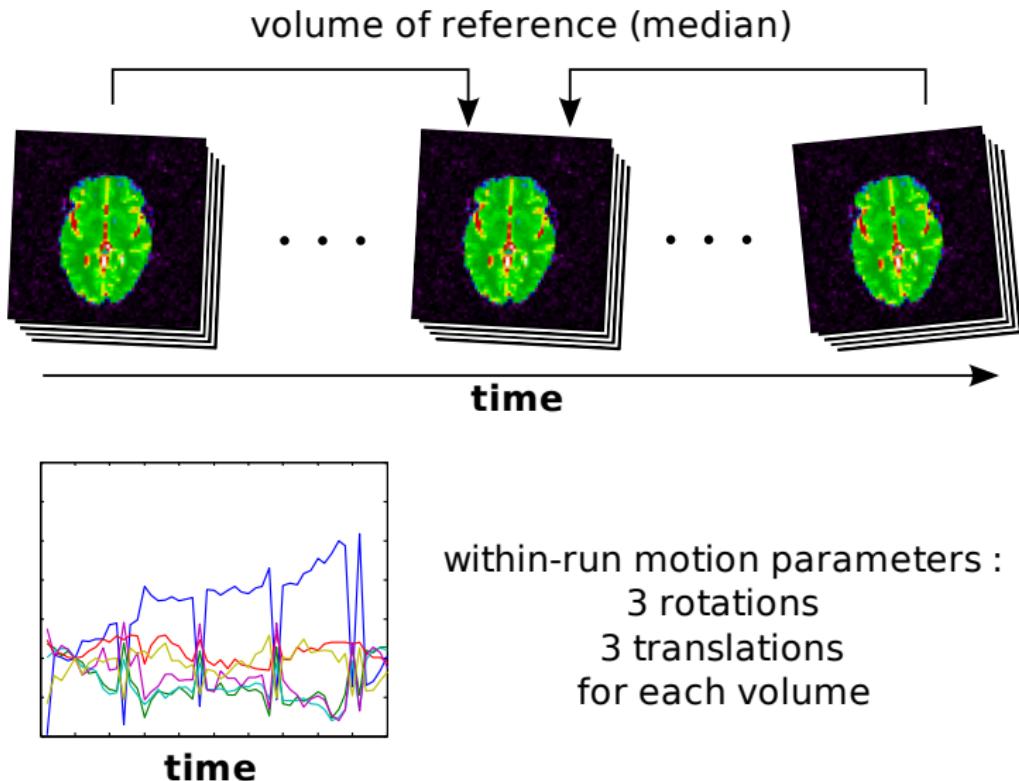
Slice timing correction



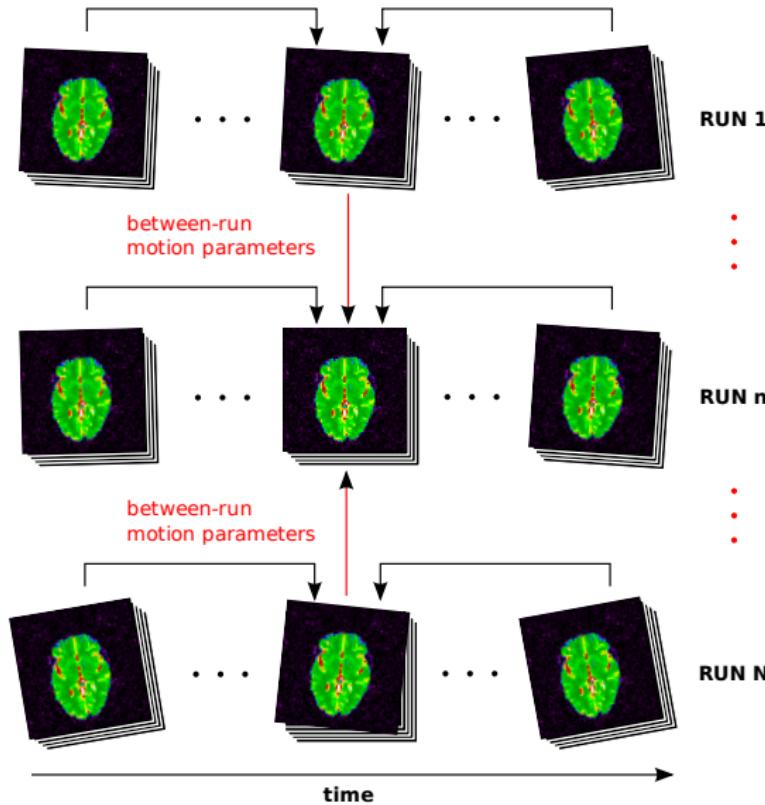
→ temporal interpolation to a single reference time
for each volume (cubic spline interpolation)

Courtesy of Dr M. Péligrini-Issac.

