MEDICAL UNIVERSITY OF VIENNA

CIR

Voxel-wise Nuisance Regression for Suppressing the Residual Motion in Resting state in-utero fMRI

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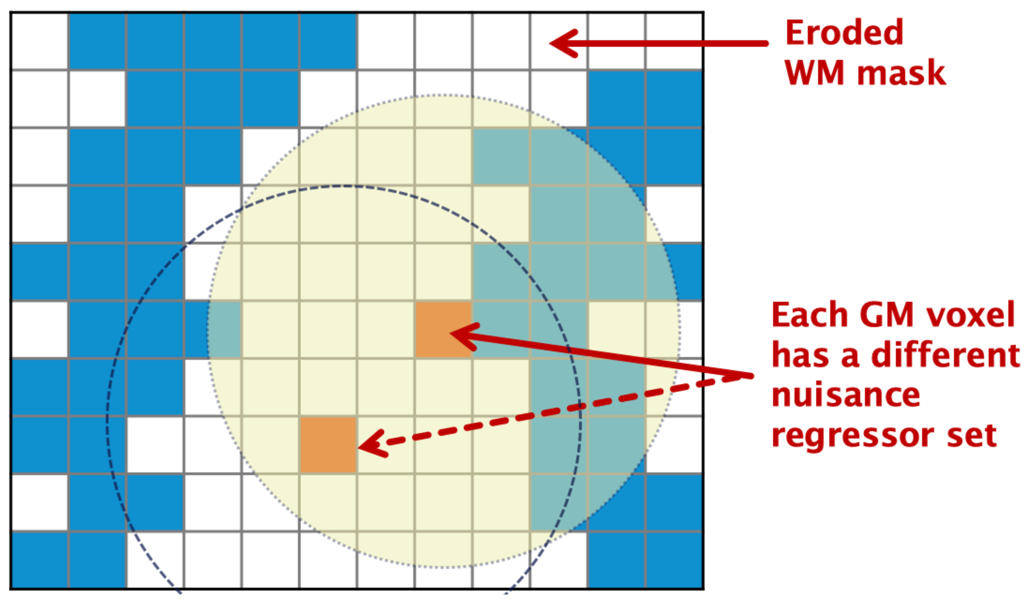
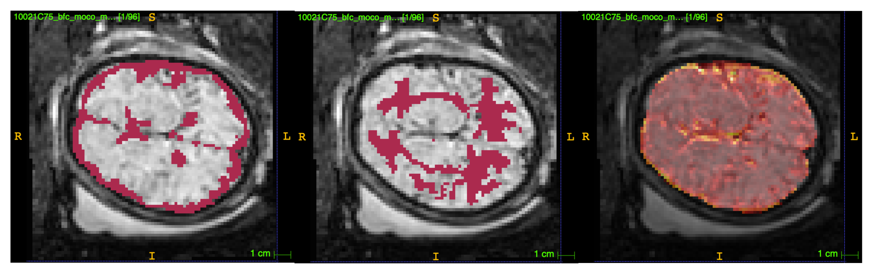
Objective

The underlying assumption of the conventional nuisance regression strategies is that the noise components covary with the BOLD signal coherently at the level of the whole brain. To the degree that this assumption is violated, the regression approach can reintroduce artifacts into fMRI data. Here we develop an approach to reduce the contribution of spatially localized fluctuations that emanate from non-gray matter (GM) sources while minimizing the bias that such contribution can introduce into the resultant resting state functional connectivity maps. To examine our regression model, we perform correlation analysis for each individual subject and for the whole group of subjects.

Confound Regression Strategies	#R
1. GSR	1
2. Physiological Compartments (2Phys)	2
3. Head Motion Parameters (6HMP)	6
4. 6HMP + 2Phy + GSR	9
5. 6HMP + 6D + 6Q + 6DofQ (24HMP)	24
6. 24HMP + 8Phys + 4GSR	36
7. aCompCor	10
8. tCompCor	6

