



Data Processing & Analysis of Resting-State fMRI (Part II)

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<http://rfmri.org>

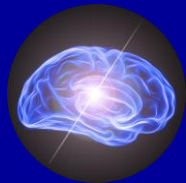
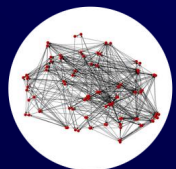
Research Scientist

The Nathan Kline Institute for Psychiatric Research

Research Assistant Professor

Department of Child and Adolescent Psychiatry /

NYU Langone Medical Center Child Study Center, New York University



Disclosure

Initiator

DPARSE, DPABI, PRN and The R-fMRI Network (RFMRI.ORG)

Founder, Chief & Programmer

My Research Network (RNET.PW)



Outline

- 
- 
- **DPARSF (Basic Edition)**
 - **RNET: a cloud way for doing research**





DPARSF: a MATLAB toolbox for “pipeline” data analysis of resting-state fMRI

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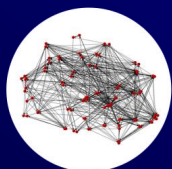
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Resting-state functional magnetic resonance imaging (fMRI) has attracted more and more attention because of its effectiveness, simplicity and non-invasiveness in exploration of the intrinsic functional architecture of the human brain. However, user-friendly toolbox for “pipeline” data analysis of resting-state fMRI is still lacking. Based on some functions in Statistical Parametric Mapping (SPM) and Resting-State fMRI Data Analysis Toolkit (REST), we have developed a MATLAB toolbox called Data Processing Assistant for Resting-State fMRI (DPARSF) for “pipeline” data analysis of resting-state fMRI. After the user arranges the Digital Imaging and Communications in Medicine (DICOM) files and click a few buttons to set parameters, DPARSF will then give all the preprocessed (slice timing, realign, normalize, smooth) data and results for functional connectivity, regional homogeneity, amplitude of low-frequency fluctuation (ALFF), and fractional ALFF. DPARSF can also create a report for excluding subjects with excessive head motion and generate a set of pictures for easily checking the effect of normalization. In addition, users can also use DPARSF to extract time courses from regions of interest.

Keywords: data analysis, DPARSF, REST, resting-state fMRI, SPM

Data Processing Assistant for Resting-State fMRI (DPARSF)

Yan and Zang, 2010. Front Syst Neurosci.



<http://rfmri.org/DPARSF>

DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition **DPARSF**

Working Directory: ...

Participants:

Sub_001
Sub_002
Sub_003

Time Points:
TR (s):

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☐ Detrend ☒ ALFF ☒ fALFF Band (Hz): ~

☐ Scrubbing ☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #: Starting Directory Name:

DPABI: a toolbox for Data Processing & Analysis of Brain Imaging

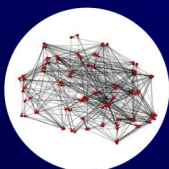
License: GNU GPL



Chao-Gan Yan
Programmer
Initiator

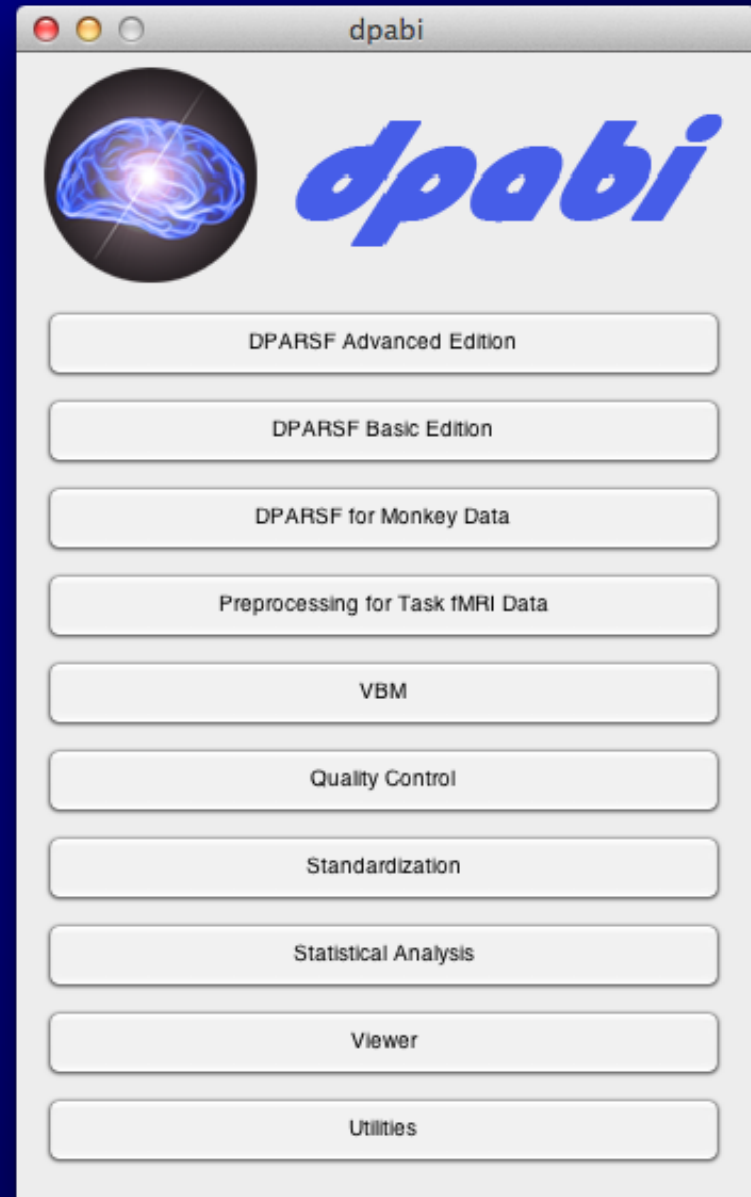


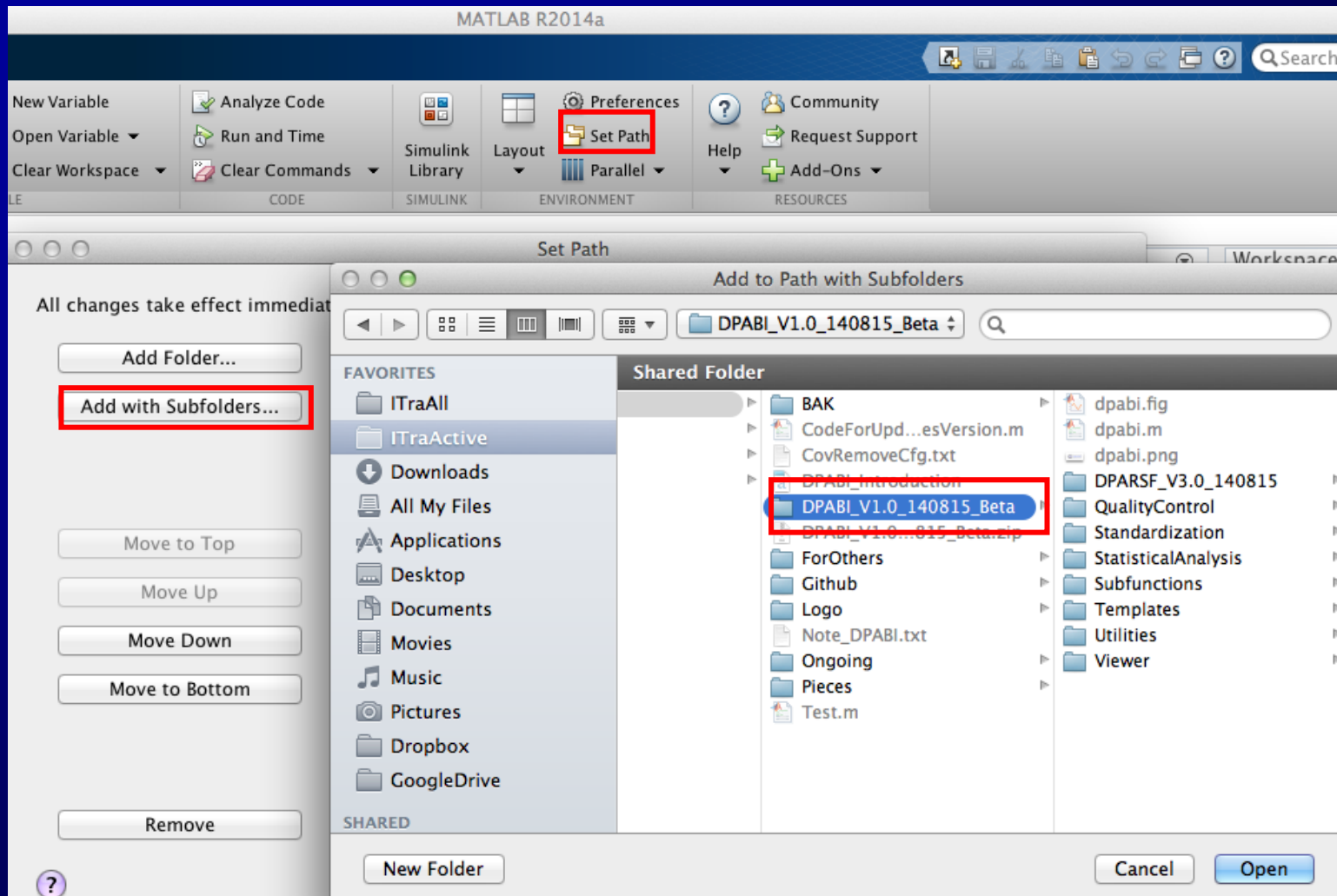
Xin-Di Wang
Programmer




<http://rfmri.org/dpabi>

<http://dpabi.org>





DPARSF

- 
- **Data Preparation**
 - **Preprocessing**
 - **ReHo, ALFF, fALFF Calculation**
 - **Functional Connectivity**
 - **Utilities**



Data Organization

ProcessingDemoData.zip

FunRaw

Sub_001

Sub_002

Sub_003



Functional DICOM data

T1Raw

Sub_001

Sub_002

Sub_003



Structural DICOM data

<http://rfmri.org/DemoData>

Data Organization

ProcessingDemoData.zip

FunImg

Sub_001

Sub_002

Sub_003

Functional NIfTI data
(.nii.gz., .nii or .img)



T1Img

Sub_001

Sub_002

Sub_003

Structural NIfTI data
(.nii.gz., .nii or .img)



DPARSF

- **Data Preparation**



- **Preprocessing**
- **ReHo, ALFF, fALFF Calculation**
- **Functional Connectivity**
- **Utilities**

DPARSF Basic Edition's procedure

- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



DPARSF Basic Edition's procedure



- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



DPARSF

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #: Starting Directory Name:



DPARSF Basic Edition's procedure



- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition **DPARSF**

Working Directory: ...

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☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

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☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~


☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #: Starting Directory Name:



DPARSF Basic Edition's procedure

- 
- **Convert DICOM files to NIFTI images**
 - **Remove First 10 Time Points**
 - **Slice Timing**
 - **Realign**
 - **Normalize**
 - **Smooth (optional)**
 - **Detrend (optional)**
 - **Nuisance covariates regression**
 - **Calculate ALFF and fALFF**
 - **Filter**
 - **Calculate ReHo (without smooth in preprocessing)**
 - **Calculate Functional Connectivity**

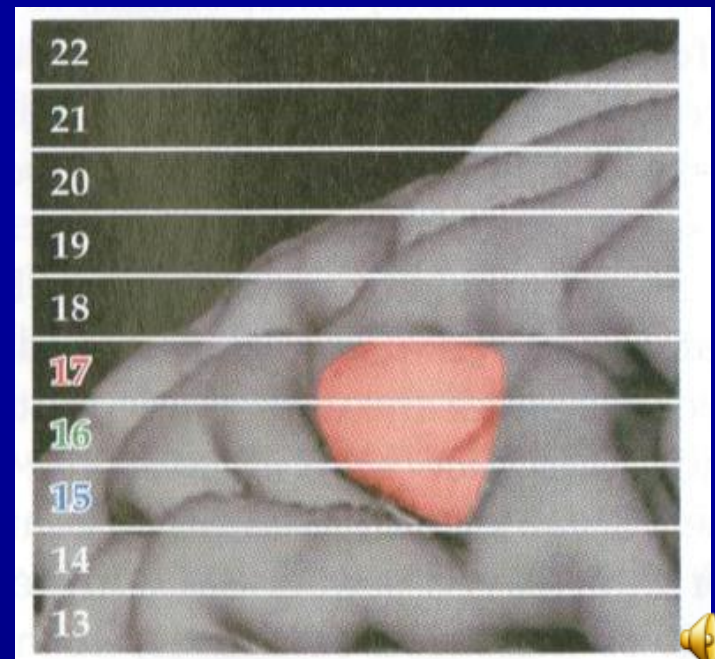
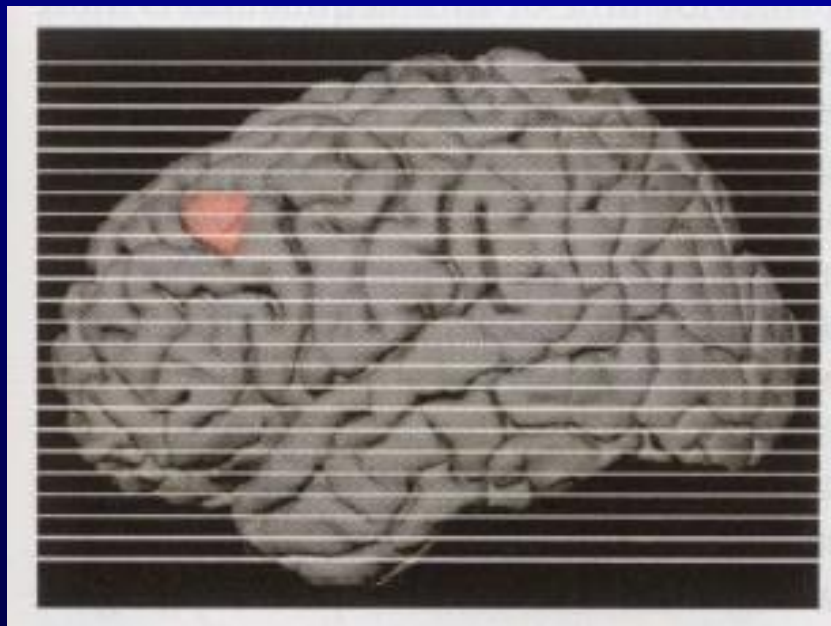
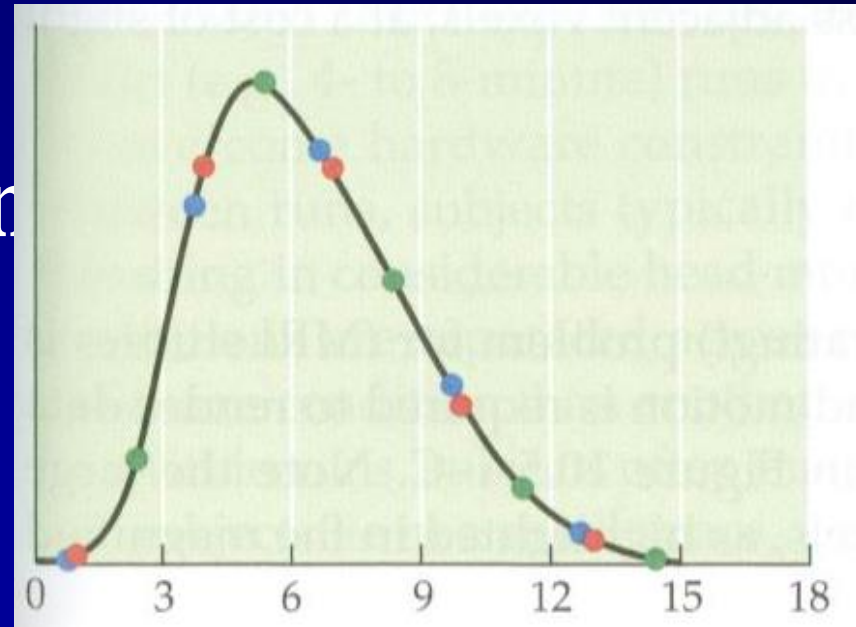
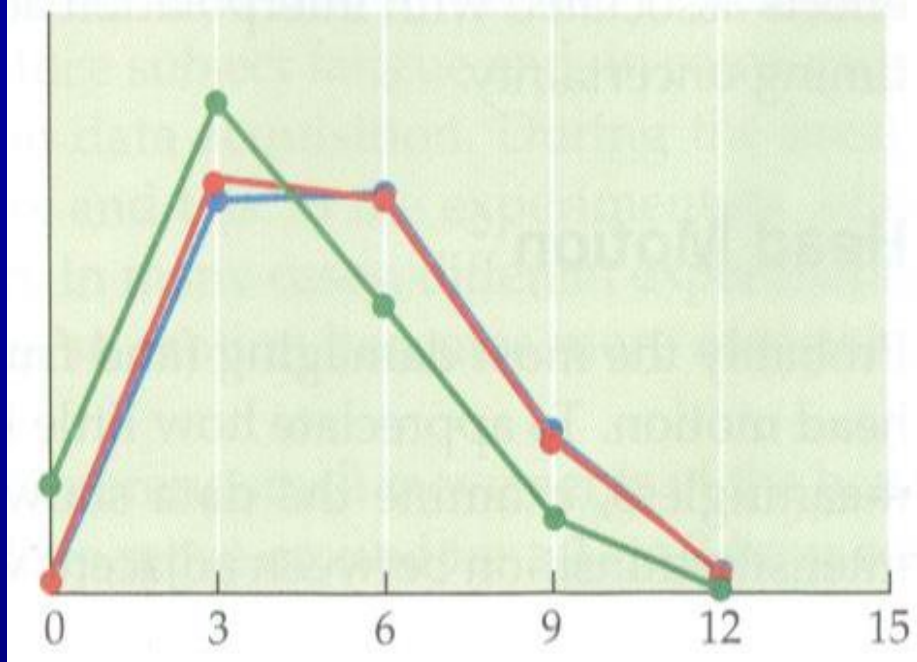


