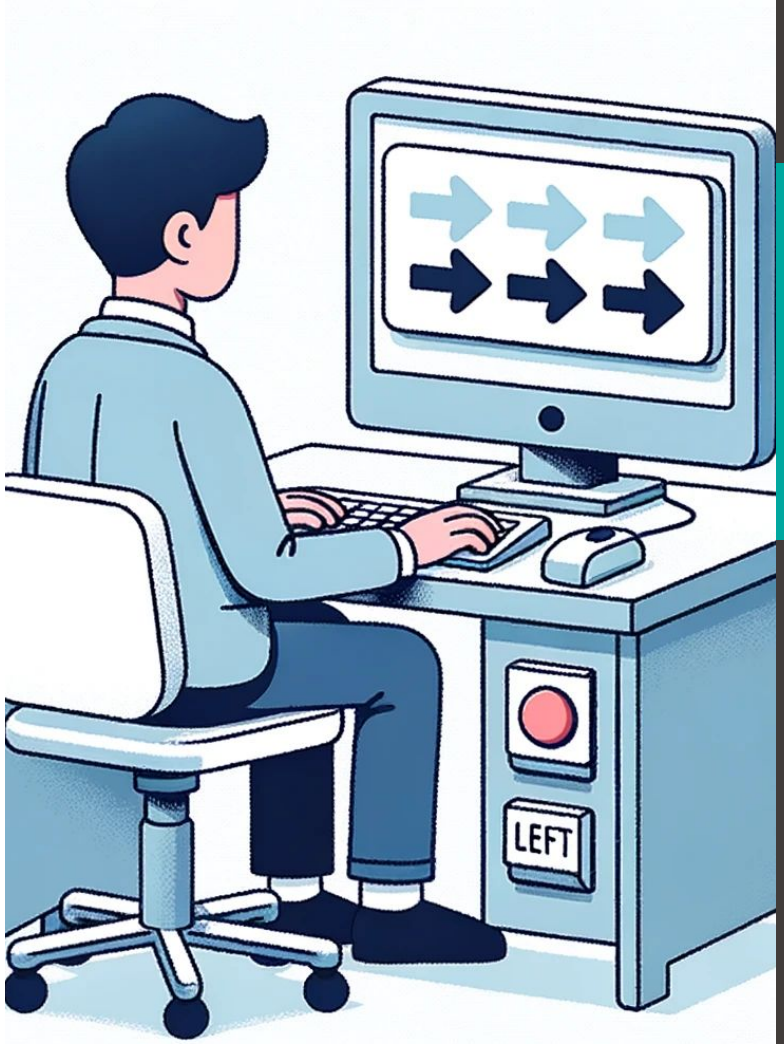

Motion Correction - fMRI preprocessing

Nicolas Francio, Mehdi Hajoub, Louis-Alexandre Léger, Pingsheng Li, Shiyi Huang

Variant 2
Groupe Z

Introduction

"subject motion produces substantial changes in the timecourses of resting state functional connectivity MRI (rs-fcMRI) data despite compensatory spatial registration and regression of motion estimates from the data."

- Spurious but systematic correlations in functional connectivity MRI networks arise from subject motion

Spurious but systematic correlations in functional connectivity MRI networks arise from subject motion

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[d] Department of Anatomy & Neurobiology, Washington University School of Medicine, St. Louis, MO, USA
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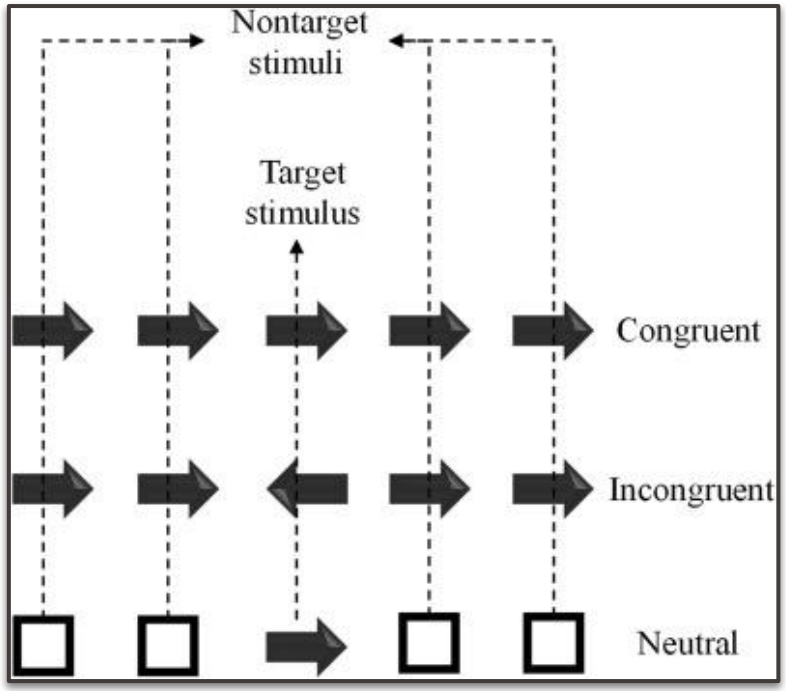
Flanker Test