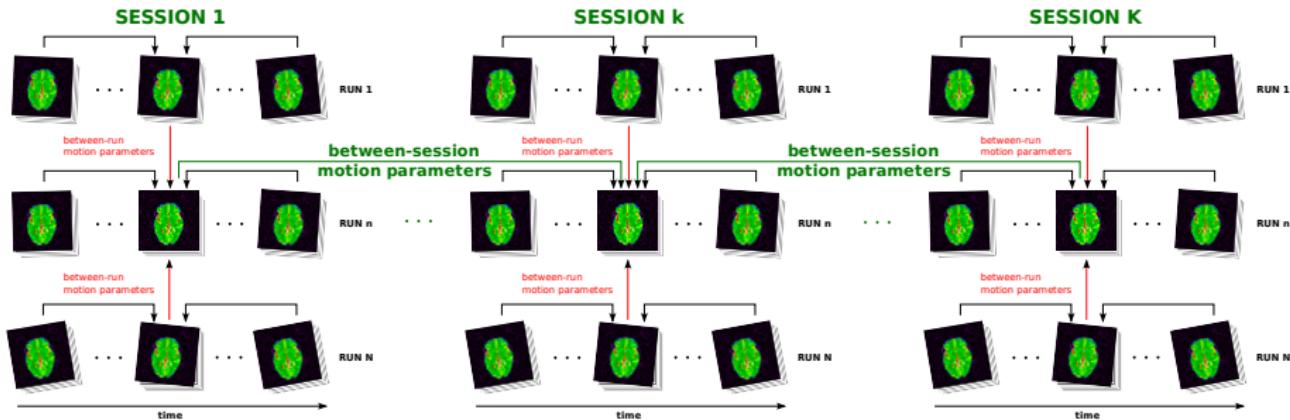
Motion estimation: within-run



Motion estimation: between-run / within-session

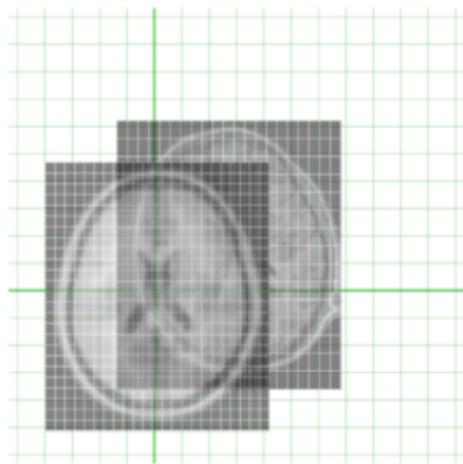


Motion estimation: between sessions



Estimation of between-run (between-session) rigid-body motion.

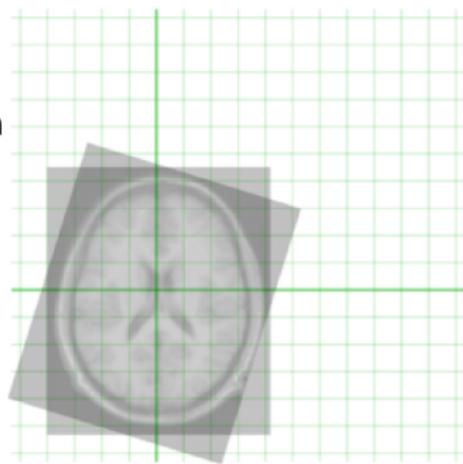
T_1 processing: linear coregistration



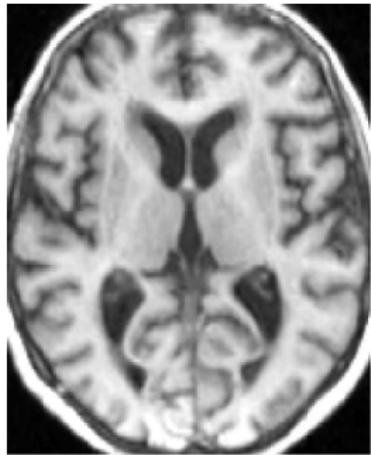
Linear transformation



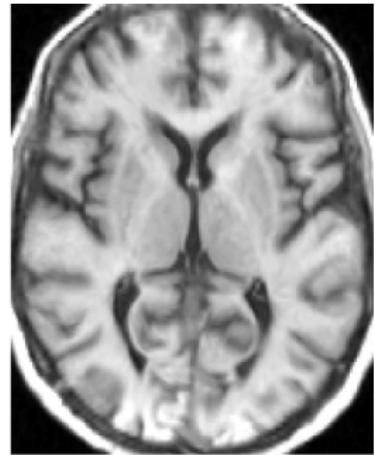
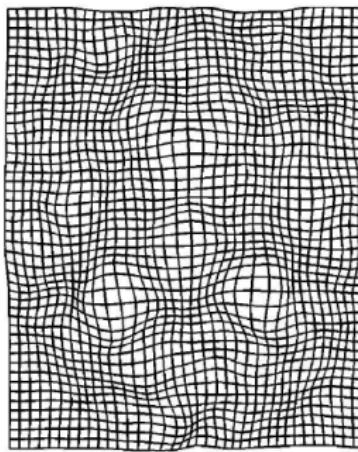
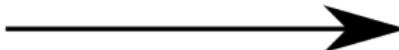
3 rotations
3 translations
3 scalings