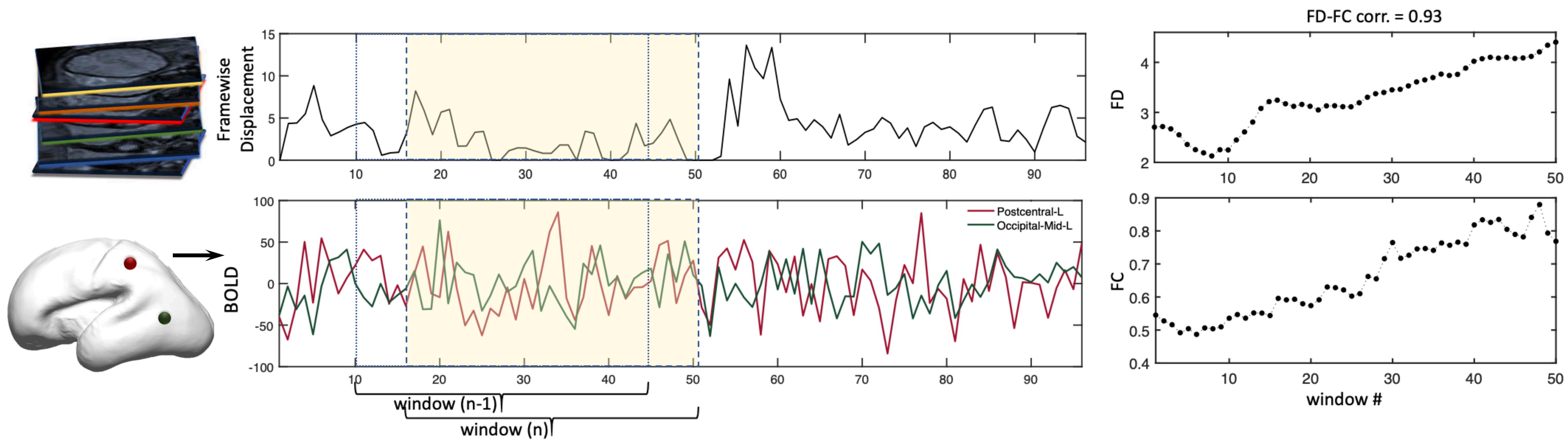
More nuisance regressors
⇩
More loss of degrees of freedom
⇩
Less statistical confidence