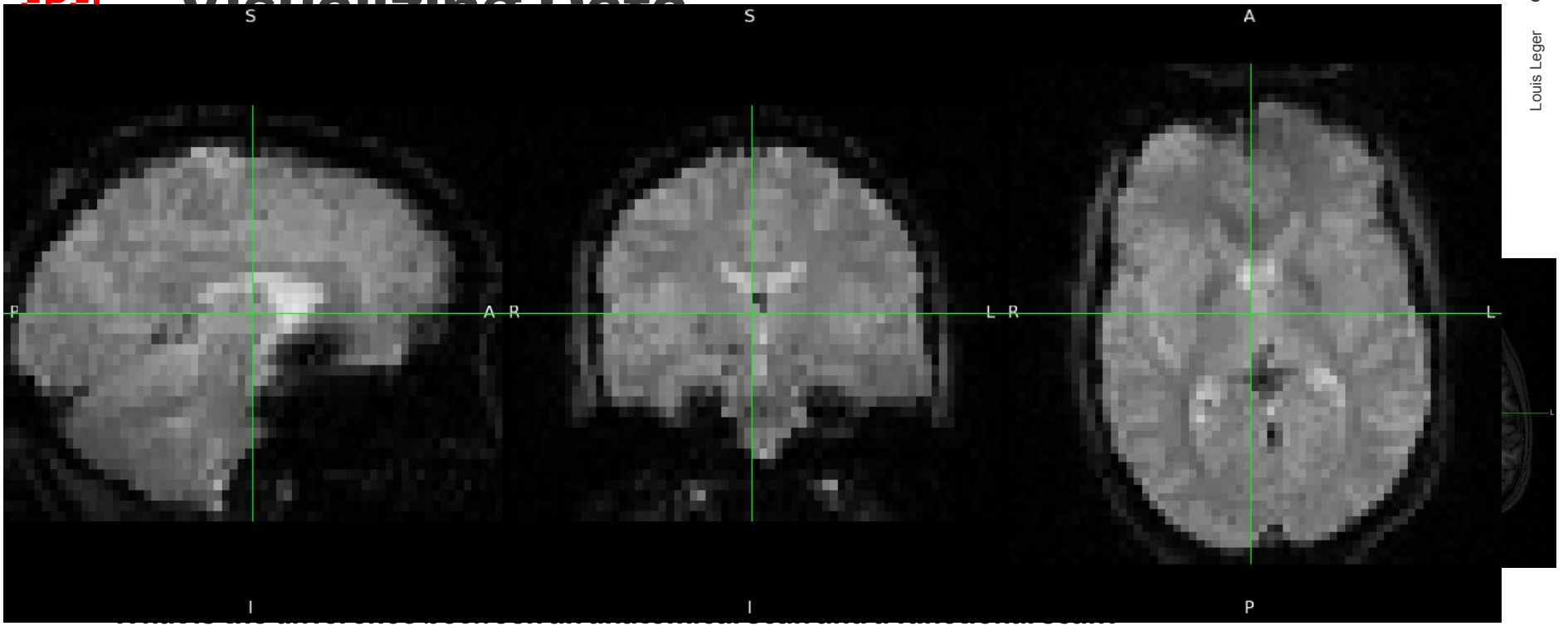


- Flanker test :
  - Participants respond to a central target stimulus while surrounded by congruent or incongruent flanker stimuli, testing attention and cognitive control.
  - Utilized in fMRI to analyze brain activity, revealing the neural basis of decision making and conflict resolution during cognitive tasks

Visualizing Data

What are the typical artefacts observed in functional and anatomical scan?

Visualizing Data

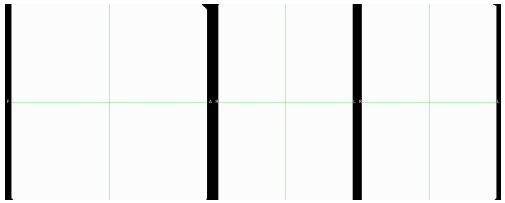


What are the typical artefacts observed in functional and anatomical scan?

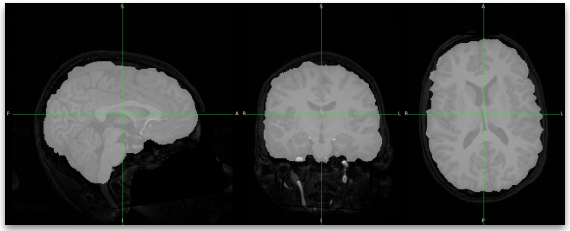
Can they be identified by visual inspection?