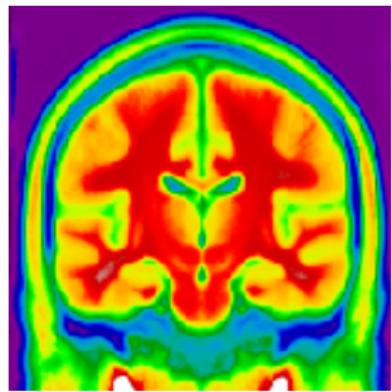
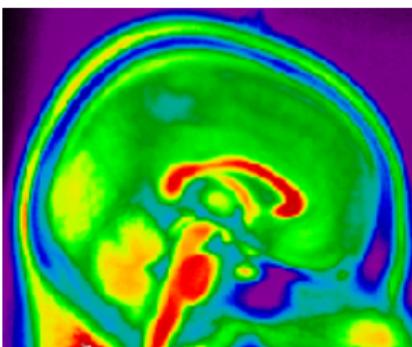
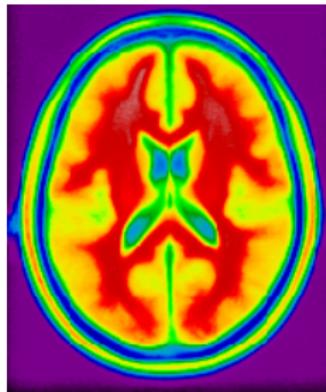
T_1 processing: non-linear coregistration



Non-linear (smooth)
transformation

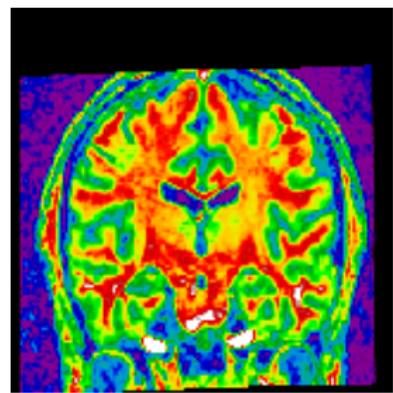
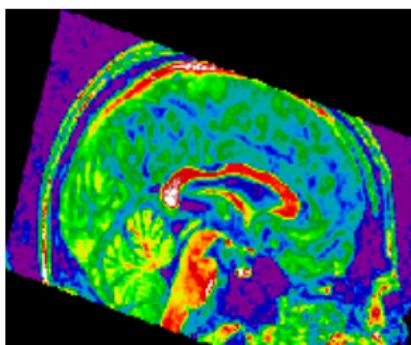
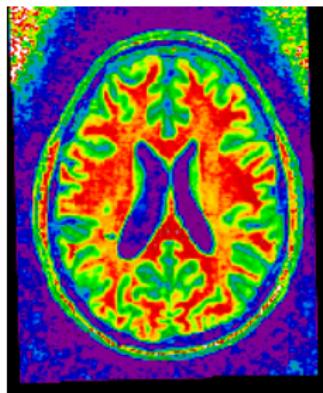


T_1 processing: linear template



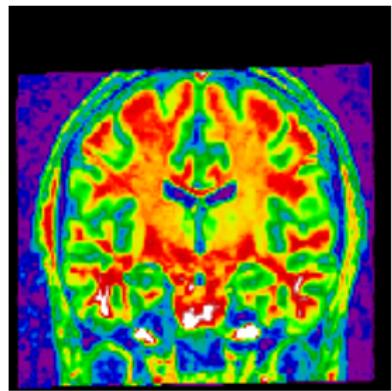
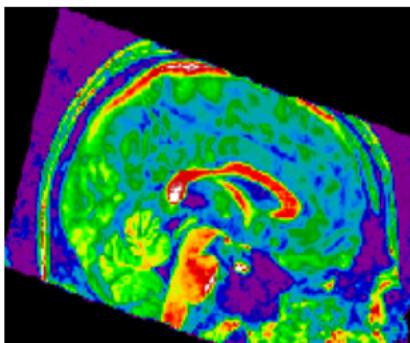
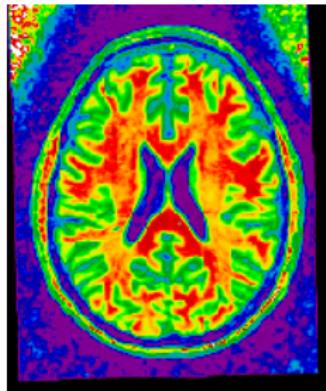
Linear ICBM template (average of 152 subjects)