Slice Timing

Why?



in



Huettel et al., 2004



DPARSF

1:2:33,2:2:32

Data Processing Assistant for Resting-State fMRI *Basic Edition* DPARSF

Working Directory: ...

Participants:

Sub_001

Sub_002

Sub_003

Time Points:

TR (s):

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~



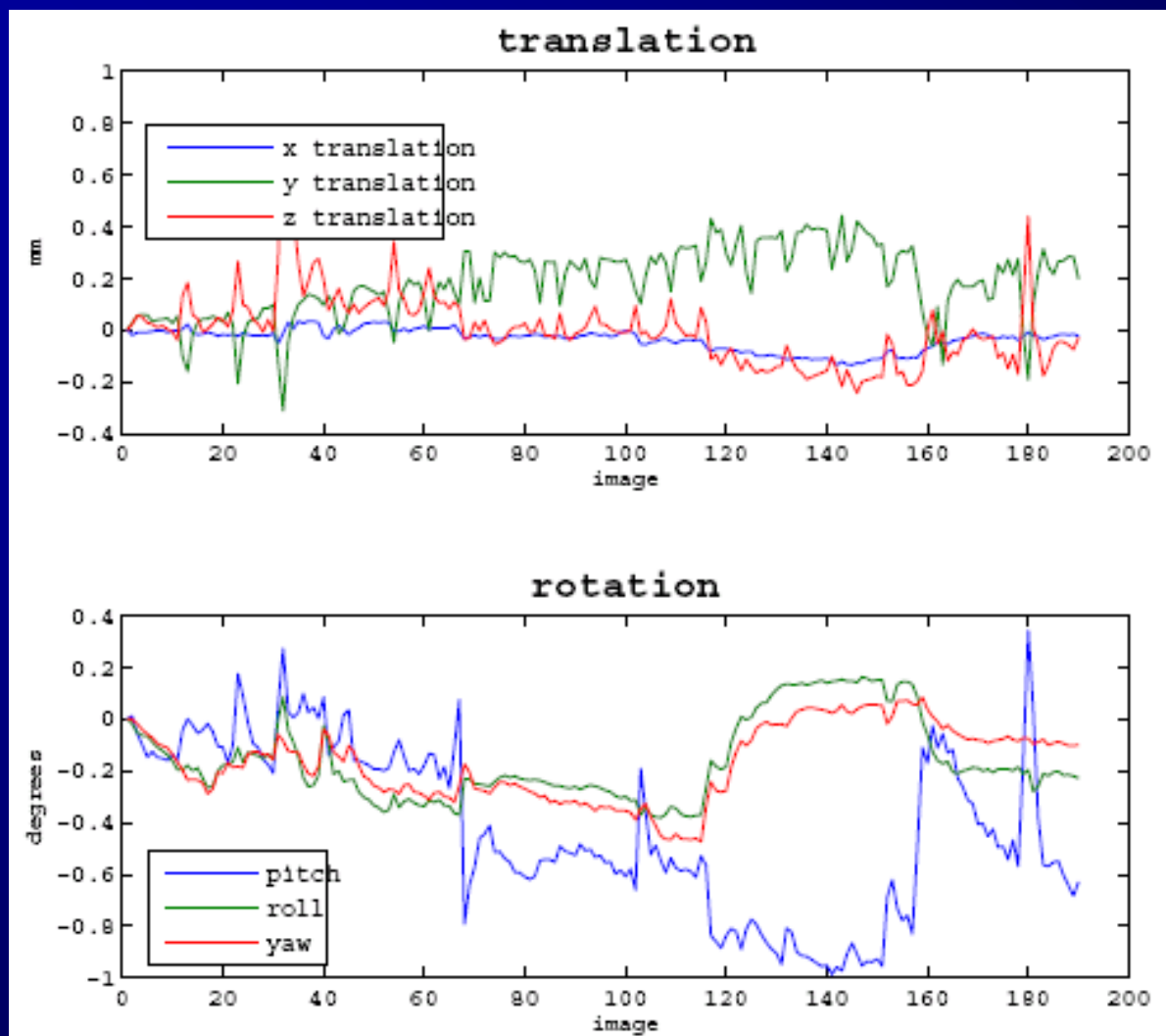
DPARSF Basic Edition's procedure

- Convert DICOM files to NIFTI images
- Remove First 10 Time Points
- Slice Timing
- ➔ ● Realign
- Normalize
- Smooth (optional)
- Detrend (optional)
- Nuisance covariates regression
- Calculate ALFF and fALFF
- Filter
- Calculate ReHo (without smooth in preprocessing)
- Calculate Functional Connectivity



Realign

Why?



DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition

DPARSF

Working Directory: ...

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #: Starting Directory Name:



Realign

Check head motion:

{WorkingDir}\RealignParameter\Sub_xxx:

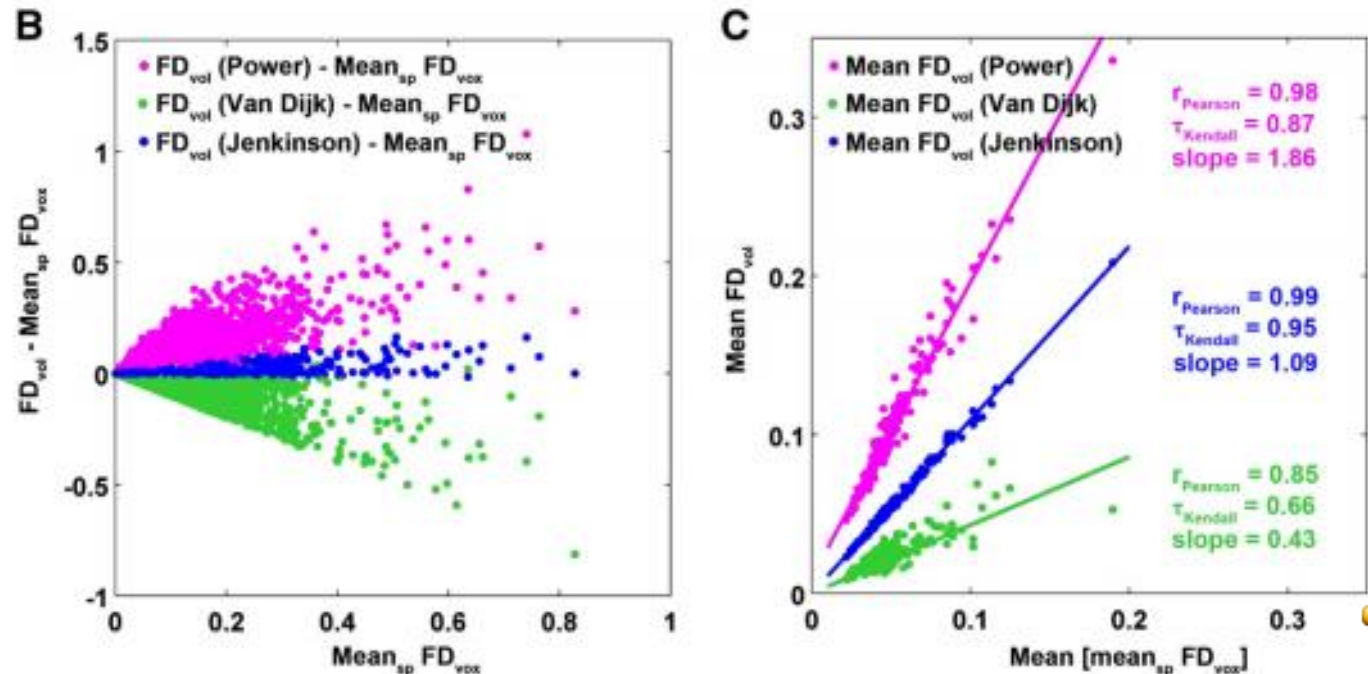
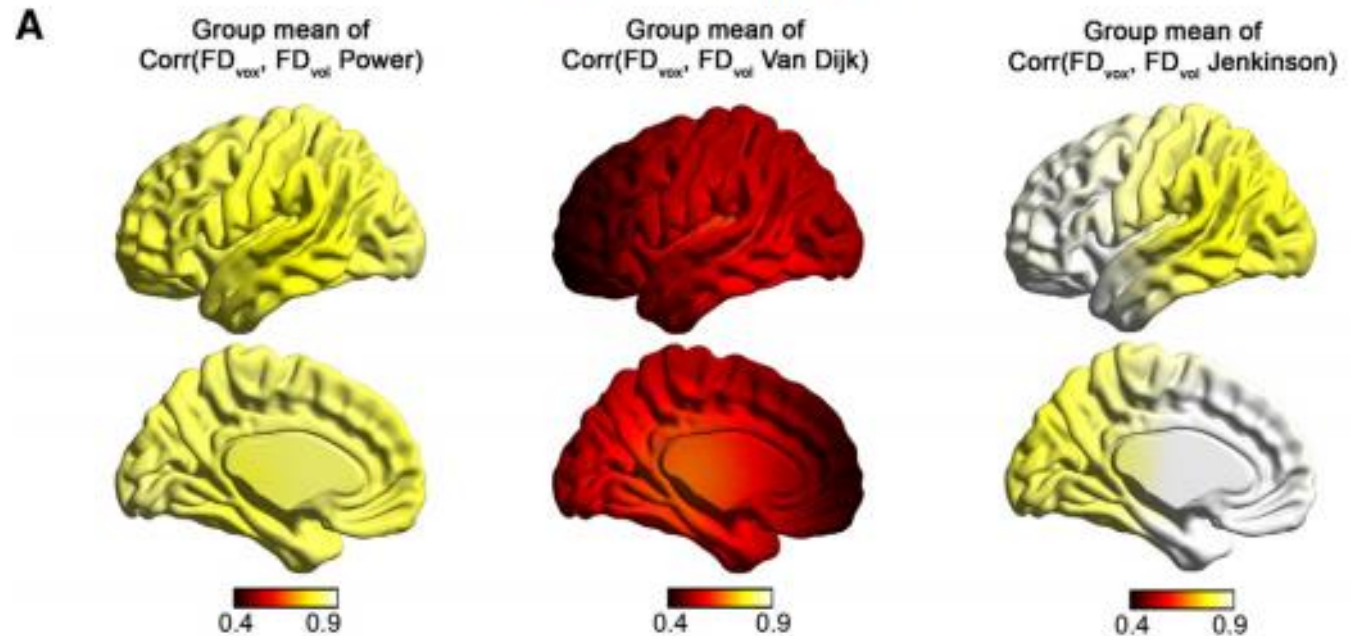
rp_*.txt: realign parameters

FD_Power_*.txt: Frame-wise Displacement (Power et al., 2012)

FD_VanDijk_*.txt: Relative Displacement (Van Dijk et al., 2012)

FD_Jenkinson_*.txt: Relative RMS (Jenkinson et al., 2002)





(Yan et al.,
Neuroimage
2013a)

Check

{Worki

Exclud

**Excluding Criteria: 2.5mm and 2.5 degree in max head motion
None**

**Excluding Criteria: 2.0mm and 2.0 degree in max head motion
Sub_013**

**Excluding Criteria: 1.5mm and 1.5 degree in max head motion
Sub_013**

**Excluding Criteria: 1.0mm and 1.0 degree in max head motion
Sub_007
Sub_012
Sub_013
Sub_017
Sub_018**

Realign

Check head motion:

HeadMotion.csv: head motion characteristics for each subject (e.g., max or mean motion, mean FD, # or % of FD>0.2)

Threshold:

Group mean (mean FD) + 2 * Group SD (mean FD)

Yan et al., 2013b, Neuroimage; Di Martino, 2013, Mol Psychiatry

Preprocessing and R-fMRI measures Calculation

Voxel-Specific Head Motion Calculation

(Yan et al.,
Neuroimage
2013a)

DPARSFA

Data Processing Assistant for Resting-State fMRI

Advanced Edition **DPARSFA**

Working Directory: ...