Brain Extraction

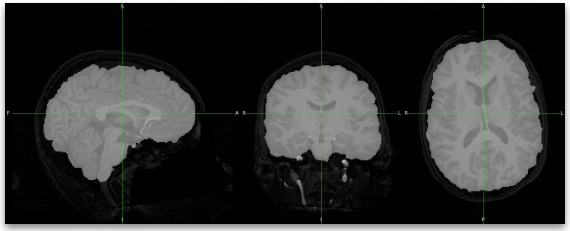
FIT = 0



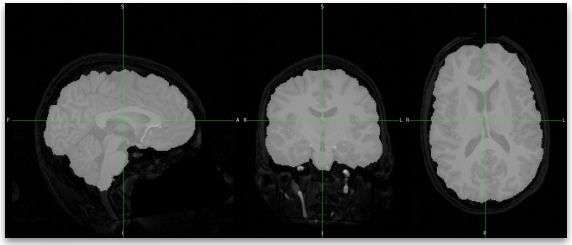
0.25 FIT < 0.5



FIT = 0.125

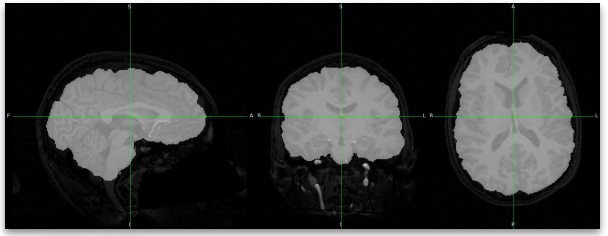


FIT = 0.25

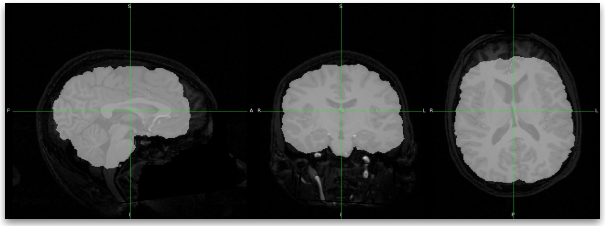


FIT = 0.375

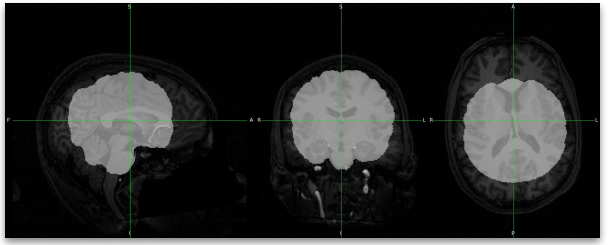
FIT > 0.5



FIT = 0.5



FIT = 0.625



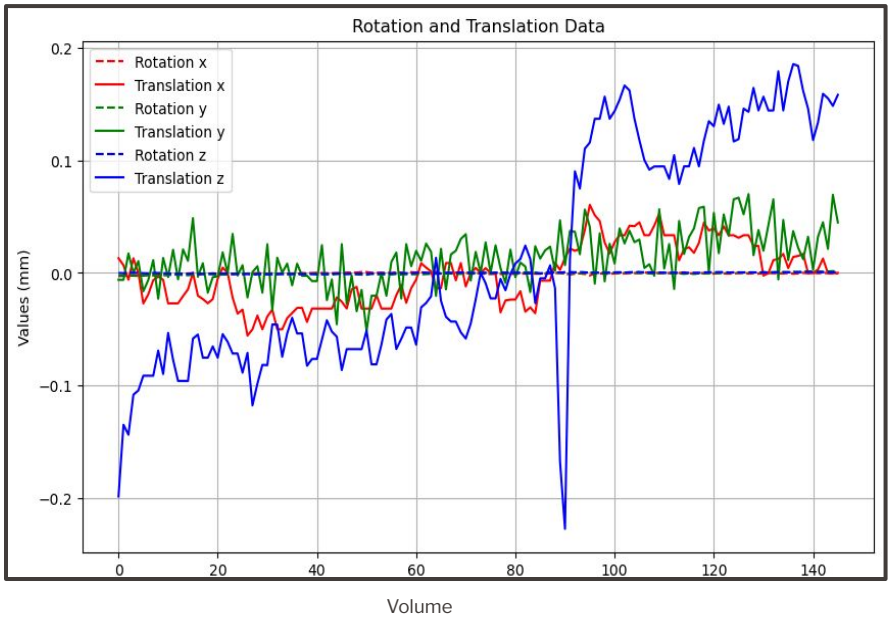
FIT = 0.75

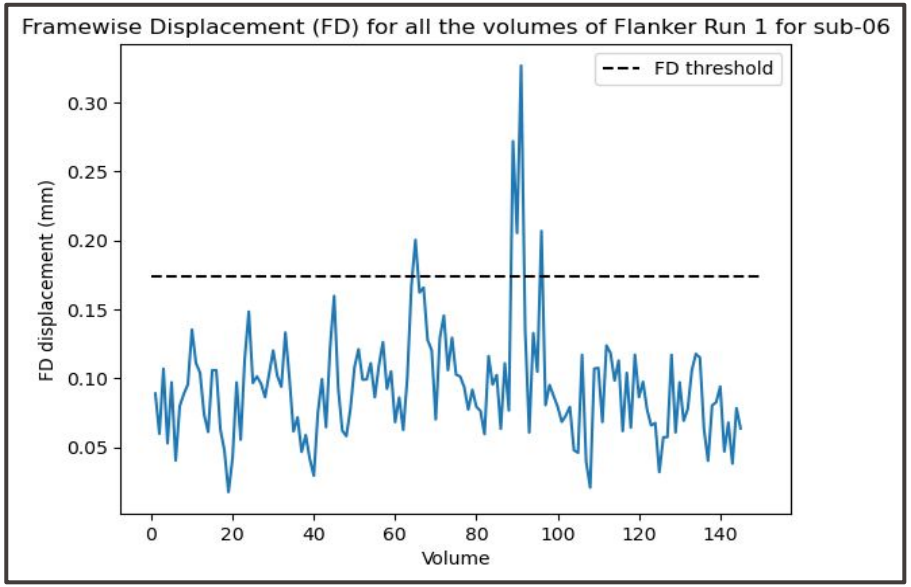
Observations:

- FIT = 0 takes the whole volume as a mask.
- FIT = 1 fails completely at masking the gray and some white matter.
- The best FIT seems to be in the 0.25-0.5 range.