T_1 processing: linear coregistration



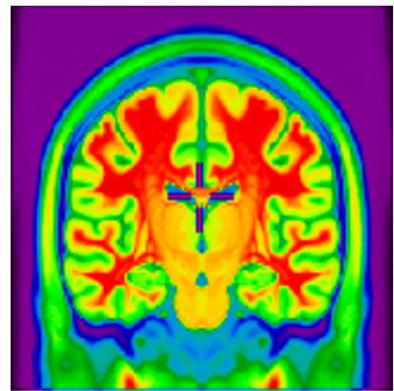
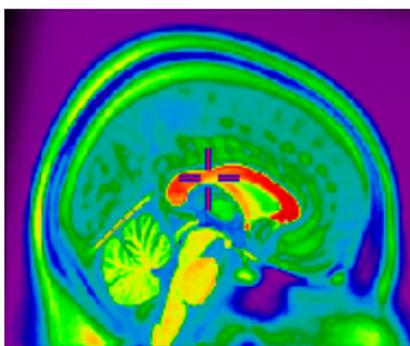
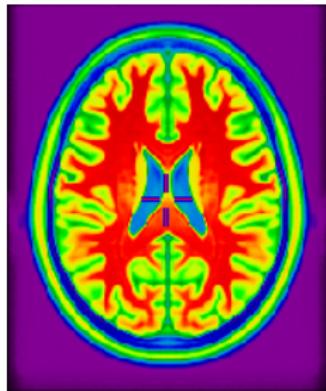
Individual structural scan (linear coregistration)

T_1 processing: non-linear coregistration



Individual structural scan (non-linear coregistration)

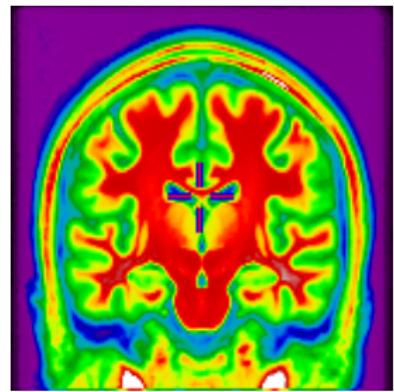
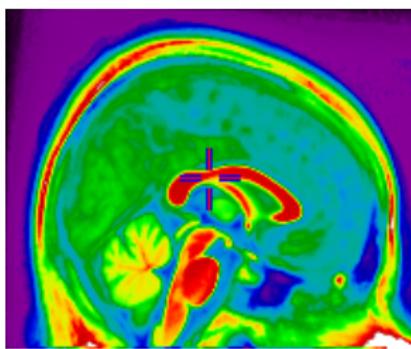
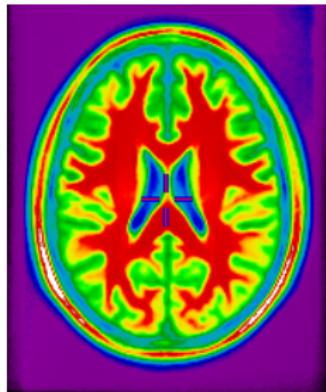
T_1 processing: nonlinear template



Symmetric non-linear ICBM template (average of 152 subjects) release
2009a.

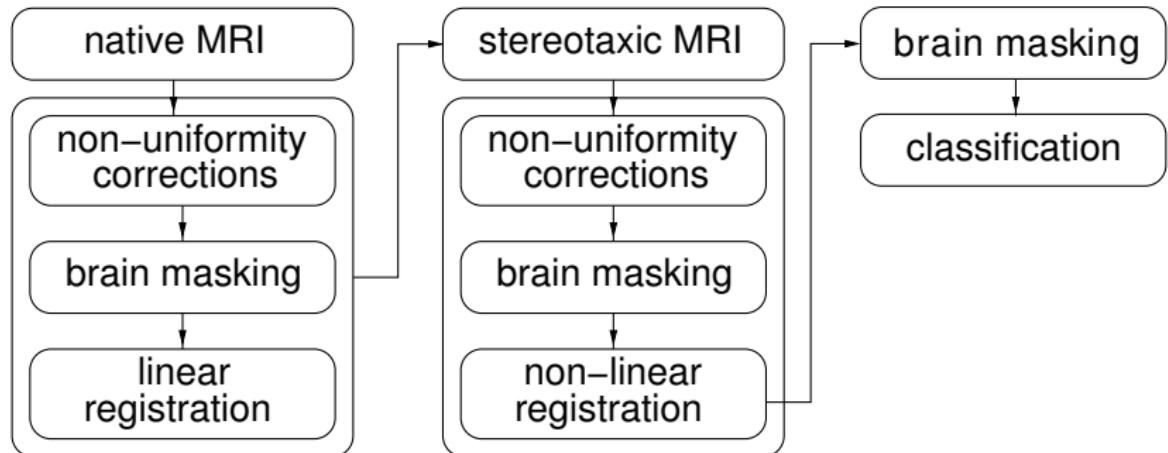
<http://www.bic.mni.mcgill.ca/ServicesAtlases/ICBM152NLin2009>