Participants:

- Sub_001
- Sub_002
- Sub_003
- Sub_004
- Sub_005
- Sub_006

Time Points:

TR (s):

Calculate in Ori... ☒ EPI DICOM to NIFTI ☒ Remove First Time Points ☒ Slice Timing

Slice Number: Slice Order: Reference Slice: ☒ Realign ☐ **Voxel-Specific Head Motion**

☒ Reorient Fun* ☒ T1 DICOM to NIFTI ☐ Crop T1 ☒ Reorient T1* ☒ T1 Coreg to Fun ☐ Reorient after Coreg*

☐ Segment ☒ New Segment + DARTEL Affine Regularisation in Segmentation: ☐ East Asian ☒ European

☒ Nuisance Covariates Regression Polynomial trend: Head Motion model: ☒ Rigid-body 6 ☐ Derivative 12

☐ Friston 24 ☐ Voxel-specific 12 ☐ Head motion scrubbing regressors ☐ Global signal

☒ White matter signal ☒ CSF signal ☐ Other covariates ☐ Filter (Hz): ~

☐ Normalize Bounding Box: Voxel Size:

☐ Normalize by using EPI templates ☐ Normalize by using T1 image unified segmentation ☒ Normalize by DARTEL

☐ Smooth ☐ Smooth by DARTEL FWHM:

☒ Default mask ☐ No mask ☐ User-defined mask ... ☒ Warp Masks into Individual Space


☐ Detrend ☒ ALFF+fALFF Band (Hz): ~ ☒ Filter ☐ Nuisance Covariates Regression

☐ Scrubbing ☒ ReHo Cluster: ☐ 7 ☐ 19 ☒ 27 voxels ☐ Smooth ReHo ☒ Degree Centrality

☒ Functional Connectivity ☒ Extract ROI time courses ☐ Define ROI Interactively* ☐ CNAS

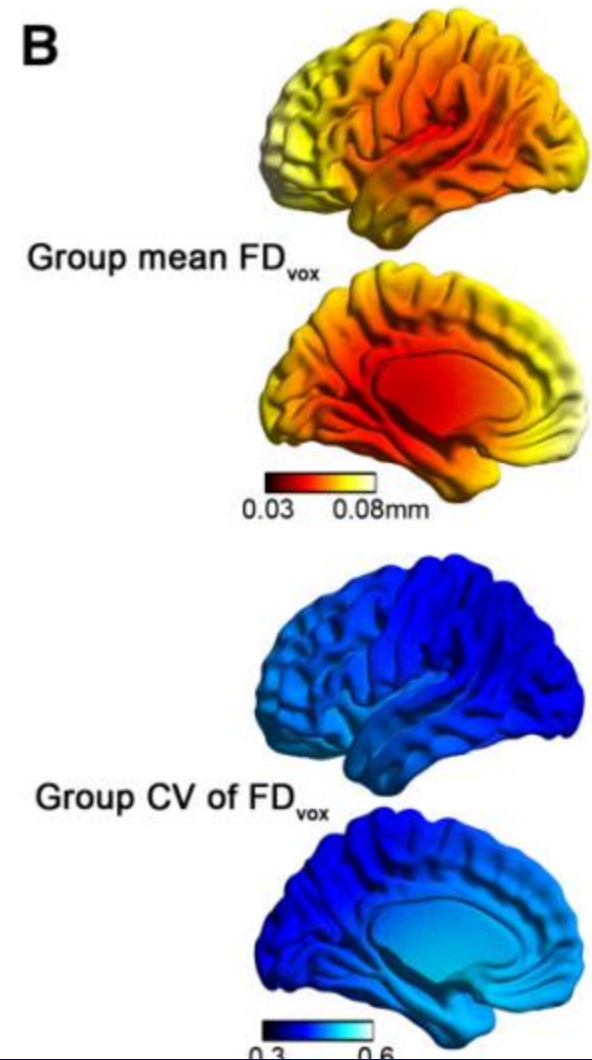
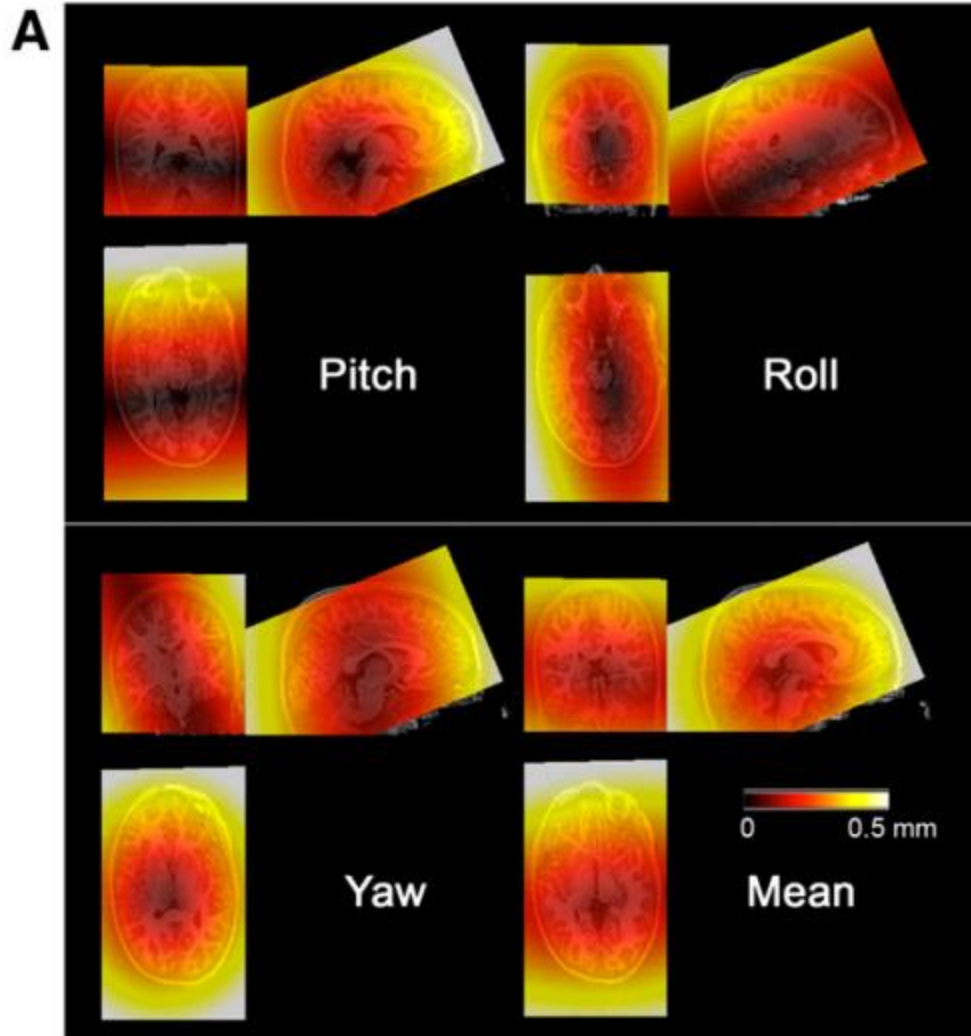
☐ Normalize to Symmetric Template ☐ VMHC ☒ Normalize Derivatives ☒ Smooth Derivatives

Parallel Workers #: Functional Sessions #: Starting Directory Name:

 28

Voxel-Specific Head

C.-G. Yan et al. / NeuroImage 76 (2013) 183–201



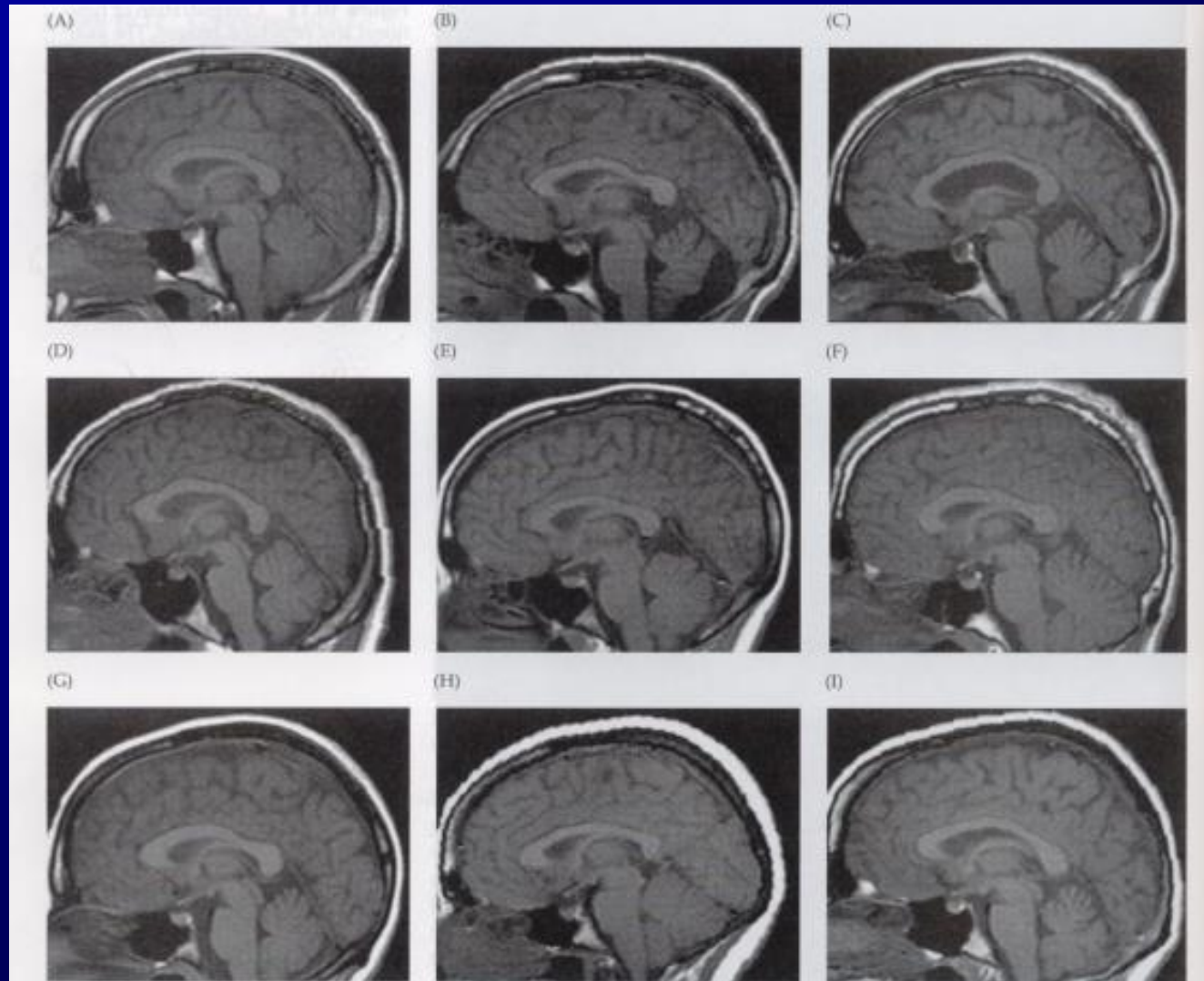
DPARSF Basic Edition's procedure

- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- ➔ ● **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



Normalize

Why?



Huettel et al.,
2004

Normalize

Methods:

- I. Normalize by using EPI templates**
- II. Normalize by using T1 image unified segmentation**
- III. Normalize by using DARTEL**
- IV. Normalize by using T1 templates (Not supported)**



Normalize

Methods:



I. Normalize by using EPI templates

II. Normalize by using T1 image unified segmentation

III. Normalize by using DARTEL

IV. Normalize by using T1 templates (Not supported)



DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition **DPARSF**

Working Directory: ...

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity


Parallel Workers #: Starting Directory Name:



Normalize

Methods:

I. Normalize by using EPI templates

 **II. Normalize by using T1 image unified segmentation**

III. Normalize by using DARTEL

IV. Normalize by using T1 templates (Not supported)



Normalize

II. Normalize by using T1 image unified segmentation

- ❖ Structural image was coregistered to the mean functional image after motion correction
- ❖ The transformed structural image was then segmented into gray matter, white matter, cerebrospinal fluid by using a unified segmentation algorithm
- ❖ Normalize: the motion corrected functional volumes were spatially normalized to the MNI space using the normalization parameters estimated during unified segmentation (*_seg_sn.mat)



DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition

DPARSF

Working Directory: ...

Participants:

Sub_001

Sub_002

Sub_003

Time Points:

TR (s):

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☐ EPI templates ☒ T1 image unified segmentation ☐ DARTEL

☐ T1 DICOM to NIFTI Affine Regularisation in Segmentation: ☐ East Asian ☒ European

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #: Starting Directory Name:



Normalize

Methods:

I. Normalize by using EPI templates

II. Normalize by using T1 image unified segmentation

III. Normalize by using DARTEL

IV. Normalize by using T1 templates (Not supported)



Normalize

III. Normalize by using DARTEL

- ❖ Structural image was coregistered to the mean functional image after motion correction
- ❖ The transformed structural image was then segmented into gray matter, white matter, cerebrospinal fluid by using a unified segmentation algorithm (New Segment)
- ❖ DARTEL: create template
- ❖ DARTEL: Normalize to MNI space. The motion corrected functional volumes were spatially normalized to the MNI space using the normalization parameters estimated in DARTEL.



DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition

DPARSF

Working Directory: ...

Participants:

Sub_001

Sub_002

Sub_003

Time Points:

TR (s):

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☐ EPI templates ☒ T1 image unified segmentation ☐ DARTEL

☐ T1 DICOM to NIFTI Affine Regularisation in Segmentation: ☐ East Asian ☒ European

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

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☒ Filter (Hz): ~

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☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #:

Starting Directory Name:



DPARSF

T1 Data should be arranged in T1Raw or T1Img (co*.img) directory!

Data Processing Assistant for Resting-State fMRI

Basic Edition

DPARSF

Working Directory: ...