Motion correction

- Objective: a given voxel describes the same brain position in all volumes

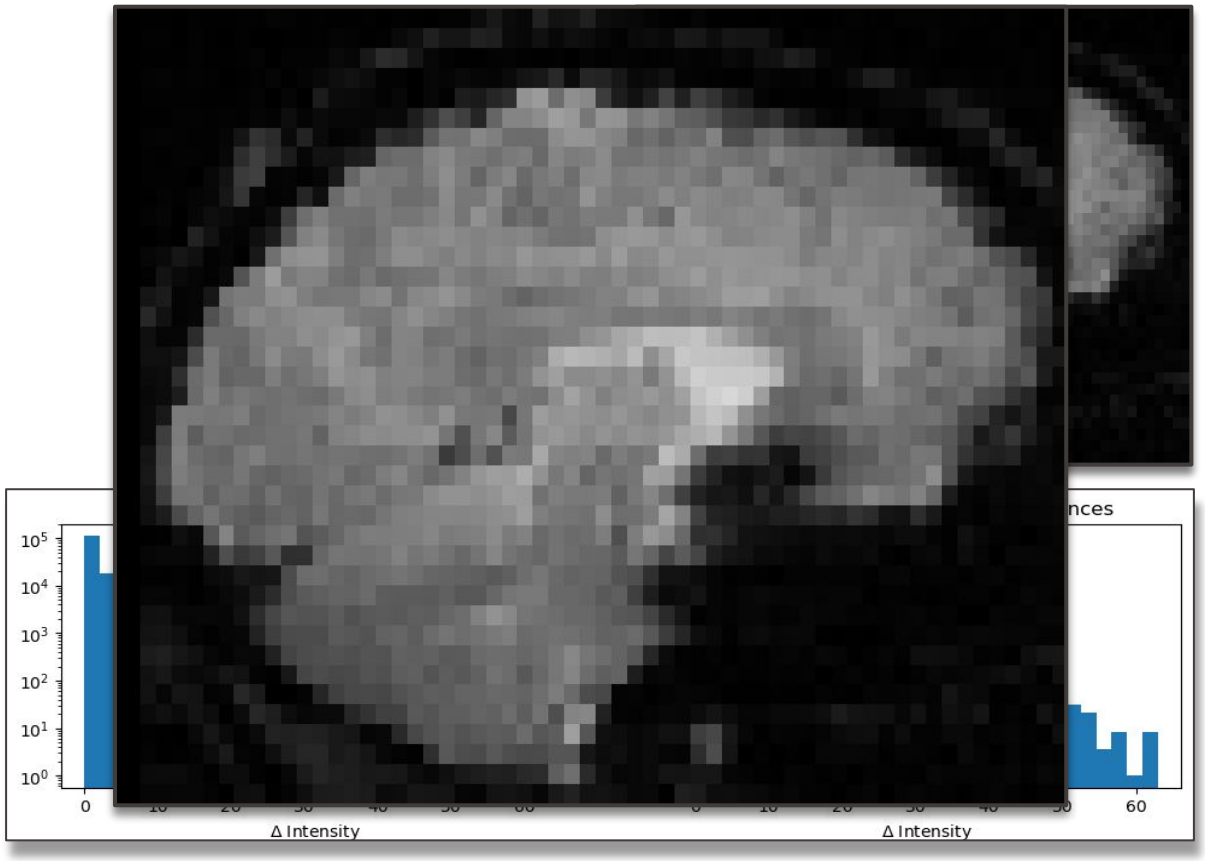




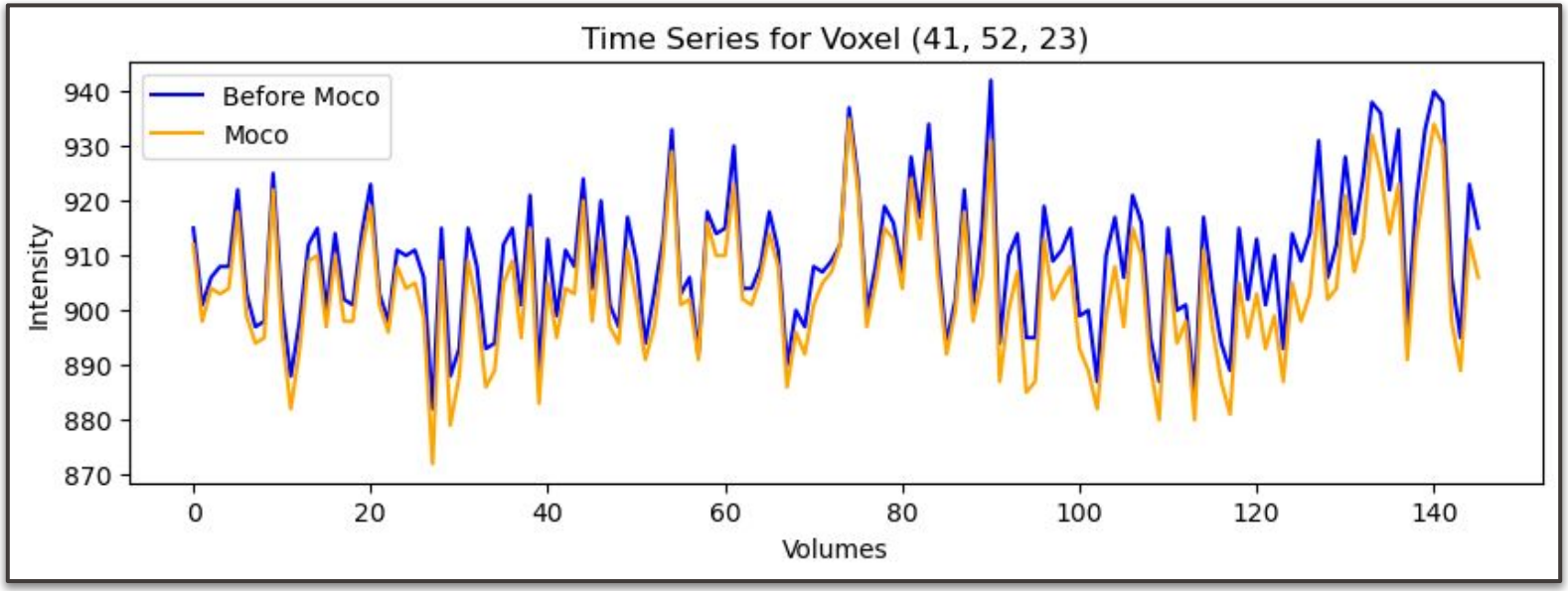
Visualizing the result for a volume:

Before

After



Visualizing the result: time series for a specific voxel



- Baseline shift (Scaling factor)
- Temporal Preservation

Louis Leger

Cost Functions

	RMS	Average FD
mutualinfo	0.094162	0.077112
woods	0.182136	0.177952
corratio	0.095800	0.088877
normcorr	0.095991	0.093267
normmi	0.095785	0.079037
leastsquares	0.099433	0.089022

- What are different types of cost functions used in FSL's motion correction?