T_1 processing: group average



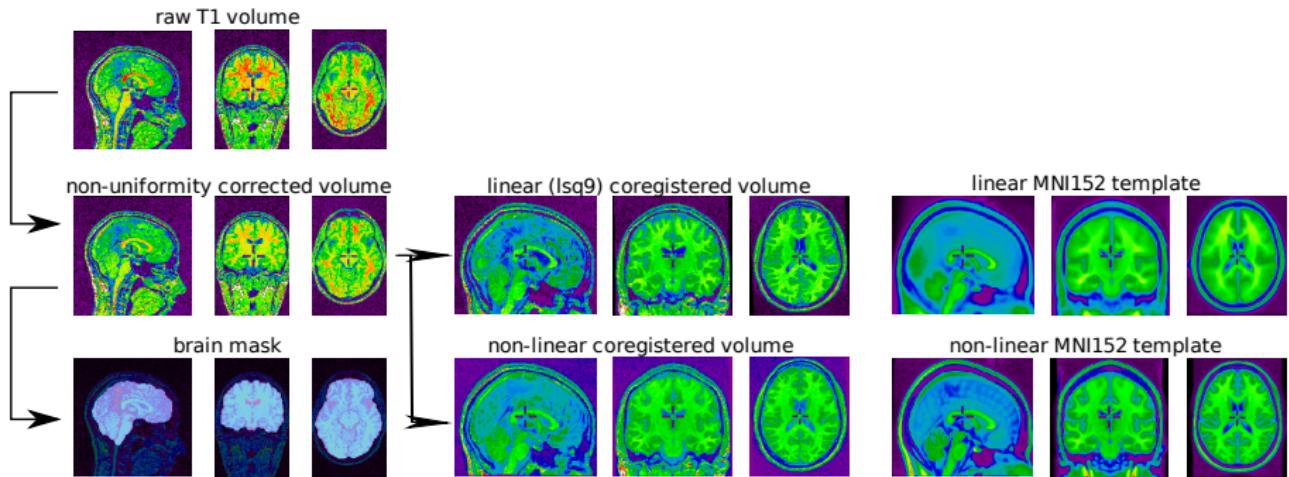
Average of 17 subjects (non-linear coregistration)

T₁ processing: Flowchart of the CIVET pipeline



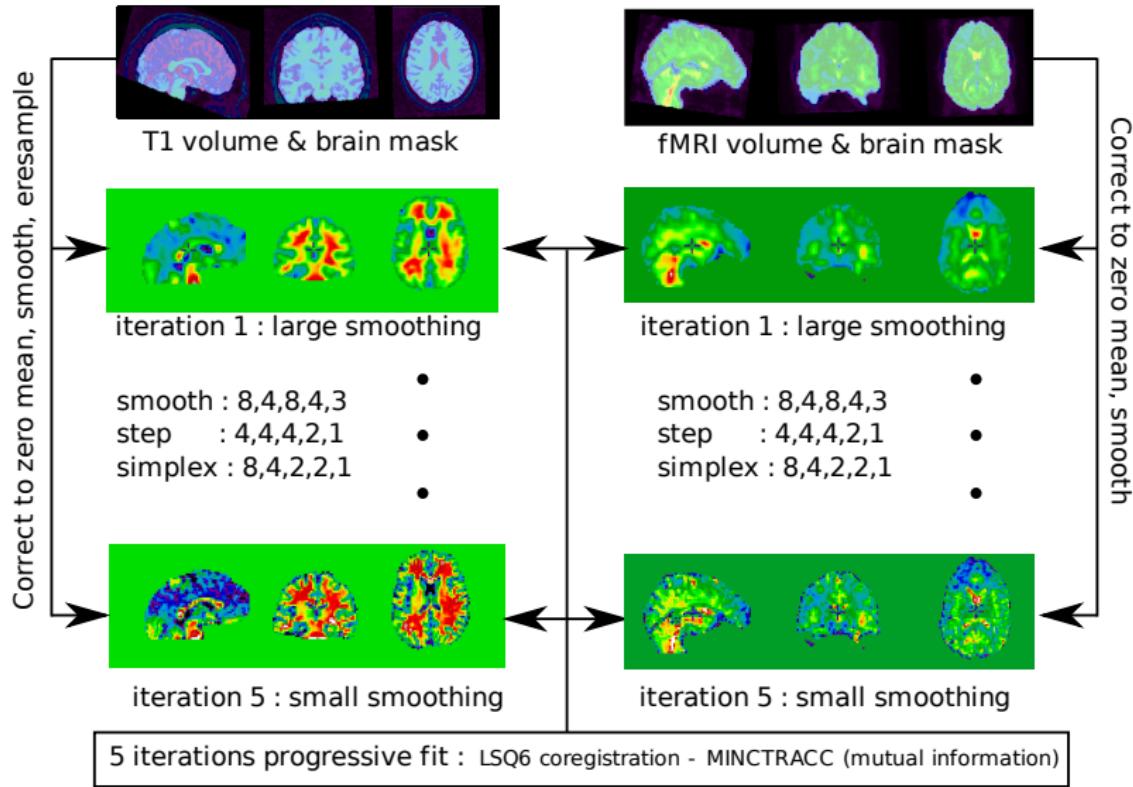
Flowchart of the T₁ preprocessing.

T_1 processing: main outputs



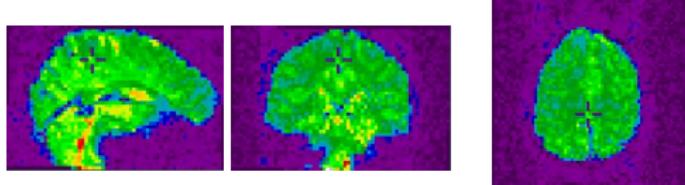
The main outputs of the T_1 processing pipeline.