Participants:

Sub_001

Sub_002

Sub_003

Time Points:
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☒ Slice Timing Slice Number: Slice Order: Reference Slice:

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Normalize by using: ☐ EPI templates ☒ T1 image unified segmentation ☐ DARTEL

☐ T1 DICOM to NIFTI Affine Regularisation in Segmentation: ☐ East Asian ☒ European

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

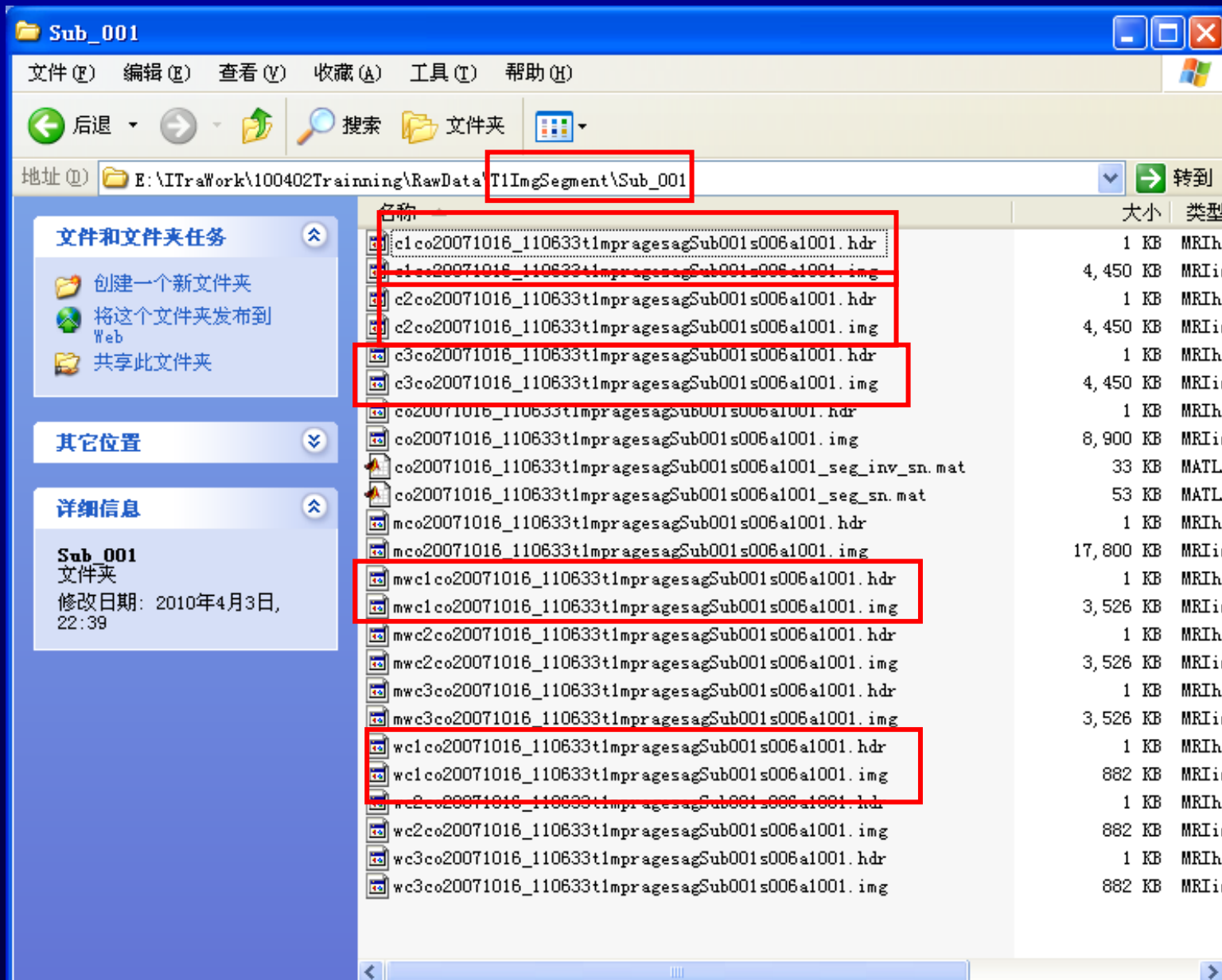
☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☐ Extract ROI time courses ☐ Functional Connectivity

Parallel Workers #: Starting Directory Name:

By-Product: VBM



GM in

original

space in

CSE in

original

space

GM in

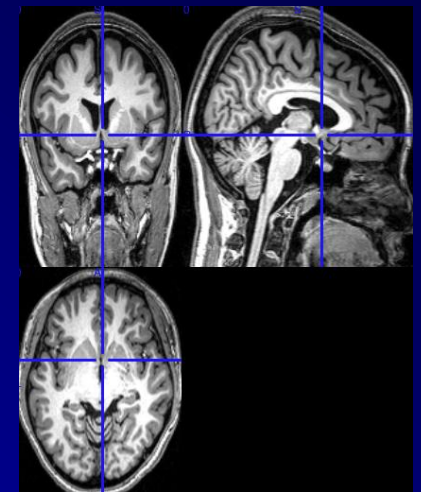
GM in

normalized

space

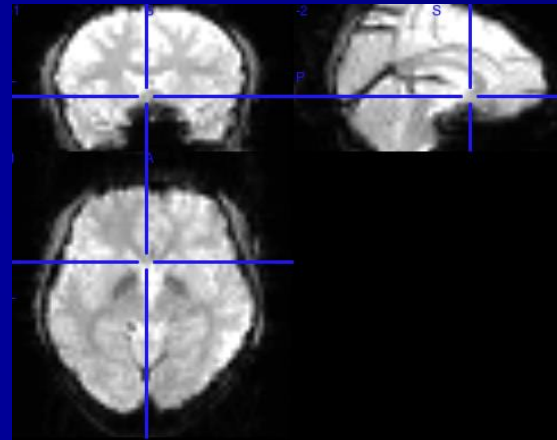
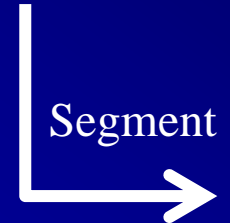