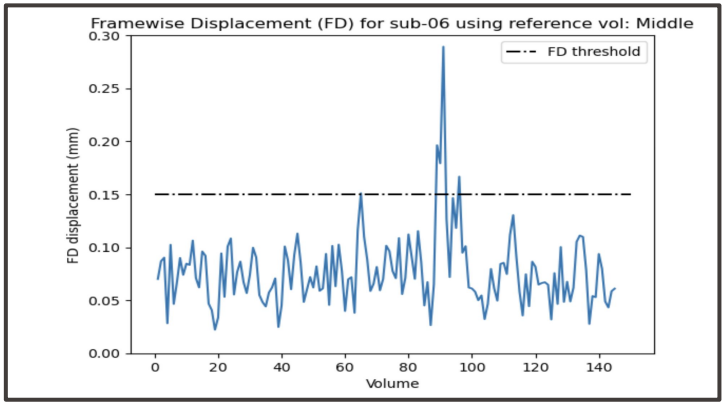
C^{NC}	$\frac{\sum(X.Y)}{\sqrt{\sum X^2}\sqrt{\sum Y^2}}$

C^{MI}	$H(X,Y) - H(X) - H(Y)$

Nicolas Francio

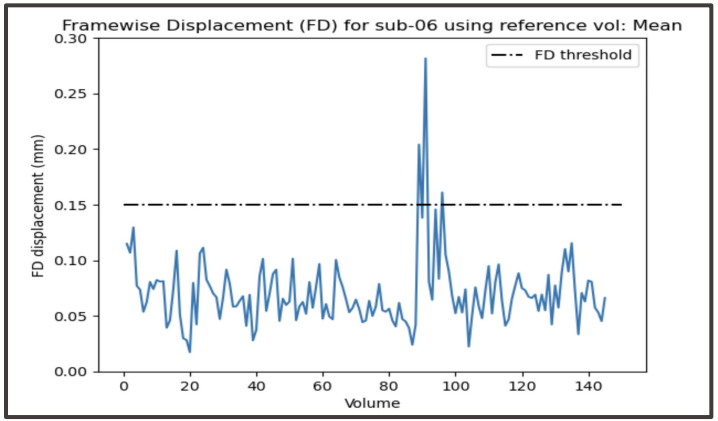
Middle vs Mean Reference Volumes & Subject Comparison