Coregistration between the T₁ and fMRI volumes

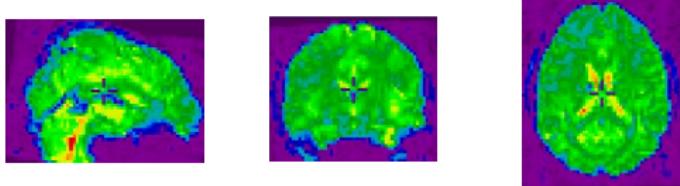


Spatial resampling

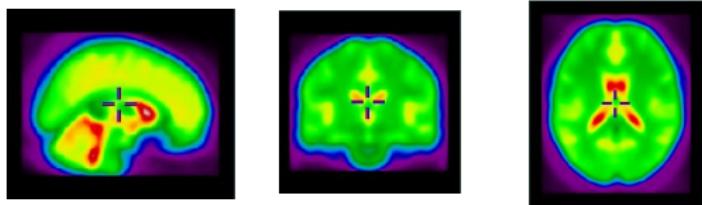
native functional space



stereotaxic space - individual volume - non-linear transform -

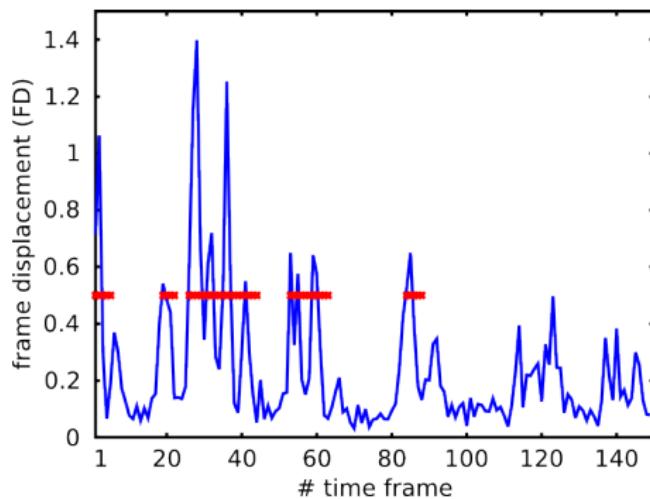


stereotaxic space - average of 40 subjects



The transformations to correct for rigid-body motion during the fMRI acquisition and the transformation to match the T₁ image and then (non-linearly) coregister into stereotaxic space are all combined, and a single step of spatial resampling is applied.

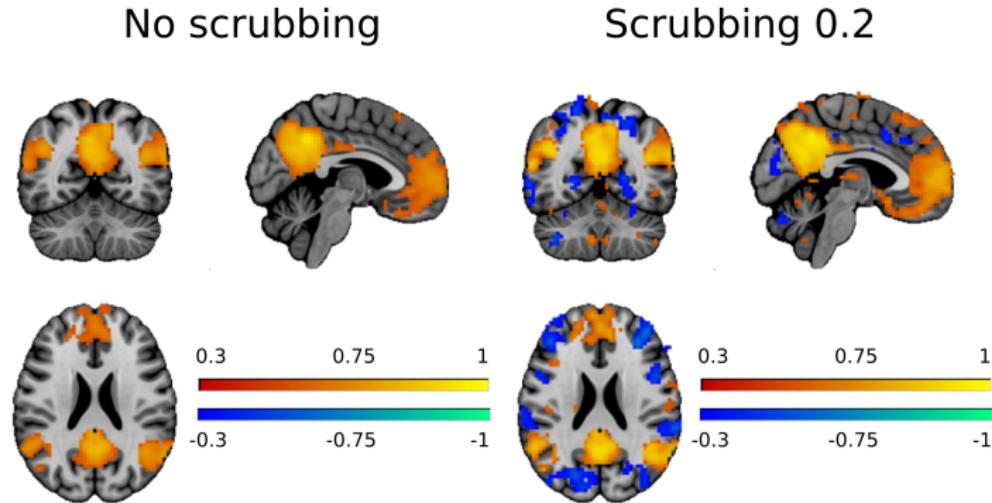
Scrubbing: frame displacement



Frame displacement is the sum of absolute displacements in translation and rotation motion parameters. For each frame with excessive FD (here $FD > 0.5$), four frames are suppressed (the target one + one before + two after, marked with red stars on the figure). The original method was proposed by Power et al. Neuroimage 2012. Note that, unlike the original method, only FD is used in NIAK (and not DVARS).