Bet & Coregistration

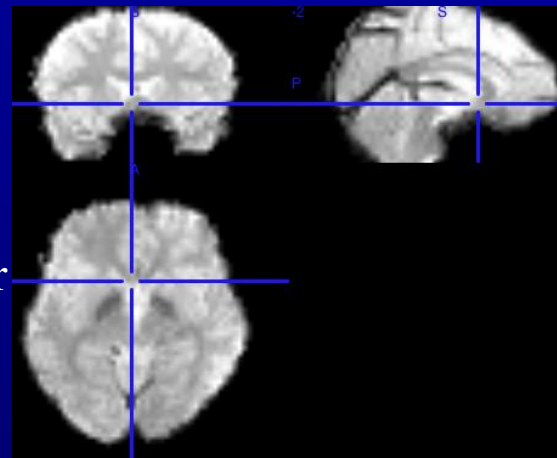


T1ImgCoreg/Sub_001

Segment



RealignParameter/Sub_001/mean*.nii

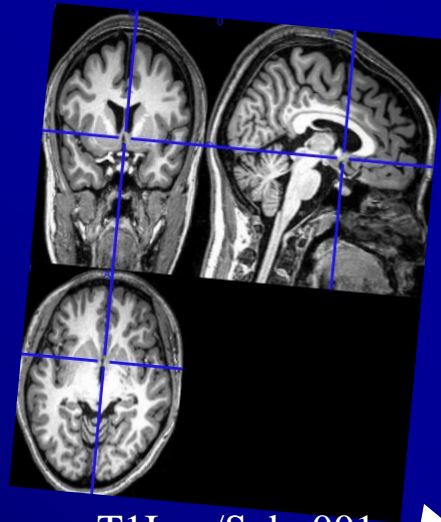


RealignParameter/Sub_001/Bet_mean*.nii

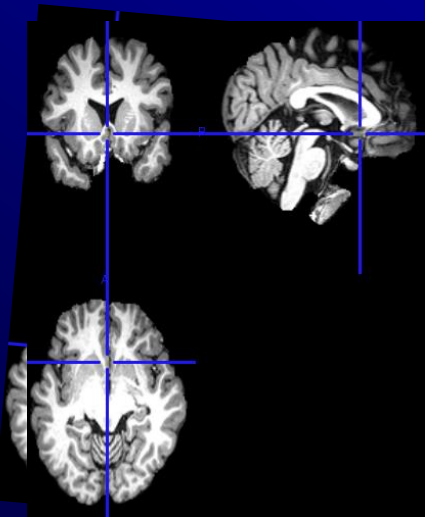
Apply



Coregister



T1Img/Sub_001

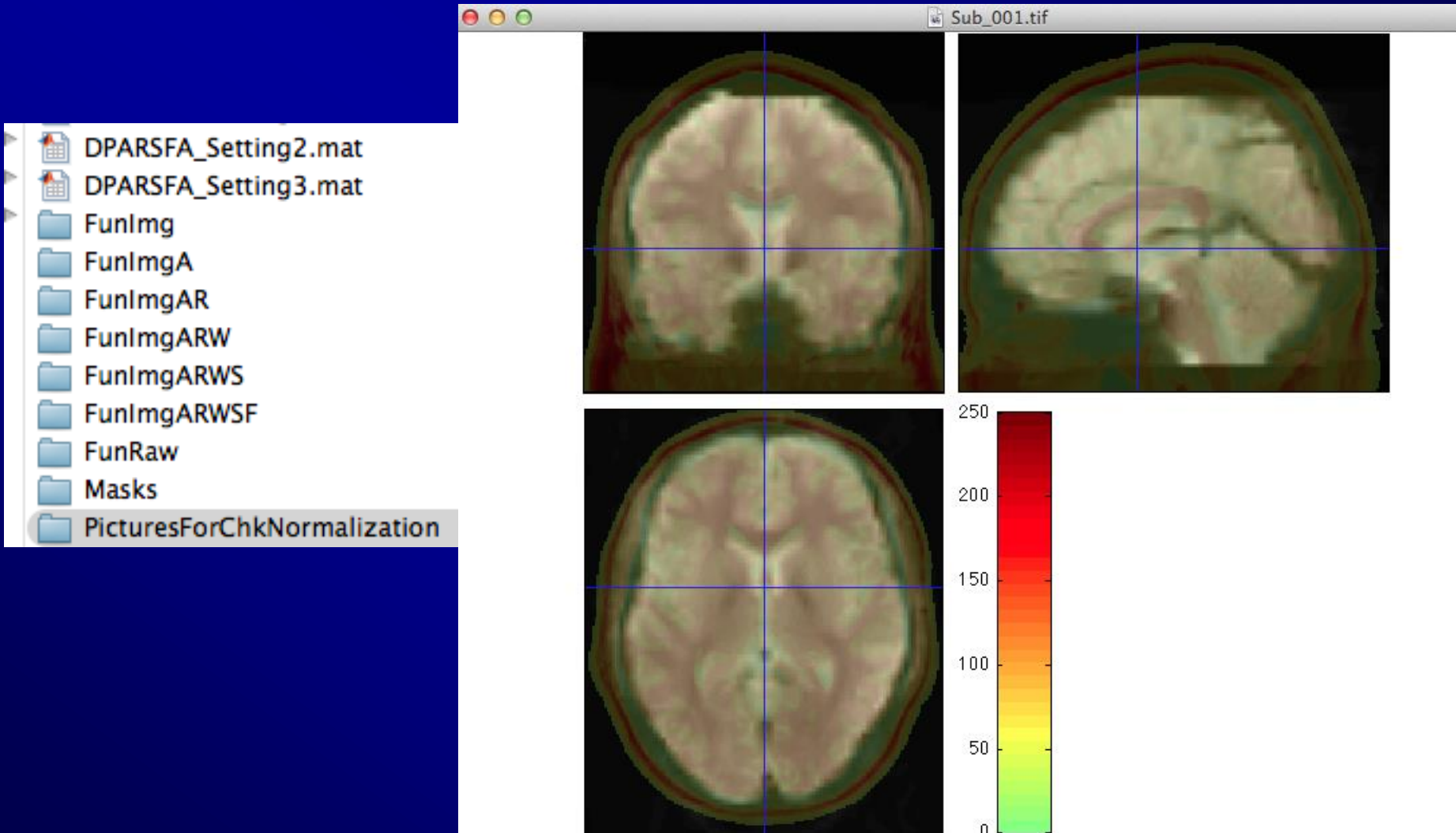


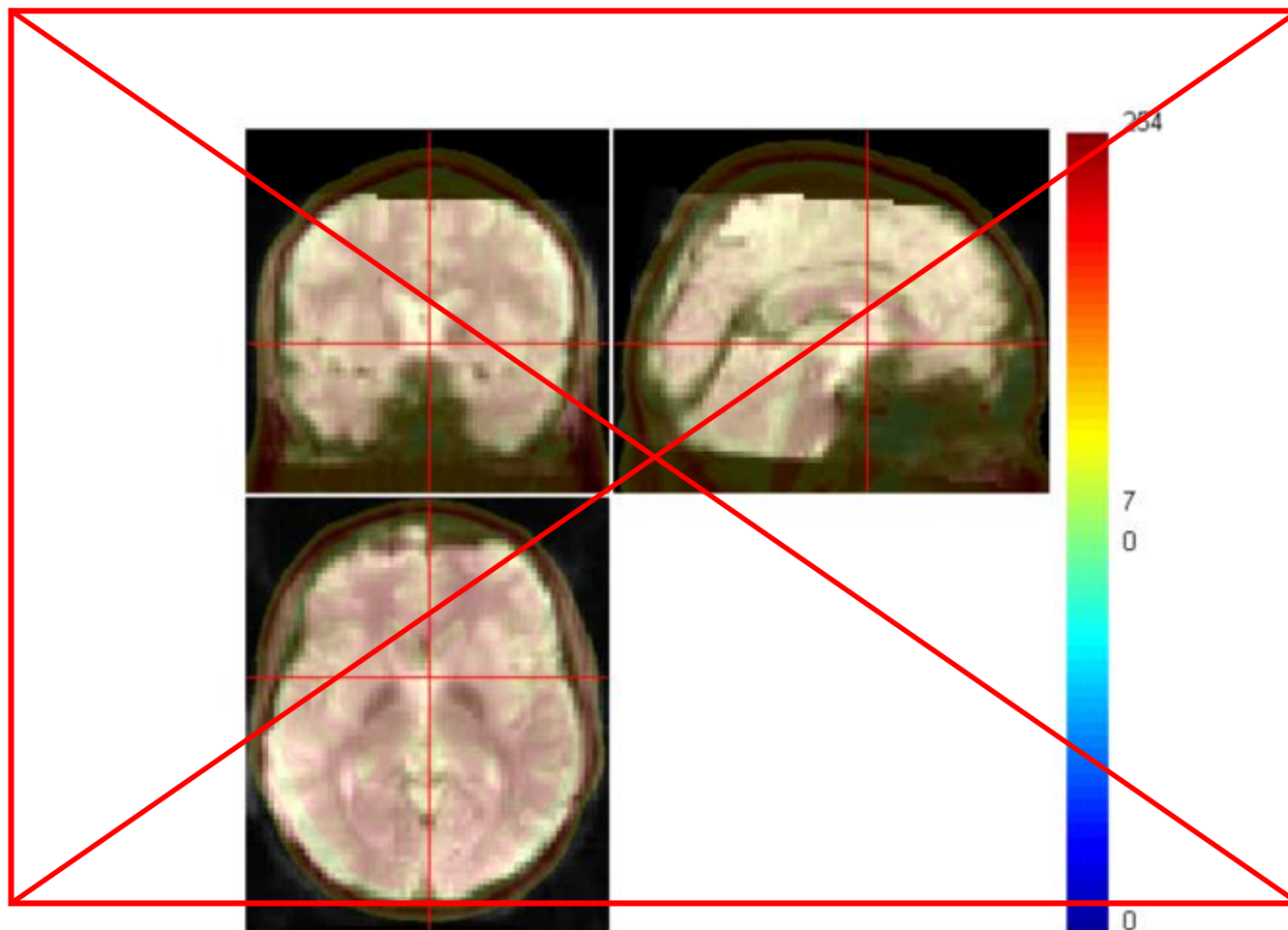
T1ImgBet/Sub_001

bet

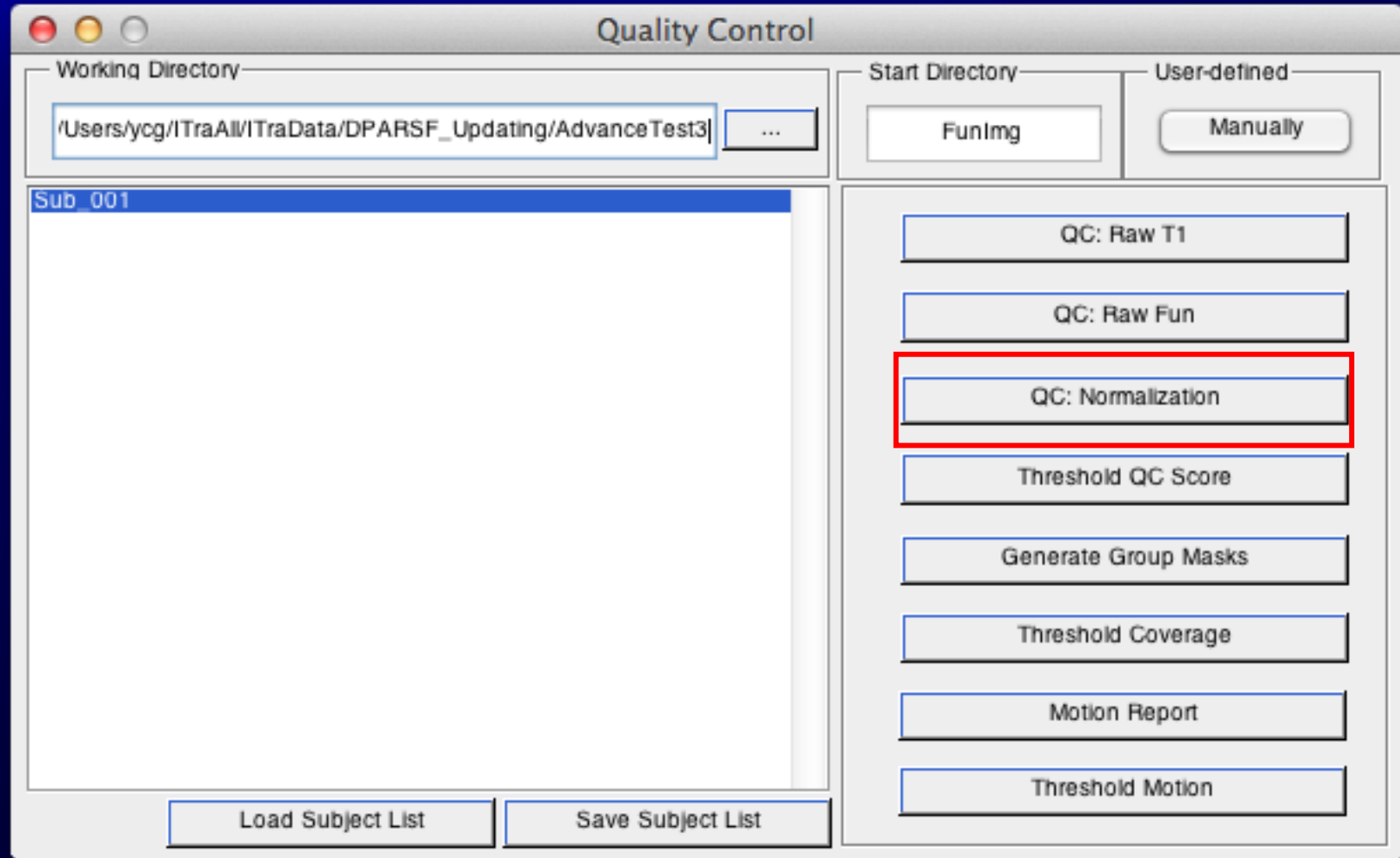


Quality Control





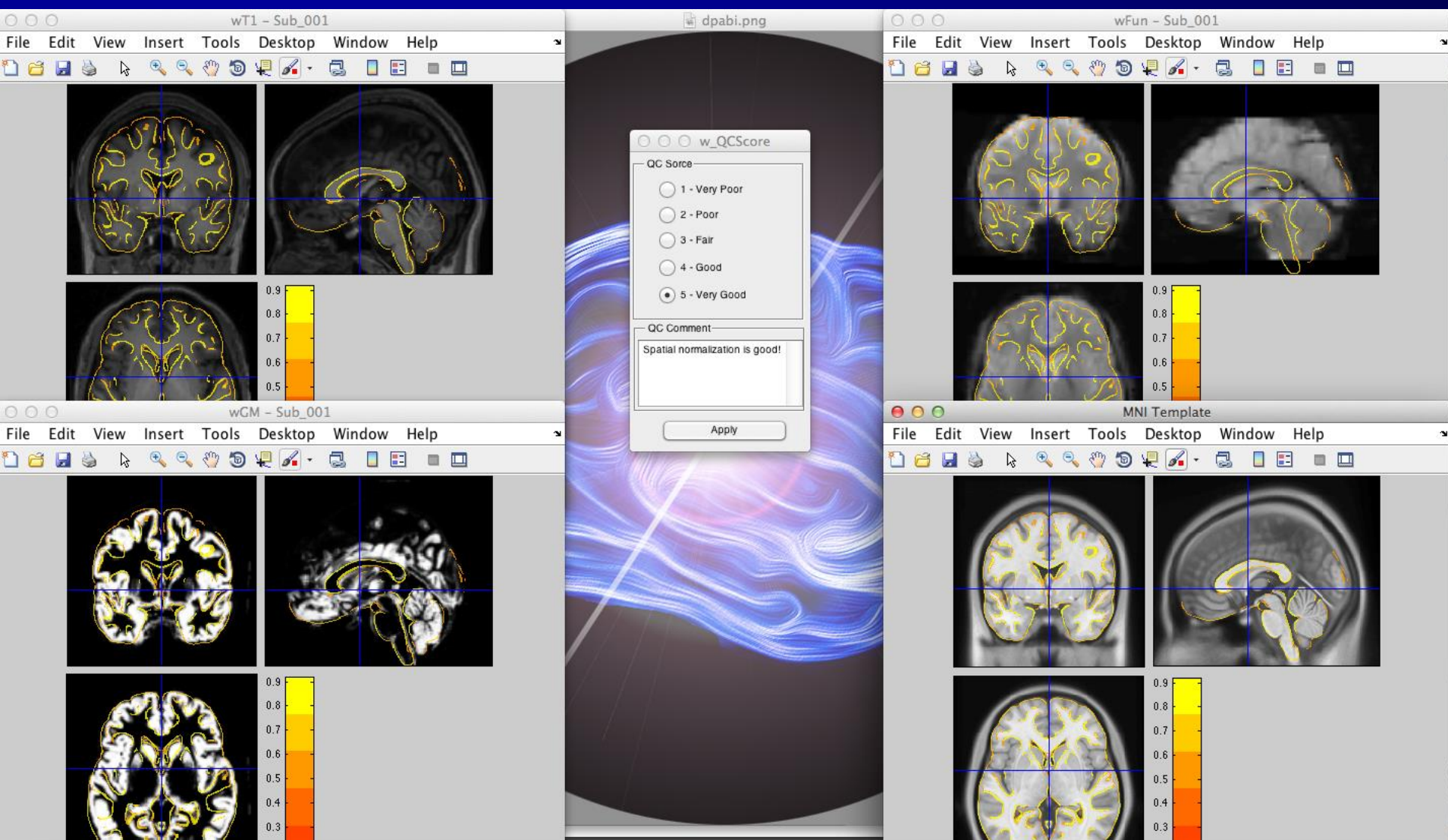
Quality Control



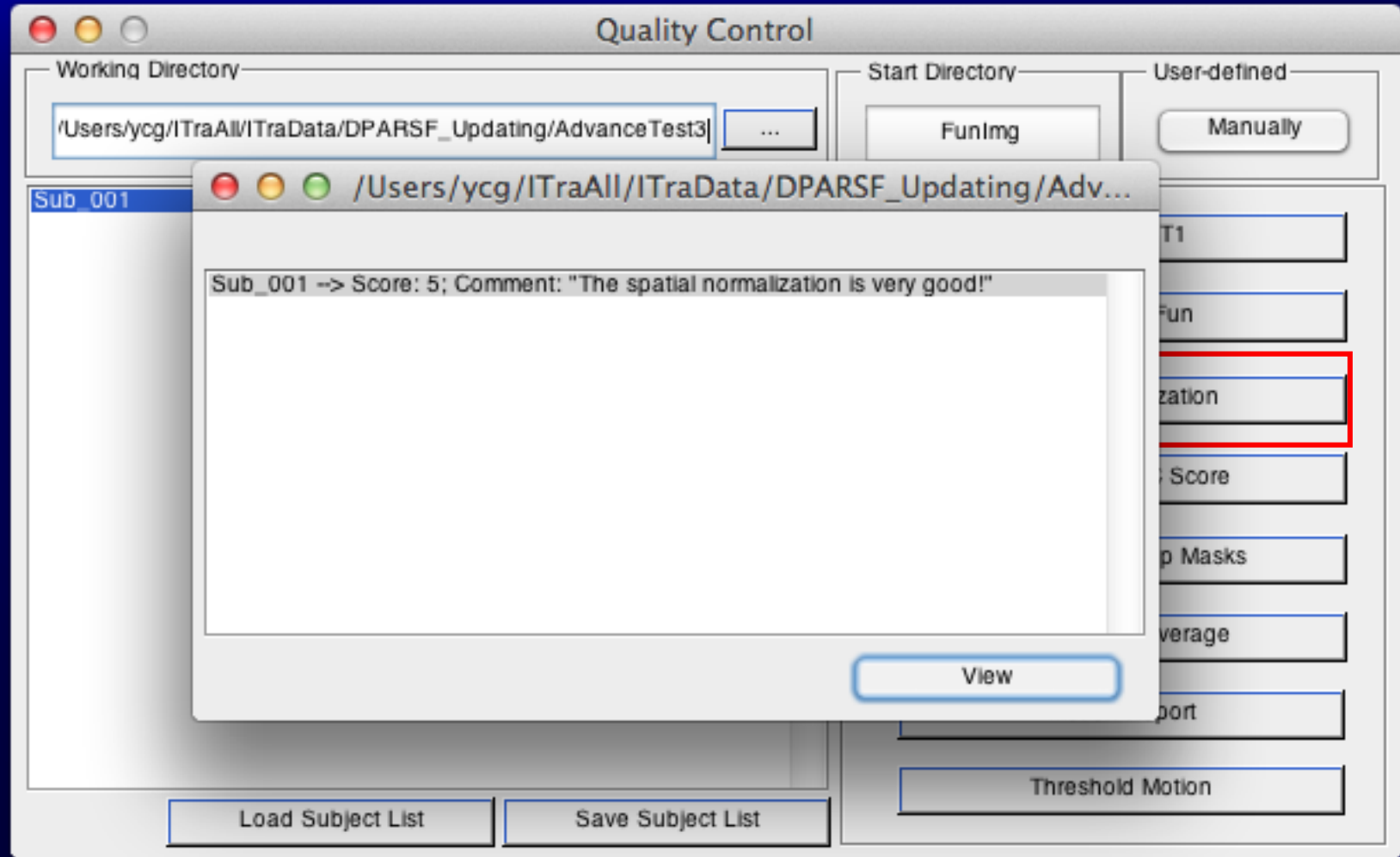
The image shows a software window titled "Quality Control". It has a standard macOS-style title bar with red, yellow, and green window control buttons. The interface is divided into several sections:

- Working Directory:** A text field containing the path `/Users/ycg/ITraAll/ITraData/DPARSF_Updating/AdvanceTest3` and a button with three dots to the right.
- Start Directory:** A button labeled "FunImg".
- User-defined:** A button labeled "Manually".
- Subject List:** A list box on the left containing the text "Sub_001".
- Buttons:** At the bottom of the list box are two buttons: "Load Subject List" and "Save Subject List".
- QC Actions:** A vertical stack of buttons on the right side:
 - QC: Raw T1
 - QC: Raw Fun
 - QC: Normalization** (highlighted with a red border)
 - Threshold QC Score
 - Generate Group Masks
 - Threshold Coverage
 - Motion Report
 - Threshold Motion

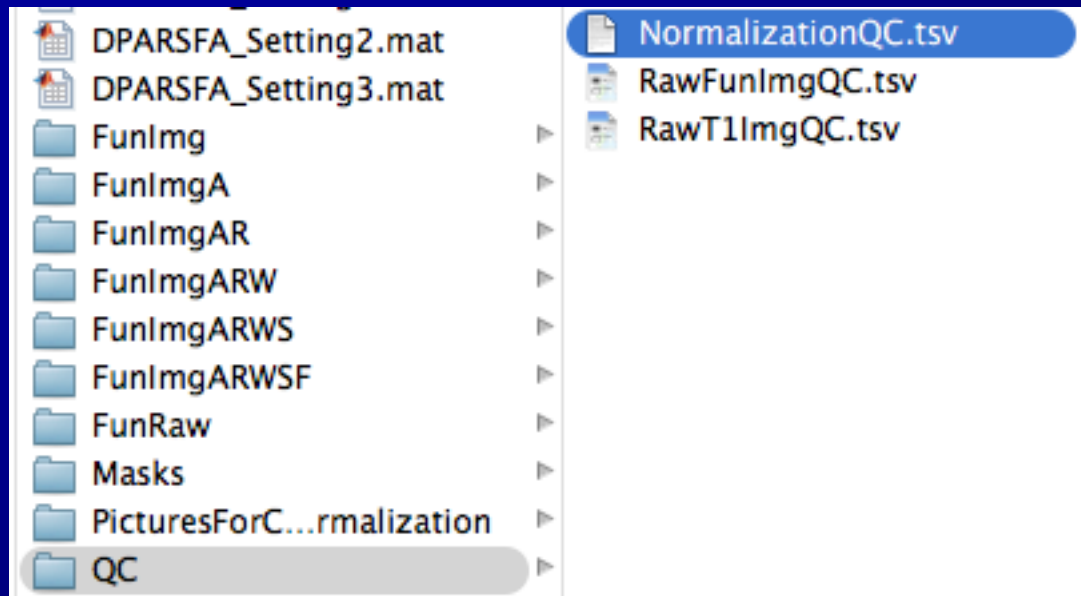
Quality Control



Quality Control



Quality Control



A	B	C	D	E
Subject ID	QC Score	QC Comment		
Sub_001	5	The spatial normalization is very good!		

DPARSF Basic Edition's procedure

- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- ➔ ● **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



Smooth

Why?

- **Reduce the effects of bad normalization**
- **Increase SNR**
- ...



DPARSF

ReHo: Do not
smooth before
calculation

Data Processing Assistant for Resting-State fMRI *Basic Edition* DPARSF

Working Directory: ...