Middle Volume Reference

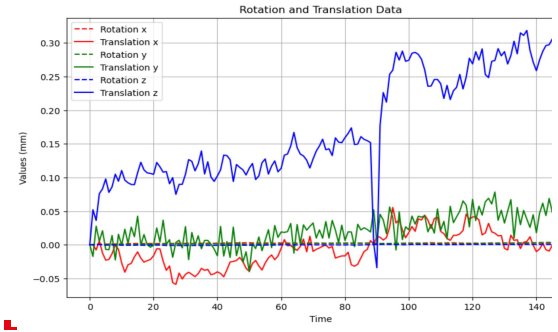


VS

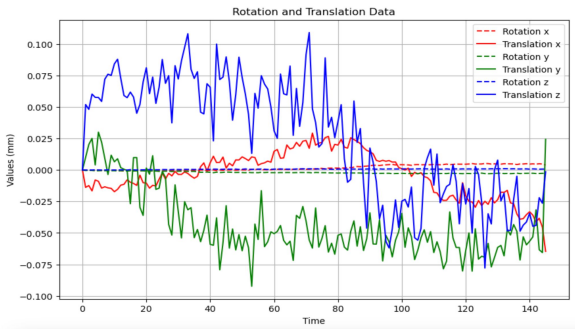
Mean Volume Reference



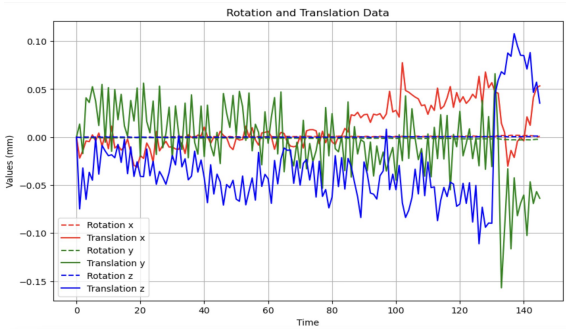
Subject-06



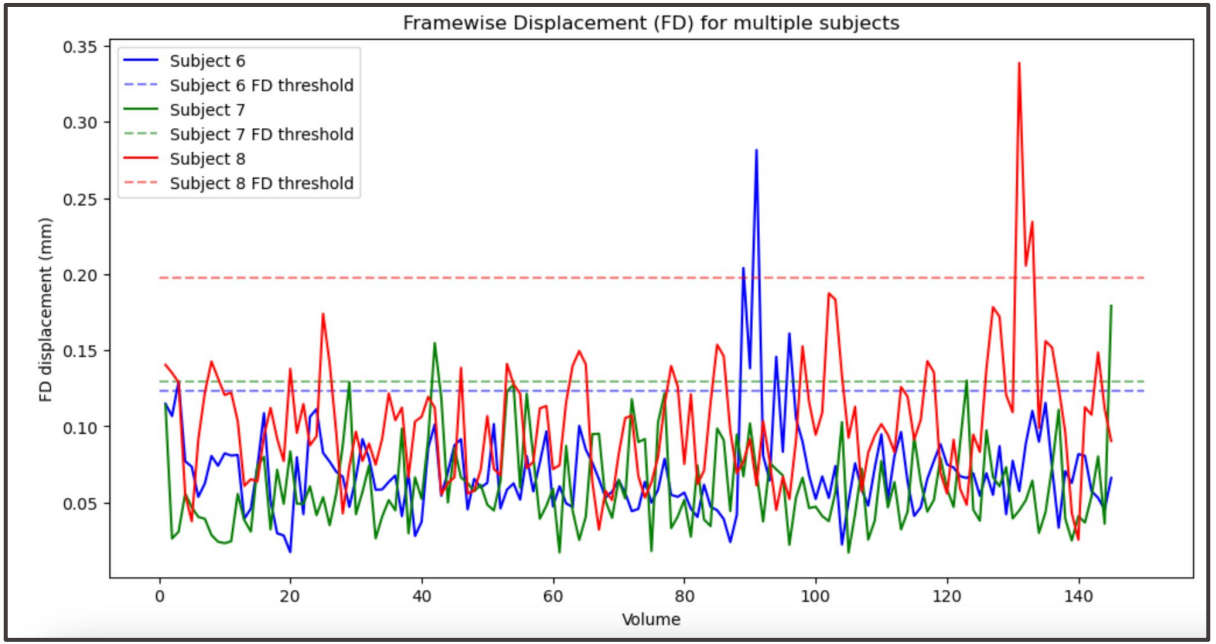
Subject-07



Subject-08

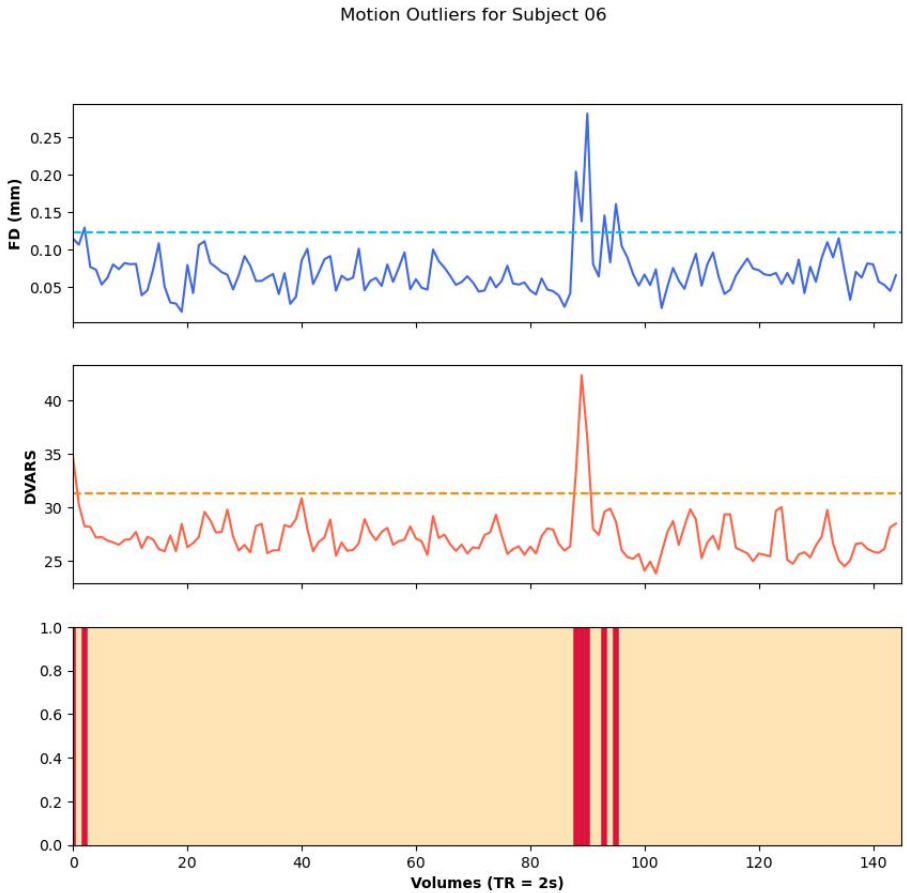