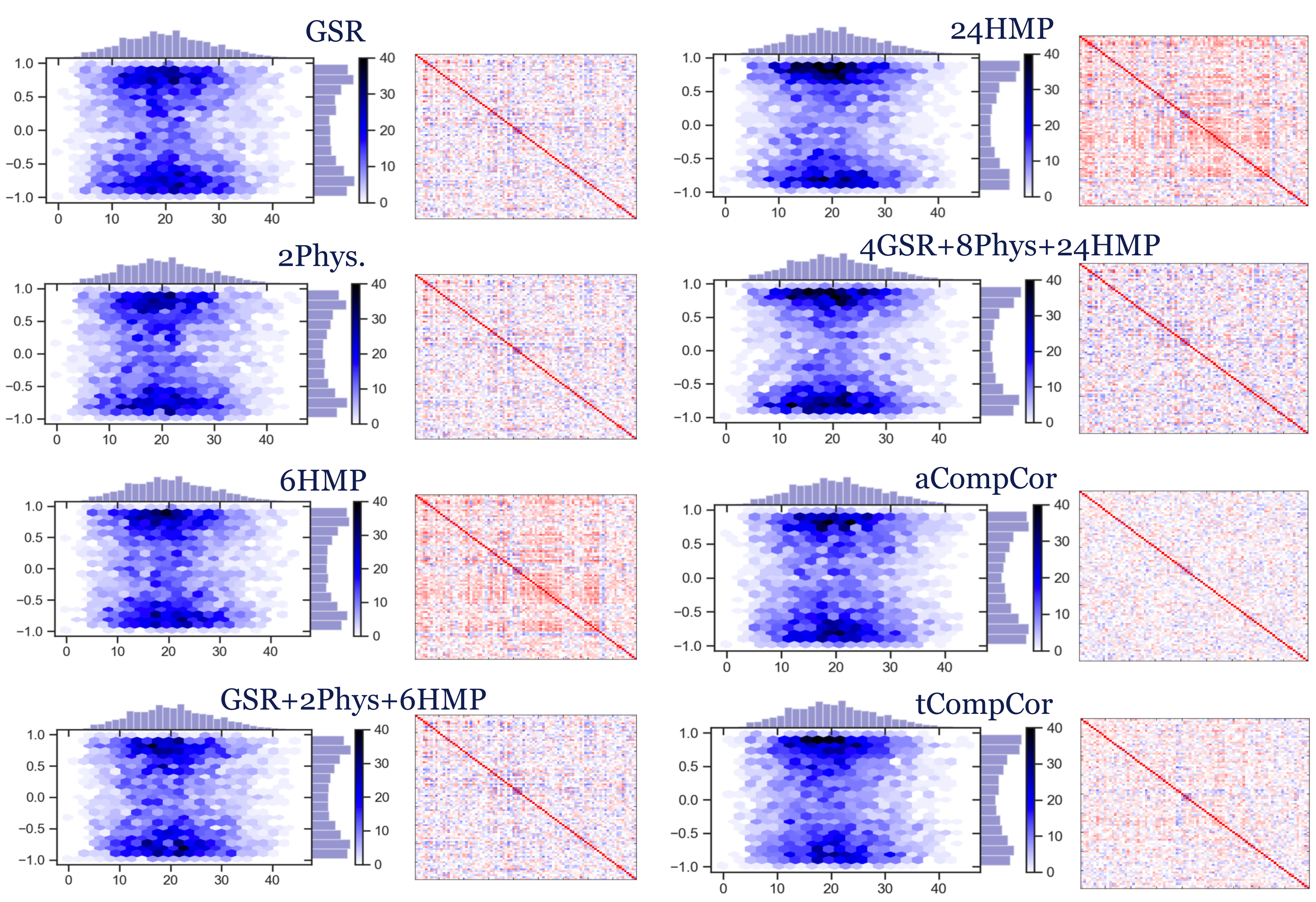


Benchmarking of the residual motion

The sources of motion in fMRI time series are *non-stationary* and can potentially induce *changes in FC over time*



Subject-level analysis of the dynamic benchmark



A density plot of FC-FD association over distance between regions. A successful strategy should have more density of datapoints around zero axis which shows fewer significant correlations with motion. Besides, it should remove the distance dependent slope and positive offset in of FC-FD vs. distance. Subject-level analysis consistent with group-level results suggested aCompCor and the 24HMP+8Phys+4GSR models have more homogeneous performance over subjects and the commonly used regression strategy relying only on the six motion parameters fared the worst. However, it aslo revealed that clear remaining signs of motion artifacts are still present in datasets and underscored the need for greater care in dealing with fetus motion.

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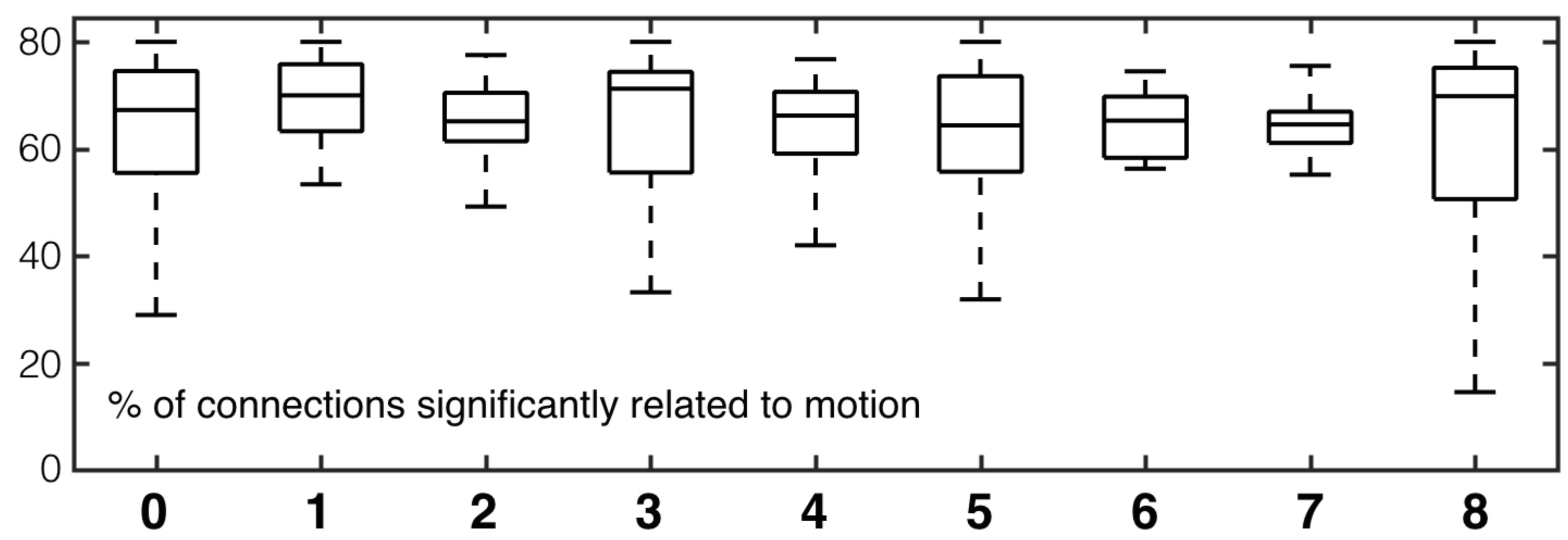
Group-level analysis of the dynamic benchmark



Group-level analysis of the QC-FC benchmark

Each point in this plot shows the correlation between the FC of one specific edge and the average FD over the whole sample. According to this benchmark, 6HMP outperforms other strategies, as no significant FC-FD association remained. However, the average FC map after 6HMP exhibits dramatically increased FC values across the cortex.