Participants:

Sub_001

Sub_002

Sub_003

Time Points:

TR (s):

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~

DPARSF Basic Edition's procedure

- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- ➔ ● **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



DPARSF Basic Edition's procedure

- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- ➔ ● **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



Regress out nuisance Covariates

DPARSF

Polynomial trend

Based on rp*.txt

BrainMask_05_61x

73x61.img

WhiteMask_09_61x

73x61.img

CsfMask_07_61x73

x61.img

The screenshot shows the DPARSF software interface with the following settings:

- ☒ Smooth FWHM: [4 4 4] ☐ Detrend
- ☒ Regress out nuisance covariates: Polynomial trend: 2
- ☒ Friston 24 head motion parameters ☐ Global mean signal
- ☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates
- ☒ Default mask ☐ No mask ☐ User-defined mask Use Default Mask ...
- ☒ ALFF ☒ fALFF Band (Hz): 0.01 ~ 0.1
- ☒ Filter (Hz): 0.01 ~ 0.1
- ☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo
- ☐ Extract ROI time courses ☐ Functional Connectivity Define ROI
- Parallel Workers #: 0 Starting Directory Name: FunRaw
- Buttons: Help, Save, Load, Utilities, Quit, Run

DPARSF Basic Edition's procedure

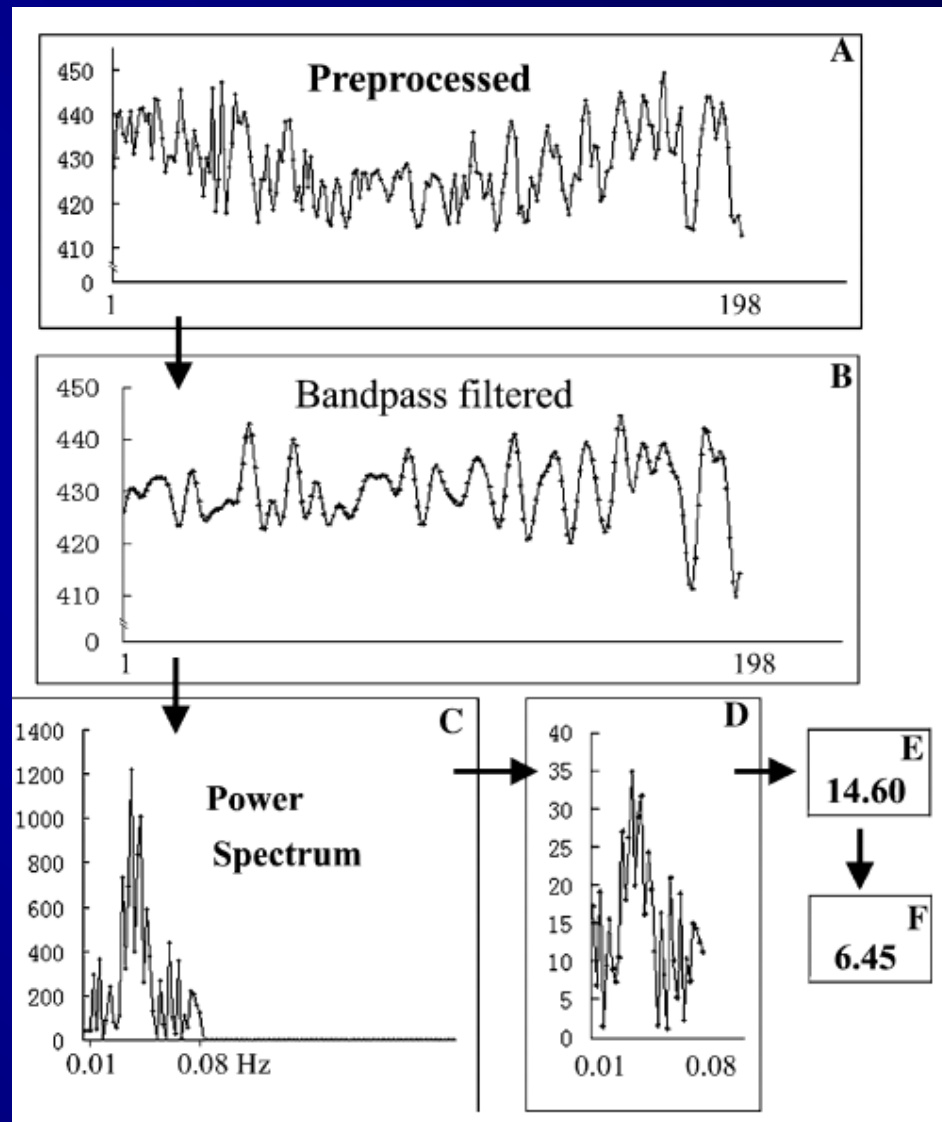
- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- ➔ ● **Calculate ALFF and fALFF**
- **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



ALFF

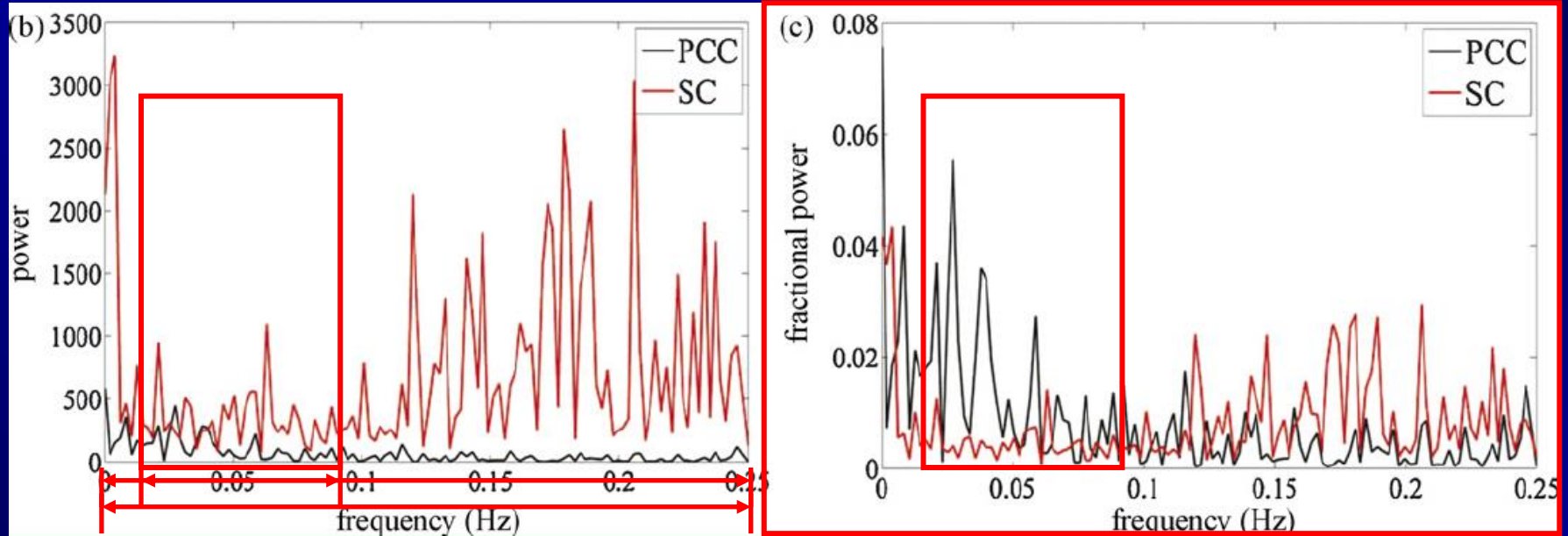
(Amplitude of Low Frequency Fluctuation)

Zang et al., 2007



fALFF

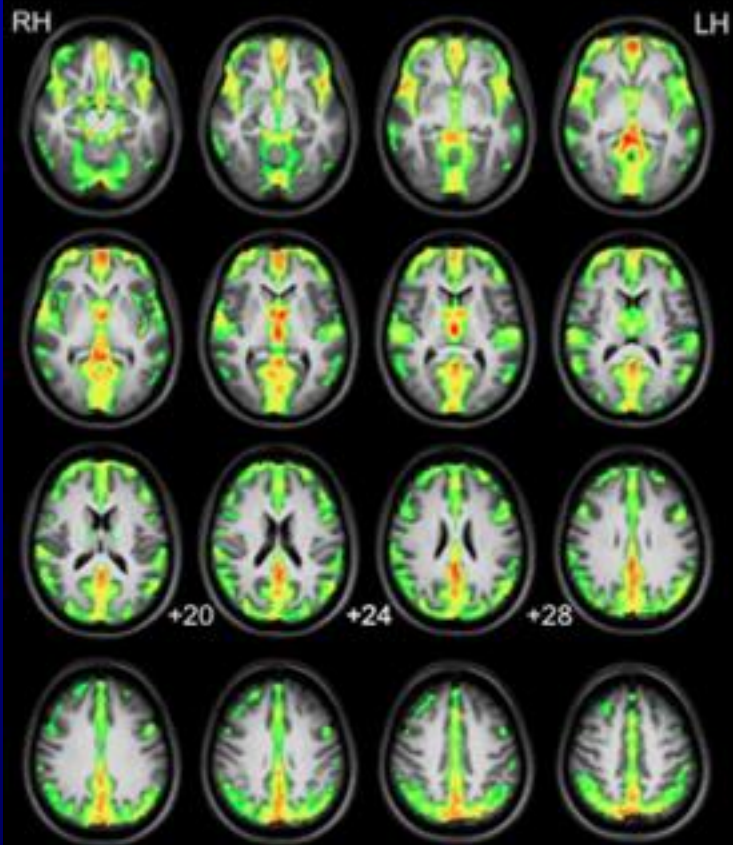
(fractional ALFF)



PCC: posterior cingulate cortex
SC: suprasellar cistern

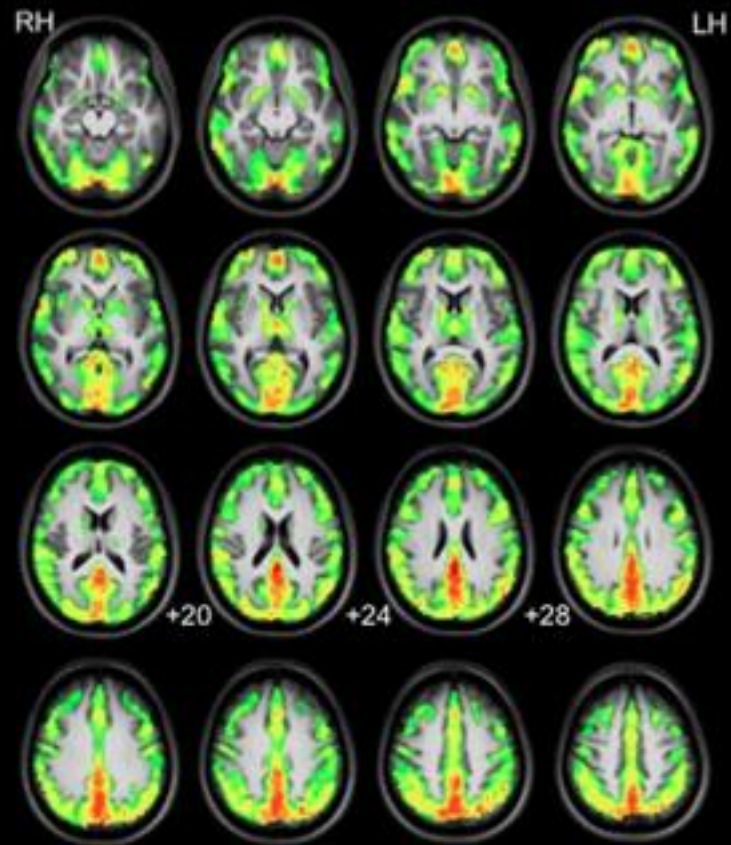
Zou et al., 2008

A ALFF



1.67 8.38
z-statistics

B fALFF



1.74 8.73
z-statistics

ALFF and fALFF

DPARSF

Please ensure the resolution of your own mask is the same as your functional data.

The screenshot shows the DPARSF software interface. Red boxes highlight the following settings:

- Masking options:** ☒ Default mask, ☐ No mask, ☐ User-defined mask. A button labeled "Use Default Mask" and an ellipsis "..." are also visible.
- Analysis methods:** ☒ ALFF and ☒ fALFF.
- Band (Hz):** Input fields for 0.01, a tilde symbol (~), and 0.1.
- Filter (Hz):** Input fields for 0.01, a tilde symbol (~), and 0.1.
- ReHo options:** ☐ ReHo, Cluster: ☐ 7 voxels, ☐ 19 voxels, ☒ 27 voxels, ☒ smReHo.
- Other options:** ☐ Extract ROI time courses, ☐ Functional Connectivity, and a "Define ROI" button.
- Parallel Workers #:** Input field with the value 0.
- Starting Directory Name:** Input field with the value FunRaw.
- Buttons:** Help, Save, Load, Utilities, Quit, and a large Run button.



DPARSF Basic Edition's procedure

- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- ➔ ● **Filter**
- **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



Filter

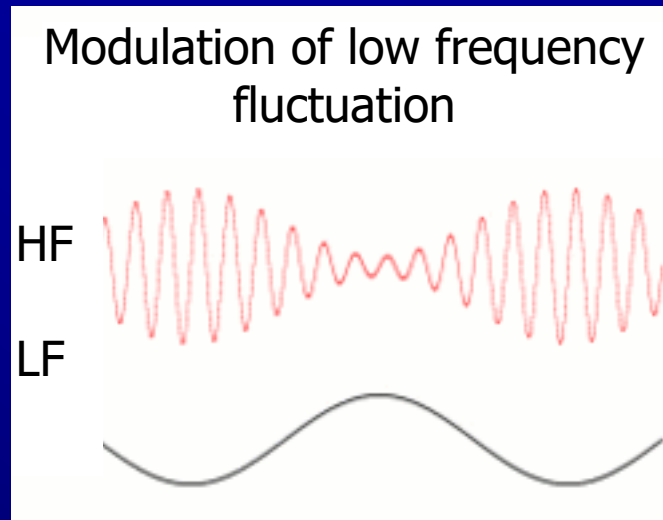
- Why?**
- **Low frequency (0.01–0.08 Hz) fluctuations (LFFs) of the resting-state fMRI signal were of physiological importance. (Biswal et al., 2005)**
 - **LFFs of resting-state fMRI signal were suggested to reflect spontaneous neuronal activity (Logothetis et al., 2001; Lu et al., 2007).**

- Biswal B, Yetkin FZ, Haughton VM, Hyde JS (1995) Functional connectivity in the motor cortex of resting human brain using echo-planar MRI. *Magn Reson Med* 34: 537–541.
- Logothetis NK, Pauls J, Augath M, Trinath T, Oeltermann A (2001) Neurophysiological investigation of the basis of the fMRI signal. *Nature* 412: 150–157.
- Lu H, Zuo Y, Gu H, Waltz JA, Zhan W, et al. (2007) Synchronized delta oscillations correlate with the resting-state functional MRI signal. *Proc Natl Acad Sci U S A* 104: 18265–18269.