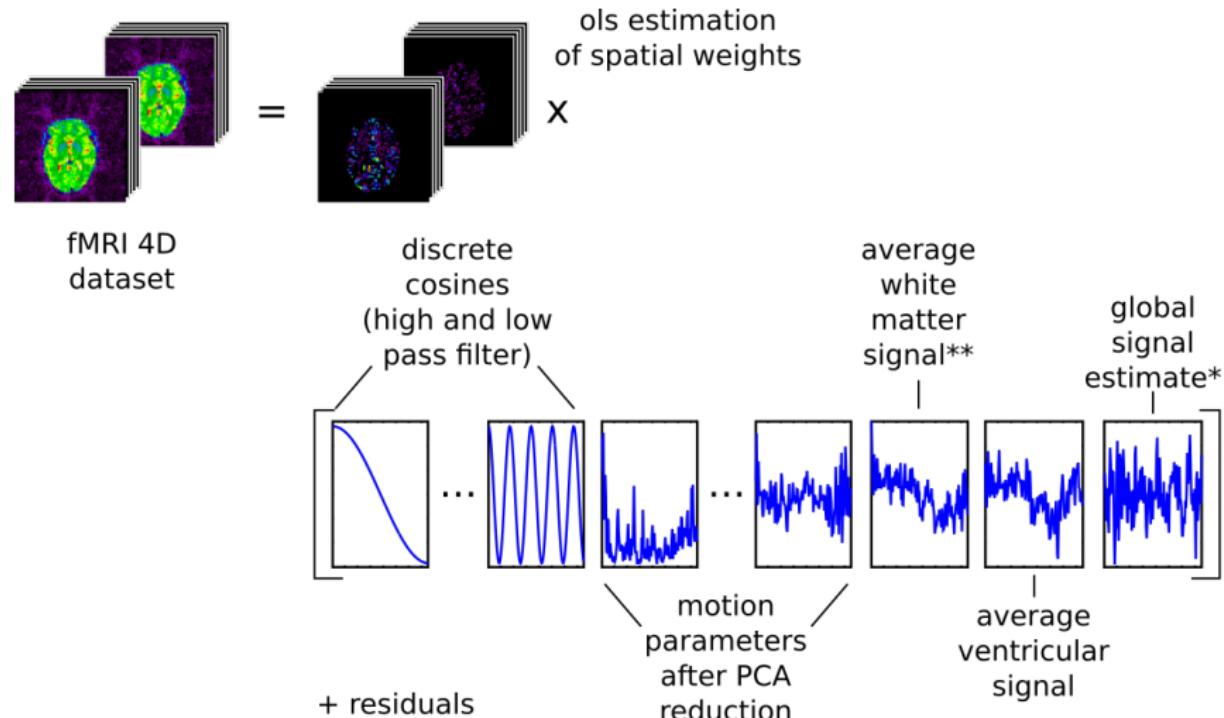
Scrubbing: example of impact on the DMN

Seed based analysis in the PCC Default mode



See Power et al. Neuroimage 2012&2014 for more info.

Regress confounds: model

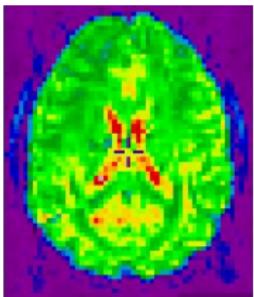
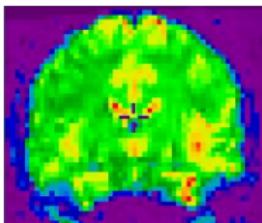
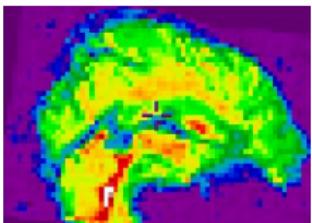


* the global signal estimate is based on a PCA decomposition
(Carbonell et al., Brain connectivity 2012).

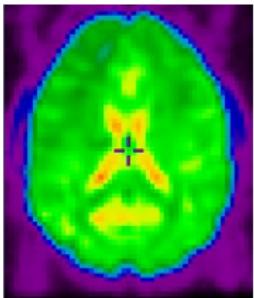
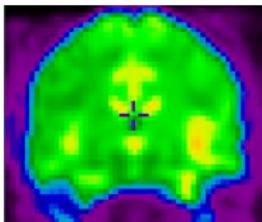
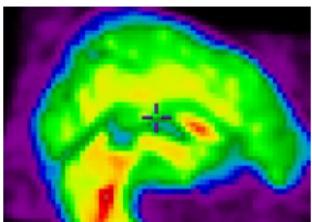
** can be replaced by a PCA reduction, aka anat COMPCOR (Chai et al., NeuroImage 2012).