Mean vs Middle Reference Volumes & Subject Comparison

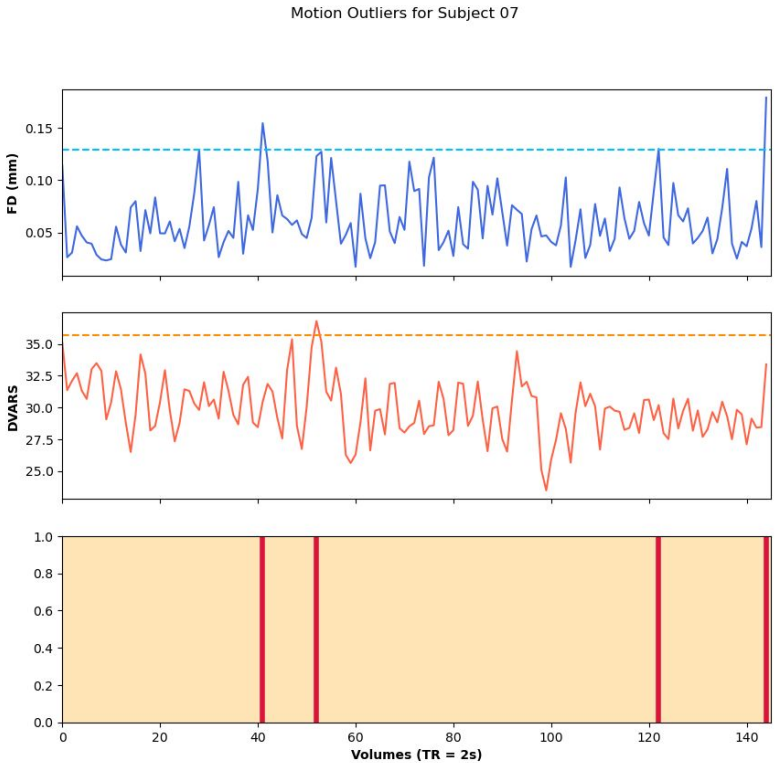


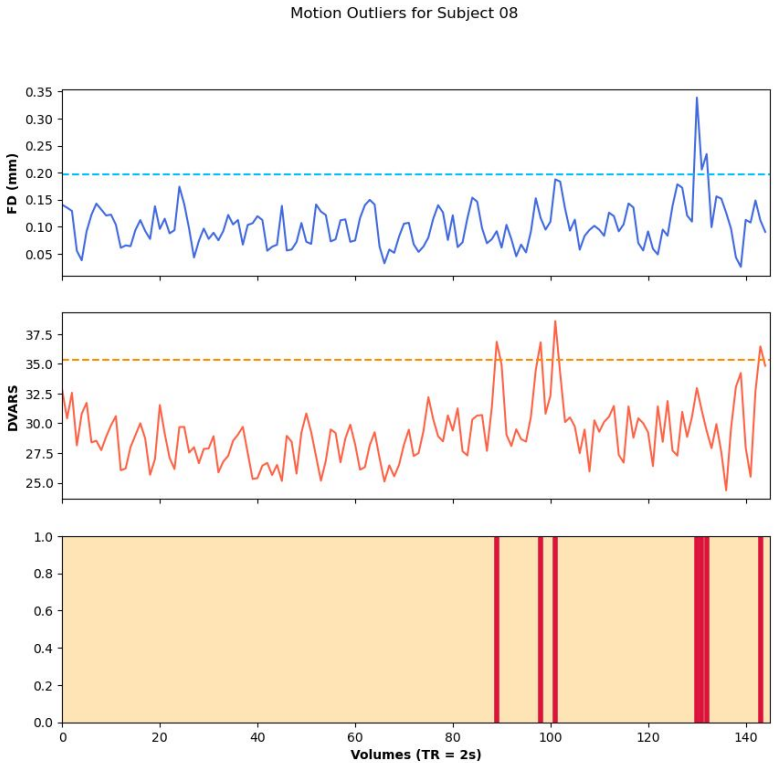
$$Threshold = Q3 + 1.5 * IQR$$

DVARS and additional outlier detection



Annexe


Motion Outliers for Subject 07
FD (mm)
DVARS
Volumes (TR = 2s)


Motion Outliers for Subject 08
FD (mm)
DVARS
Volumes (TR = 2s)