Filter

**MoLFF: A theoretical framework
of the underlying “mechanisms”
for R-fMRI spontaneous fluctuations**



DPARSF

Data Processing Assistant for Resting-State fMRI

Basic Edition DPARSF

Working Directory: ...

Participants:

Sub_001

Sub_002

Sub_003

Time Points:

TR (s):

☒ EPI DICOM to NIFTI ☒ Remove First Time Points

☒ Slice Timing Slice Number: Slice Order: Reference Slice:

☒ Realign ☒ Normalize Bounding Box: Voxel Size:

Normalize by using: ☒ EPI templates ☐ T1 image unified segmentation ☐ DARTEL

☒ Smooth FWHM: ☐ Detrend

☒ Regress out nuisance covariates: Polynomial trend:

☒ Friston 24 head motion parameters ☐ Global mean signal

☒ White matter signal ☒ Cerebrospinal fluid signal ☐ Other covariates

☒ Default mask ☐ No mask ☐ User-defined mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~



DPARSF Basic Edition's procedure

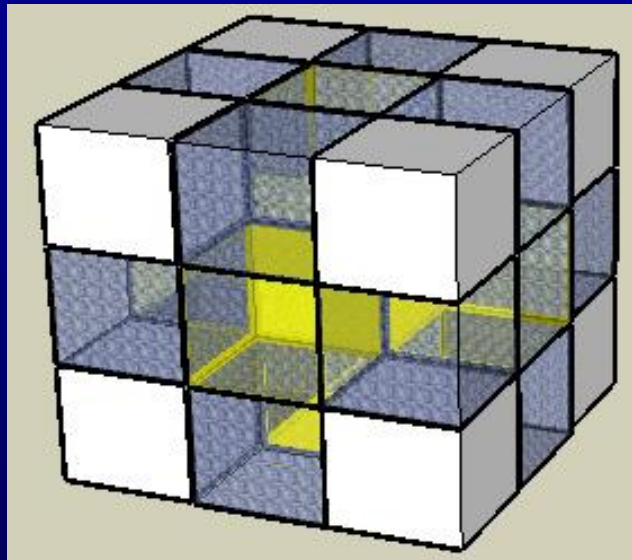
- **Convert DICOM files to NIFTI images**
- **Remove First 10 Time Points**
- **Slice Timing**
- **Realign**
- **Normalize**
- **Smooth (optional)**
- **Detrend (optional)**
- **Nuisance covariates regression**
- **Calculate ALFF and fALFF**
- **Filter**
- ➔ ● **Calculate ReHo (without smooth in preprocessing)**
- **Calculate Functional Connectivity**



ReHo

(Regional Homogeneity)

Note: Please do not smooth your data in preprocessing, just smooth your data after ReHo calculation.



$$W = \frac{\sum (R_i)^2 - n(\bar{R})^2}{\frac{1}{12}K^2(n^3 - n)}$$

Zang et al., 2004

ReHo

DPARSF

Please ensure the
Smoothing kernel
results. Task is the
same as the
step.

The screenshot shows the DPARSF ReHo analysis window. Red boxes highlight the following settings:

- Mask selection:** ☒ Default mask, ☐ No mask, ☐ User-defined mask. A button labeled "Use Default Mask" and an ellipsis button "..." are also visible.
- Frequency bands:** ☒ ALFF, ☒ fALFF. Band (Hz): 0.01 ~ 0.1.
- Filtering:** ☒ Filter (Hz): 0.01 ~ 0.1.
- ReHo settings:** ☐ ReHo, Cluster: ☐ 7 voxels, ☐ 19 voxels, ☒ 27 voxels, ☒ smReHo.
- Advanced options:** ☐ Extract ROI time courses, ☐ Functional Connectivity, and a "Define ROI" button.
- Execution settings:** Parallel Workers #: 0, Starting Directory Name: FunRaw.
- Buttons:** Help, Save, Load, Utilities, Quit, and a large "Run" button.



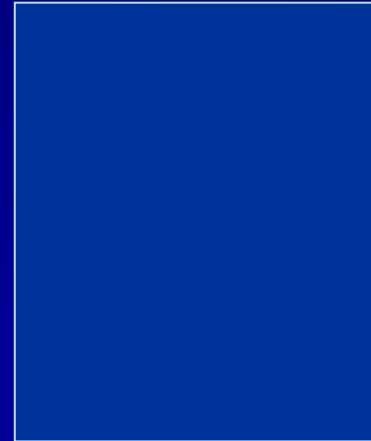
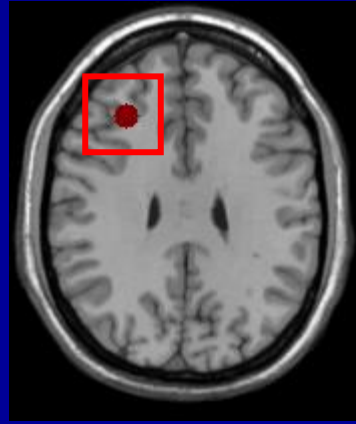
Outline

- Overview
- Data Preparation
- Preprocess
- ReHo, ALFF, fALFF Calculation
- ➔ • Functional Connectivity
- Utilities

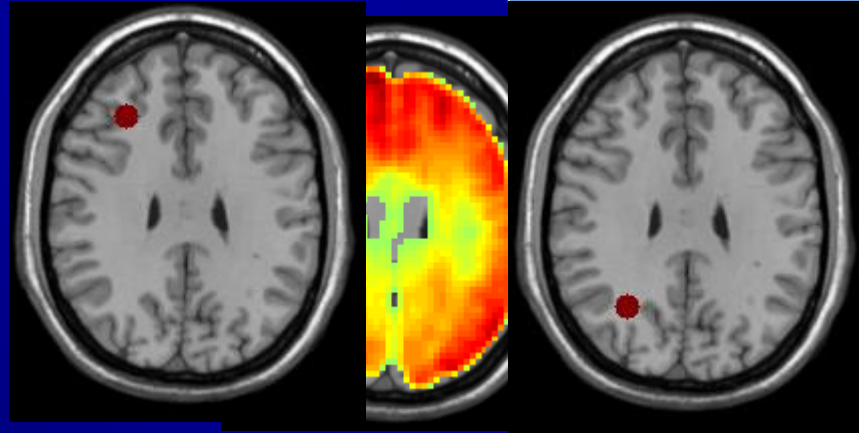


Functional Conncetivity

Voxel-wise



ROI-wise



$r=0.36$



Functional Connectivity

DPARSEF

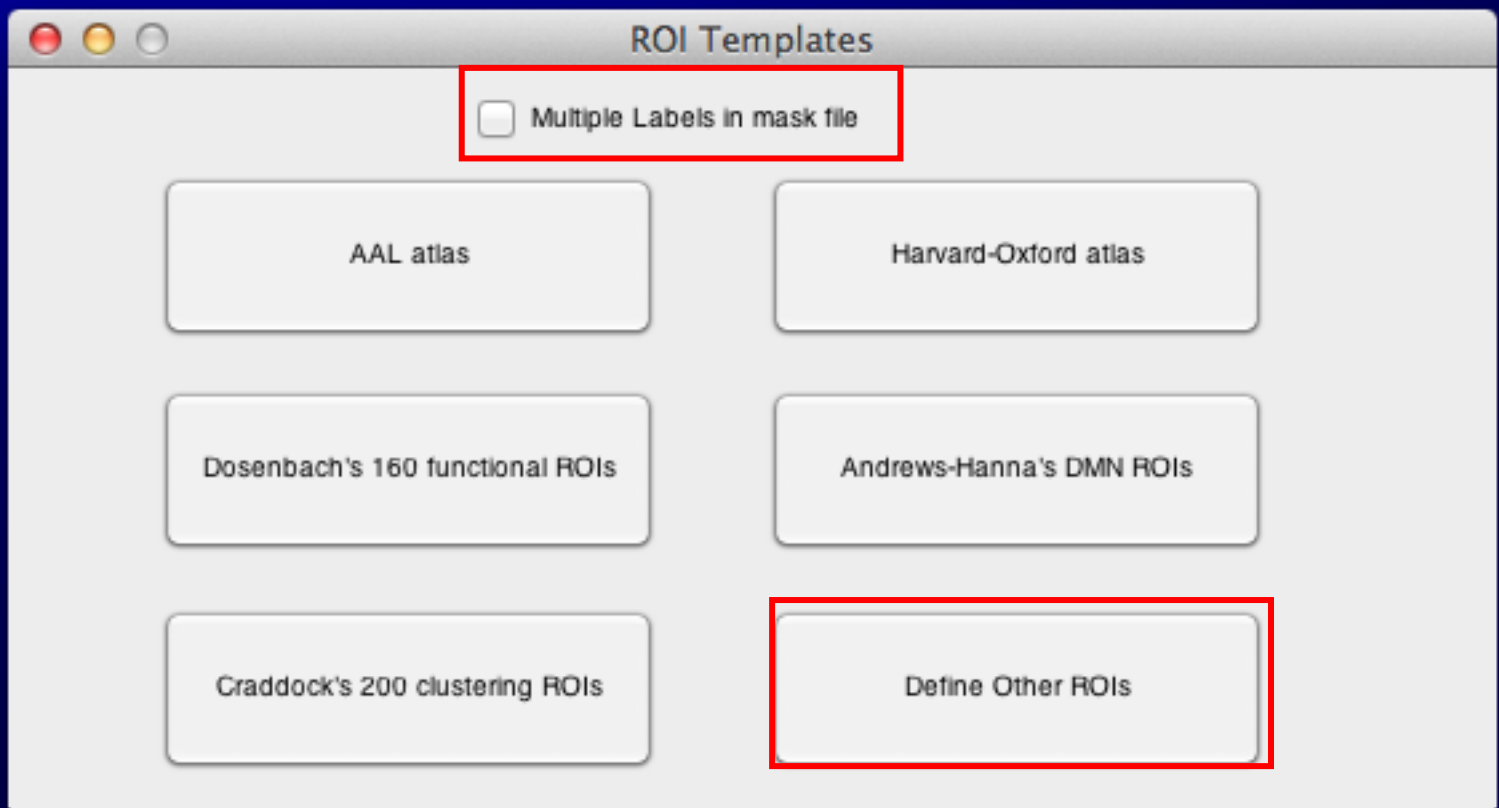
Please ensure the resolution of your own mask is the same as your functional data.

The screenshot shows the DPARSEF software interface with several settings highlighted by red boxes:

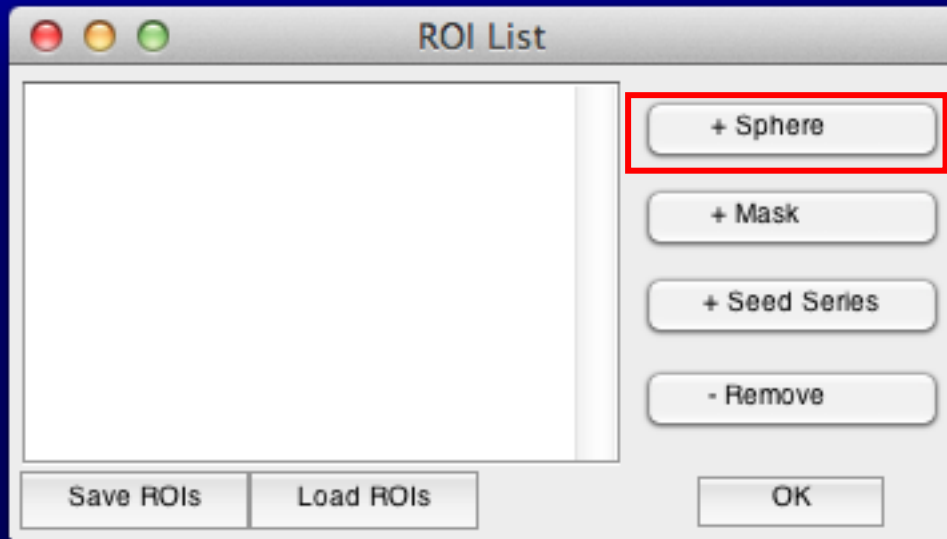
- Mask Selection:** A row of radio buttons includes "Default mask" (selected), "No mask", and "User-defined mask". A "Use Default Mask" button and an ellipsis menu are also present.
- Frequency Bands:** Checkboxes for "ALFF" and "fALFF" are checked. The "Band (Hz)" is set from 0.01 to 0.1 with a tilde symbol.
- Filtering:** A "Filter (Hz)" checkbox is checked, with a range from 0.01 to 0.1 Hz.
- ReHo Settings:** The "ReHo" checkbox is unchecked. The "Cluster" size is set to "27 voxels" (selected among 7, 19, and 27). The "smReHo" checkbox is checked.
- ROI Extraction:** The "Extract ROI time courses" checkbox is checked. The "Functional Connectivity" checkbox is unchecked. A "Define ROI" button is located to the right.
- Execution Settings:** "Parallel Workers #" is set to 0. "Starting Directory Name" is set to "FunRaw".
- Buttons:** At the bottom are buttons for "Help", "Save", "Load", "Utilities", "Quit", and a large "Run" button.



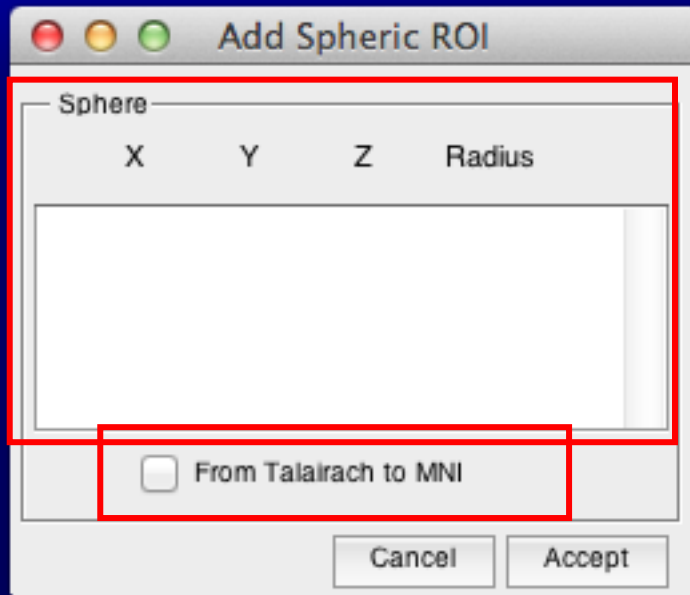
Functional Connectivity



Functional Connectivity



Functional Connectivity



Functional Connectivity

DPARSF

You will get the Voxel-wise
functional connectivity results
of each ROI in {working
directory}\Results\FC:

zROI1FCMap_Sub_001.img

zROI2FCMap_Sub_001.img

For ROI-wise results,
please see Part Utilities:

Extract ROI time courses.