Spatial smoothing

native resolution

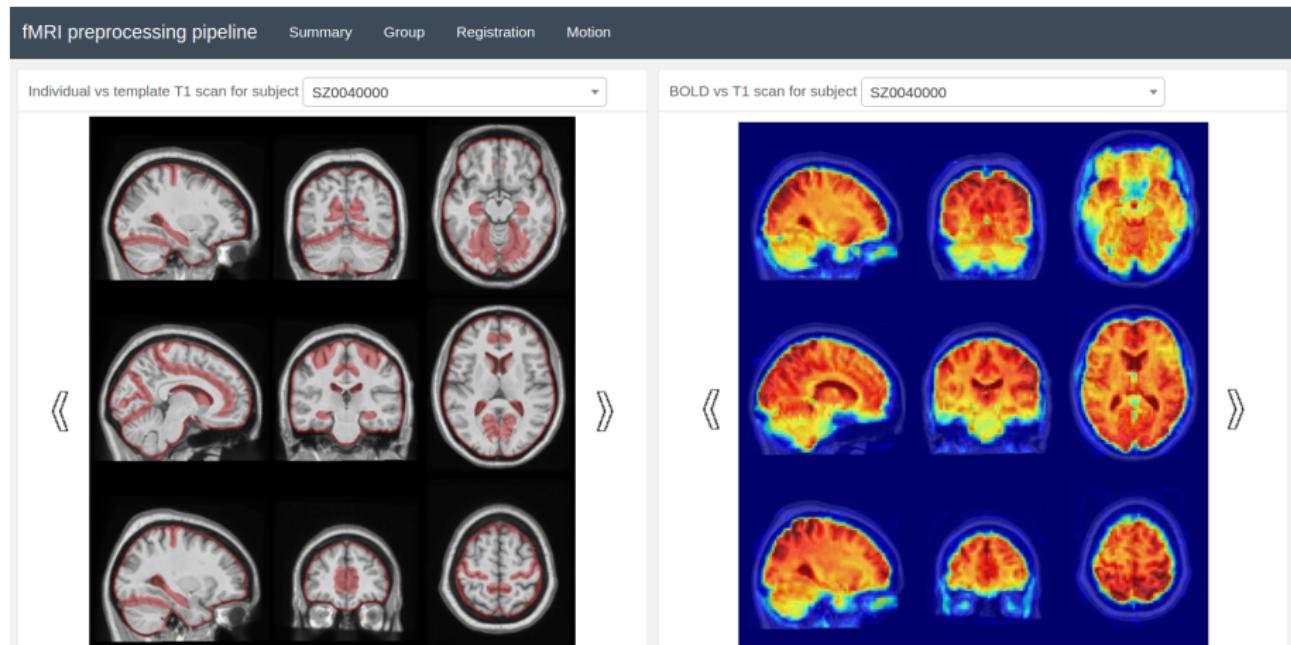


**smoothed image
isotropic Gaussian
kernel - 6 mm FWHM**



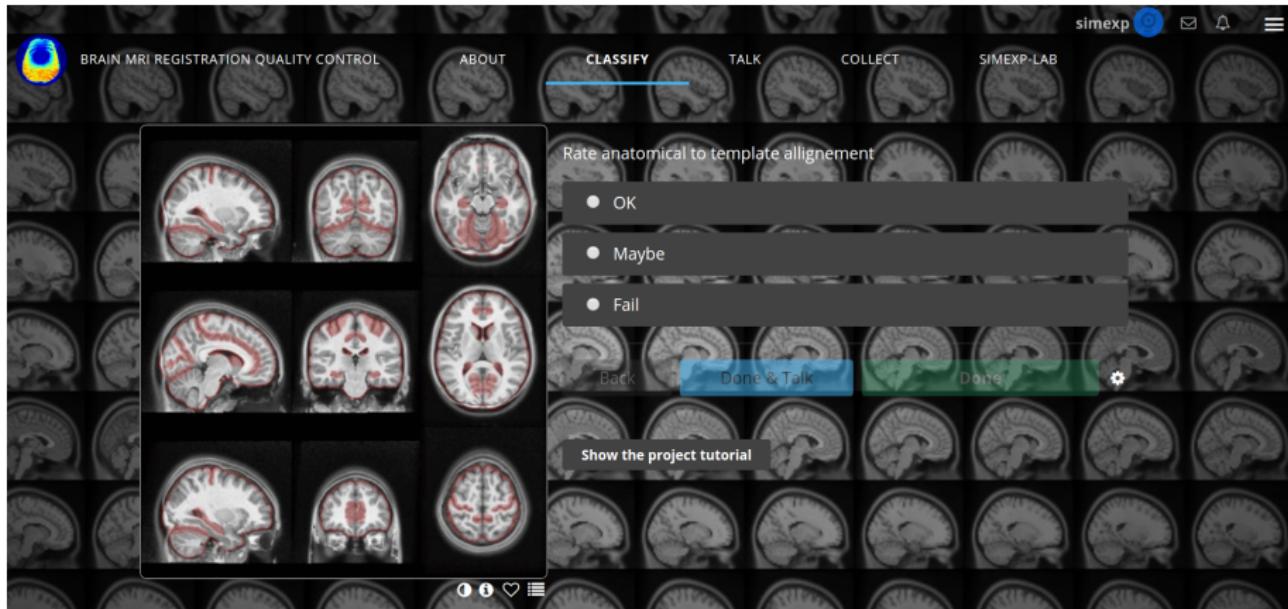
Interactive report

Reports can be consulted offline or online. Live demo at
https://simexp.github.io/qc_cobre/.



Guidelines for quality control of brain registration

Simplified guidelines for quality control as well as a collection of images to rate are available on zooniverse <https://www.zooniverse.org/projects/simexp/brain-match/classify>



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