DVARS and FD are correlated

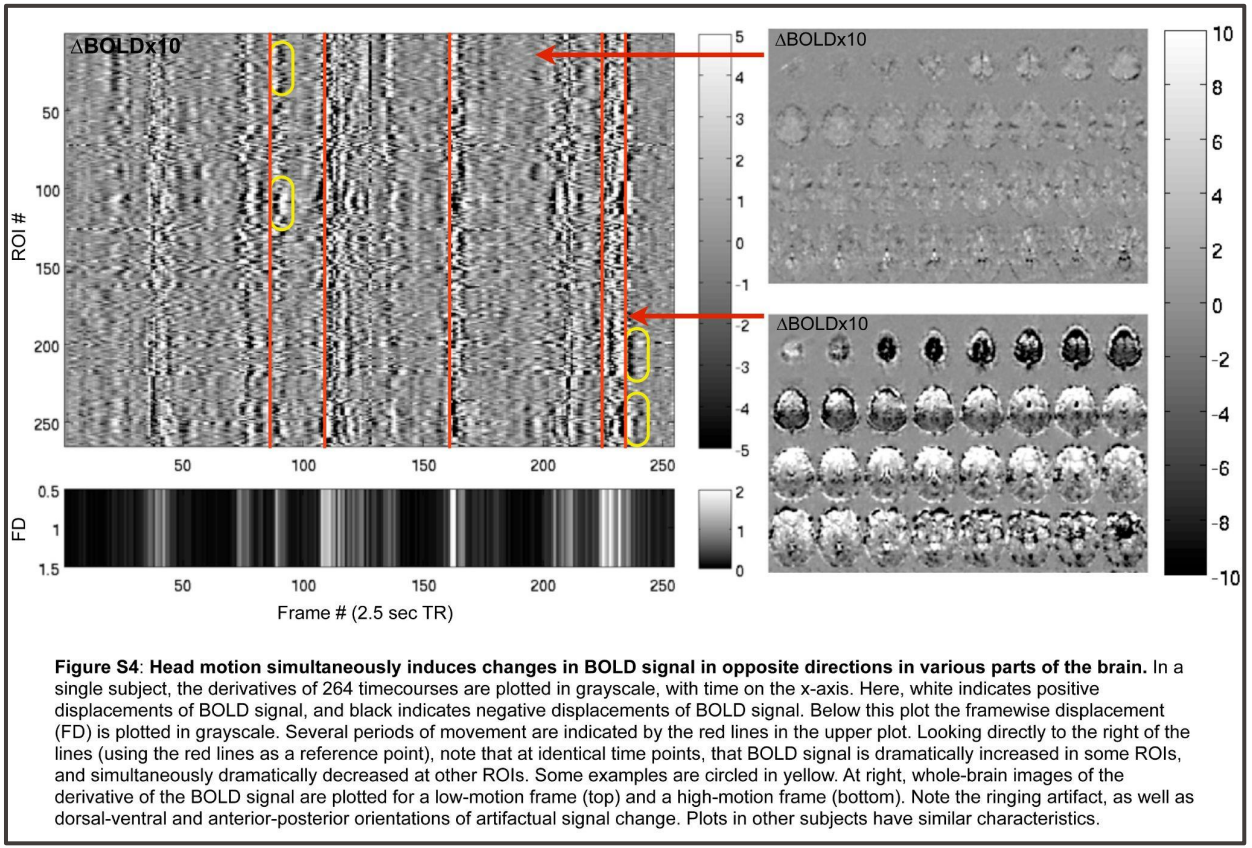
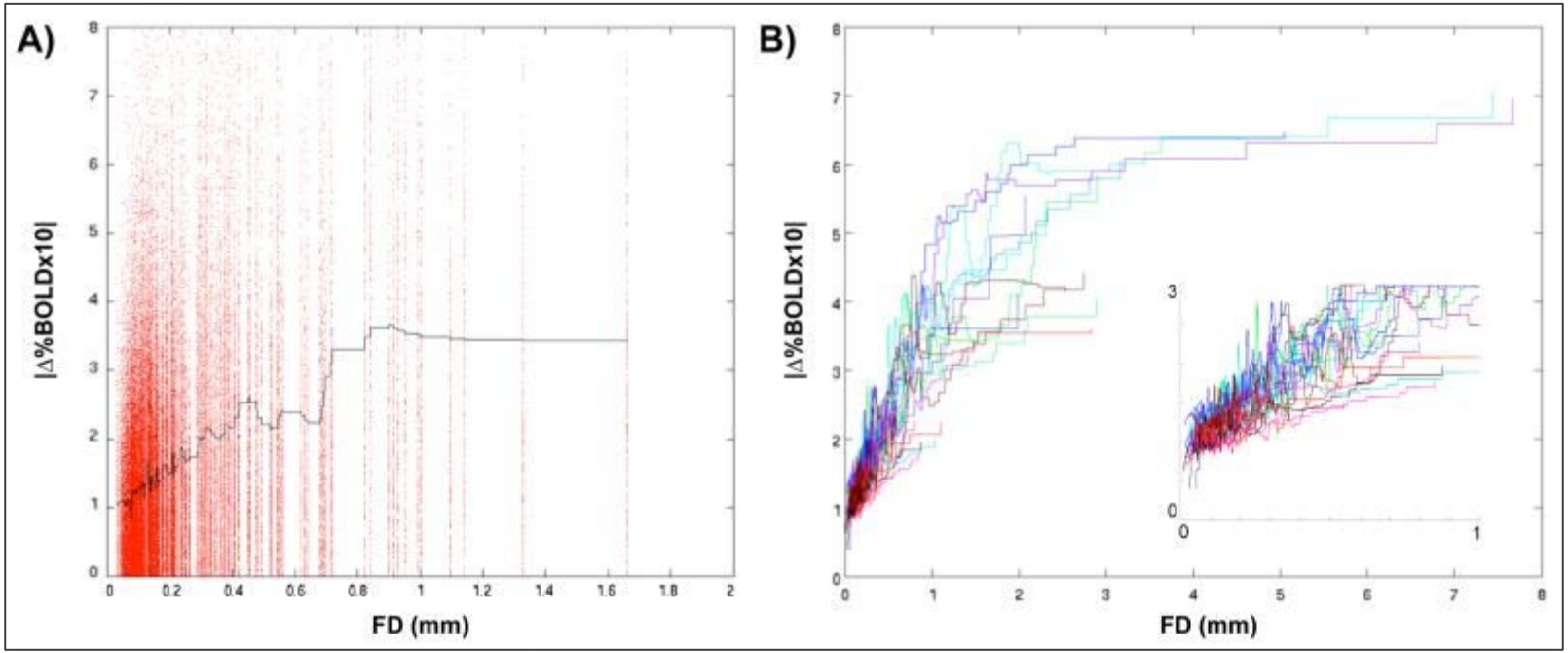


Figure S4: **Head motion simultaneously induces changes in BOLD signal in opposite directions in various parts of the brain.** In a single subject, the derivatives of 264 timecourses are plotted in grayscale, with time on the x-axis. Here, white indicates positive displacements of BOLD signal, and black indicates negative displacements of BOLD signal. Below this plot the framewise displacement (FD) is plotted in grayscale. Several periods of movement are indicated by the red lines in the upper plot. Looking directly to the right of the lines (using the red lines as a reference point), note that at identical time points, that BOLD signal is dramatically increased in some ROIs, and simultaneously dramatically decreased at other ROIs. Some examples are circled in yellow. At right, whole-brain images of the derivative of the BOLD signal are plotted for a low-motion frame (top) and a high-motion frame (bottom). Note the ringing artifact, as well as dorsal-ventral and anterior-posterior orientations of artifactual signal change. Plots in other subjects have similar characteristics.

- Spurious but systematic correlations in functional connectivity MRI networks arise from subject motion

DVARS and FD are correlated



- Spurious but systematic correlations in functional connectivity MRI networks arise from subject motion