The screenshot shows the DPARSF Functional Connectivity window. It features several settings: 'Default mask' is selected with a radio button; 'ALFF' and '1ALFF' are checked with checkboxes, with a 'Band (Hz)' range from 0.01 to 0.1; 'Filter (Hz)' is also checked with a range from 0.01 to 0.1; 'ReHo' is unchecked, with 'Cluster' options for 7, 19, and 27 voxels (27 is selected), and 'smReHo' is checked; 'Extract ROI time courses' is checked, while 'Functional Connectivity' is unchecked; a 'Define ROI' button is present; 'Parallel Workers #' is set to 0; 'Starting Directory Name' is 'FunRaw'; and a row of buttons at the bottom: 'Help', 'Save', 'Load', 'Utilities', 'Quit', and a large 'Run' button.



Outline

- Overview
- Data Preparation
- Preprocess
- ReHo, ALFF, fALFF Calculation
- Functional Connectivity
- Utilities



Extract ROI Signals

DPARSF

☒ Default mask ☐ No mask ☐ User-defined mask Use Default Mask ...

☒ ALFF ☒ fALFF Band (Hz): ~

☒ Filter (Hz): ~

☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo

☒ Extract ROI time courses ☐ Functional Connectivity Define ROI

Parallel Workers #: Starting Directory Name:

Help Save Load Utilities Quit Run



Extract ROI Signals

DPARSF

Results in {working
direcotry}\\Results\FunImgARWSC
F_ROISignals/:

The screenshot shows the DPARSF software interface with the following settings:

- ☒ Default mask ☐ No mask ☐ User-defined mask Use Default Mask ...
- ☒ ALFF ☒ fALFF Band (Hz): 0.01 ~ 0.1
- ☒ Filter (Hz): 0.01 ~ 0.1
- ☐ ReHo Cluster: ☐ 7 voxels ☐ 19 voxels ☒ 27 voxels ☒ smReHo
- ☒ Extract ROI time courses ☐ Functional Connectivity Define ROI
- Parallel Workers #: 0 Starting Directory Name: FunRaw
- Help Save Load Utilities Quit Run

ROISignals_Sub_001.txt: Time courses, each column represent a time course of one ROI.

ROICorrelation_Sub_001.txt: ROI-wise Functional Connectivity

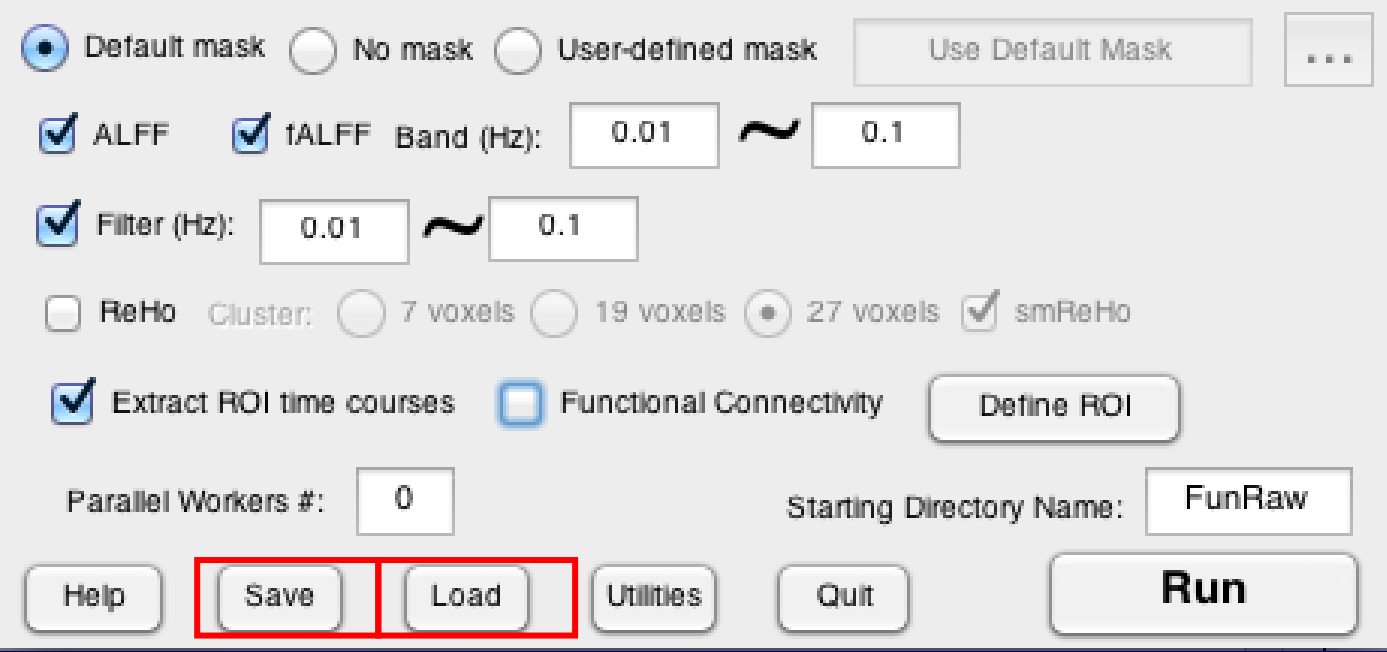


Save and Load Parameters

DPARSF

Save parameters to
*.mat

Load parameters
from *.mat



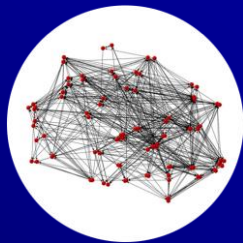
The screenshot shows the DPARSF software interface with the following settings and controls:

- Mask Selection:** ☒ Default mask, ☐ No mask, ☐ User-defined mask. Buttons: Use Default Mask, ...
- ALFF and fALFF:** ☒ ALFF, ☒ fALFF. Band (Hz): 0.01 ~ 0.1
- Filter:** ☒ Filter (Hz): 0.01 ~ 0.1
- ReHo and Cluster:** ☐ ReHo. Cluster: ☐ 7 voxels, ☐ 19 voxels, ☒ 27 voxels. ☒ smReHo
- ROI and Connectivity:** ☒ Extract ROI time courses, ☐ Functional Connectivity. Button: Define ROI
- Parallel Workers:** Parallel Workers #: 0
- Starting Directory:** Starting Directory Name: FunRaw
- Buttons:** Help, Save, Load, Utilities, Quit, Run



Further Help

Further questions:



The R-fMRI Network

<http://rfmri.org/dpabi>

<http://dpabi.org>

The R-fMRI Network

a network for supporting resting-state fMRI related studies.

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The R-fMRI Network (RFMRI.ORG)

The R-fMRI Network (RFMRI.ORG):

A network for supporting resting-state fMRI related studies!



Forum

[Propose research ideas](#)

You can propose your research ideas here. If you have an interesting idea that you would like to share with other researchers, or you are eager to see the results but lack enough time/resource to realize it, you can suggest your idea here. Researchers who are interested can pursue the idea, discuss it with you and others, and, ideally, conduct related studies. Researchers who follow-up ideas shared in this forum should acknowledge the proposer and cite this dated document when publishing or presenting their work.

[Discuss \(controversial\) issues](#)

You can discuss R-fMRI related issues here, especially controversial issues. We invite all interested researchers to provide their opinions on the issues, as an immediate, efficient, direct and "peer-viewed" way to reach some level of consensus.

[Request help for software usage](#)

If you encountered any technical problems/issues related to R-fMRI software (e.g., DPARSF, REST, C-PAC, SPM, ...), you can post your problem/issue including the error message here. A software team member or other experienced user may respond to help solve the problems/issues, which may also help other users.

[DPARSF/REST](#)

[SPM/SPM Extensions](#)

[C-PAC](#)

[GRETNA/BrainNet Viewer](#)

[CCS](#)

[GraphVar](#)

[AFNI/FSL/Freesurfer](#)

[Others](#)

[Share experiences](#)

You can share your experiences related to designing studies, performing experiments, analyzing data, writing papers, publishing articles or applying for grants. Your experiences may be helpful to other researchers, especially junior investigators.

[Report preliminary results](#)

If you would like to report your preliminary results online, to initiate discussion with other researchers, and keep a dated online document which other researcher can cite, you can post your proceeding report here.

[Initiate collaborations](#)

If you want to find collaborators who have the resources to help with your studies, please post information regarding the proposed collaboration here. We hope this forum will help to enhance collaborations among researchers, especially between those doing basic and methodological neuroscience research and those doing clinical studies (bench to bedside and vice-versa).

[Look for a job](#)

If you want to find a job, you can post your information here. Researchers who have a vacancy may contact you.

[Look for talent](#)

If you want to hire talented researchers to support your studies, you can post the job information here. Talented nodes may contact you if they are qualified and interested in your project.

[我想用中文提问 \(I want to post in Chinese\)](#)

采用我们的母语，能够进行迅捷有效的沟通。但是鉴于英文是科技通用语言，建议所有研究者采用英文发帖，做为训练自己英语的良机。如果你实在觉得英文无法表达你的思想，请在该论坛中采用美丽的中文提问。

The R-fMRI Network

a network for supporting resting-state fMRI related studies.

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Blogs

[+ Create new blog entry](#)

Yan's talk at Hangzhou Normal University

Submitted by [YAN Chao-Gan](#) on Thu, 07/31/2014 - 18:49

**R-fMRI spontaneous low frequency fluctuations: making measurements
"mechanisms"**

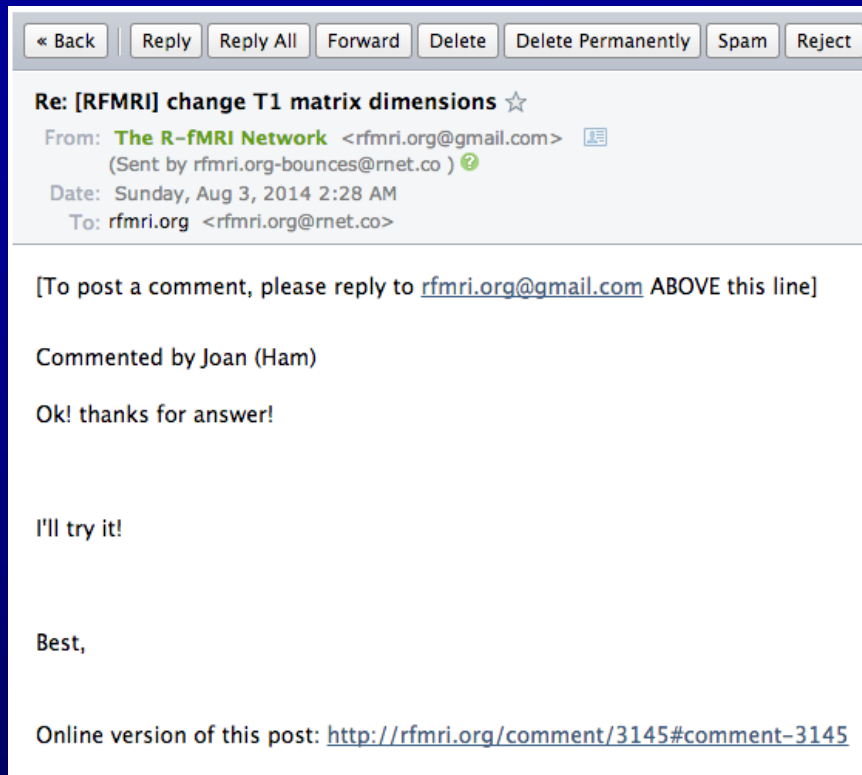
Speaker: Chao-Gan Yan, 严超赣, Ph.D.

Gray matter volume AAL regions

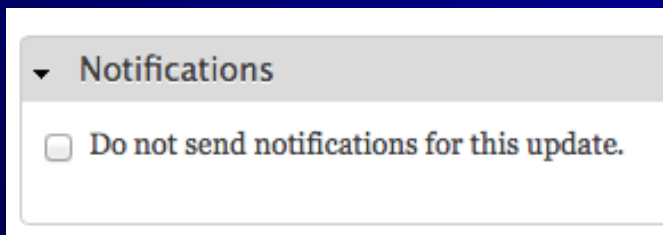
Submitted by [joana](#) on Sun, 07/06/2014 - 02:10

Dear all,

I would like to extract the gray matter volumes from the labels of the AAL
and Dosenback atlases included in DPARSF.



Send emails only to rfmri.org@gmail.com:
1) sending new email means you are posting your personal blogs, 2) replying email means you are posting comments to that topic/blog, 3) then all the other R-fMRI nodes will receive email updates of your posts.



The Next BIG Effort Here!

“Journal” of the R-fMRI Network (JRN):

*a free-submission, open-access, “peer viewed”
“Journal”*



Chao-Gan Yan, Ph.D.

Initiator
The R-fMRI Network
DPABI
DPARSF
JRN (planning)

Dear all,

We greatly appreciate that you are staying with us at the R-fMRI Network, as well as DPABI and DPARSF. These efforts are running of the researchers, by the researchers and for the researchers. Given the unfunded nature of these efforts, we sincerely hope you can help us — your kind contributions shall make these efforts not perish from the earth!

Your kind contributions, as small as

slow and inefficient "peer reviewed" journal publication system. Please stay tuned!

If you want to contribute \$100 or even more, we will greatly appreciate! Nonetheless, please keep in mind — many a little makes a mickle, ~~is it not~~ — your contributions, as small as \$1 per month, are extremely crucial for our efforts of the R-fMRI Network, DPABI, DPARSF, and more importantly, the planning effort of JRN!

\$1 per month, can help us to pay the web domains, empower the server, enhance the bandwidth, improve the website and software, and make our experience at the R-fMRI Network, as well as DPABI and DPARSF better!

The next big effort here is a free-submission, open-access, "peer reviewed" "Journal" of the R-fMRI Network (JRN). We would like to supplement the current

Thank you very much for your help!

P.S.: If you are not ready to contribute now but next time, pay some attention to (or even press) the following Google Ads will be helpful for our efforts as well!

Yours Sincerely,

YAN Chao-Guan

on behalf of
the RD Team

CONTRIBUTE

Many a little makes a mickle--聚沙成塔--Help us with an amount via PayPal

Q Have you heard of Android Wear?

☐ Yes ☐ No

Privacy Policy 1/6

GfK

DATA MODELING SOFTWARE

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>

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Neurology Q&A Review App

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ALIENWARE'S NEW

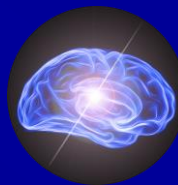
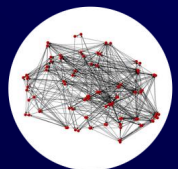
10x faster than



Xin-Di Wang
Programmer



Yu-Feng Zang
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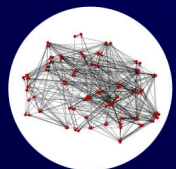
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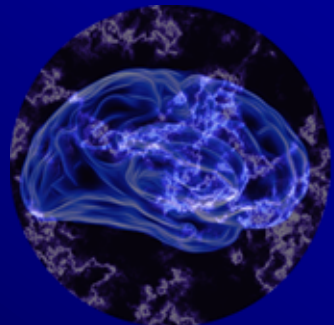
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