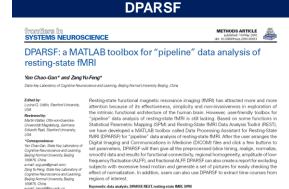
Data Processing of Resting-State fMRI: DPARSF

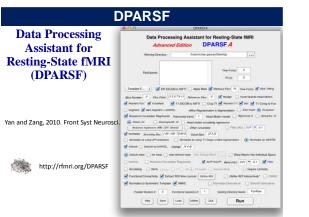
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Chao-Gan YAN, Ph.D. 严超赣 ycg.yan@gmail.com http://rfmri.org Institute of Psychology, Chinese Academy of Sciences

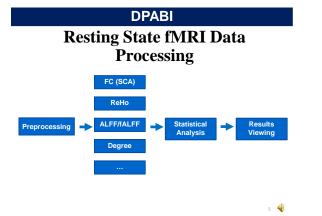


Keywords: data analysis, DPARSE REST, resting-state fMRI, SPM

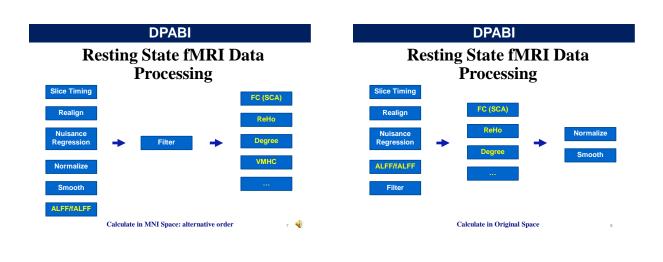
(Yan and Zang, 2010)

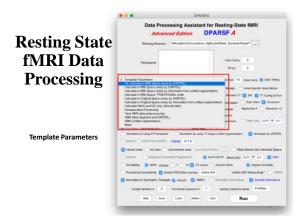


DPABI dpabi **DPABI:** a toolbox for **Data Processing &** Analysis of Brain ISF 4.2 Basic Editor Imaging License: GNU GPL VEM Quality Contro Programme Utilities http://rfmri.org/dpabi The R-MRI Maps Proje http://dpabi.org

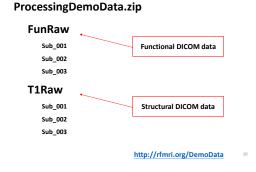


DPABI **Resting State fMRI Data** Processing Slice Timing Realign Nuisance ReHo Regression Normalize Degree Smooth Filter VMHC Detrend ALFF/fALFF Calculate in MNI Space: TRADITIONAL order 6 🍕



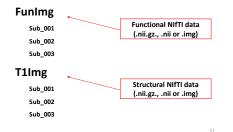


Data Organization



Data Organization

ProcessingDemoData.zip





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	Output- SubjectID/SeriesName
	Output Dir /Usersichao-ganyan/Desktop
	Anonymize DICOM files Sort

Data preparation

Arrange each subject's fMRI DICOM images in one directory, and then put them in "FunRaw" directory under the working directory.

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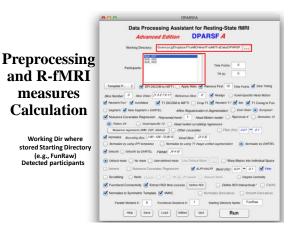
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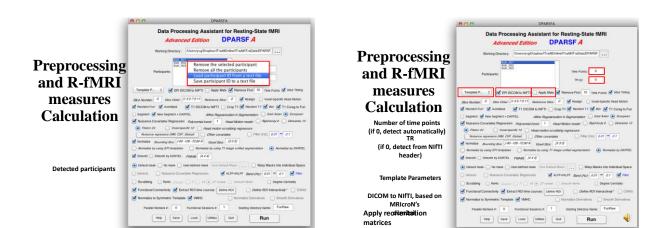
Data preparation

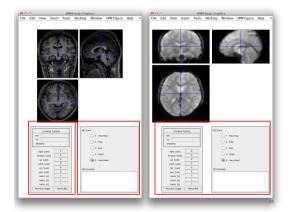
Arrange each subject's T1 DICOM images in one directory, and then put them in "T1Raw" directory under the working directory.

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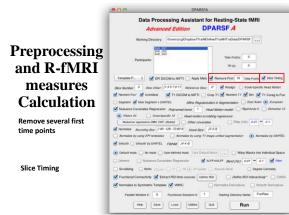
Preprocessing and R-fMRI measures Calculation

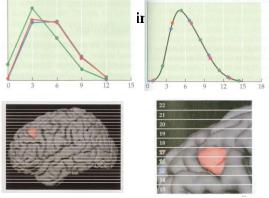
Apply reorientation matrices:

ReorientMats

Rename to:

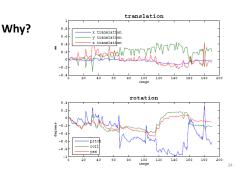
DownloadedReorientMats





Huettel et al., 2004

Realign



Preprocessing and R-fMRI measures Calculation

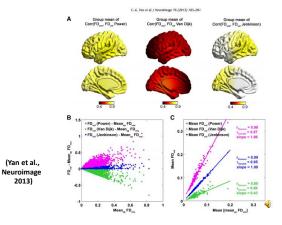
Total slice number (if 0, The slice order is then assumed as interleaved scanning: [1:2:SliceNumber,2:2:Slice Number]. The reference slice is set to the slice s



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)



 Realign

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

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

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

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 Excluding Criteria: 1.5mm and 1.0 degree in max head motion Sub_013

Realign

Check head motion:

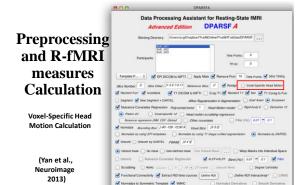
HeadMotion.csv: head motion characteristics for each subject (e.g., max or mean motion, mean FD, # or % of FD>0.2)

Threshold:

25 🌒

Group mean (mean FD) + 2 * Group SD (mean FD) Yan et al., in press Neuroimage; Di Martino, in press, Mol

Psychiatry



n # 0 Fi

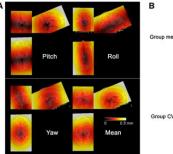
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Voxel-Specific Head Motion Calculation

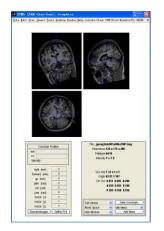
C.-G. Yan et al. / NeuroImage 76 (2013) 183-201



B Group mean FD 0 3 0 00mm Group CV of FD Preprocessing and R-fMRI measures Calculation Reorient Interactively

This step could improve the accuracy in coregistration, segmentation and normalization, especially when images had a bad initial orientation. Also can take as a QC step.

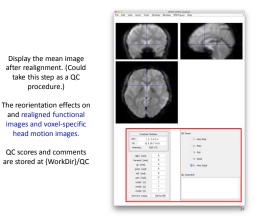
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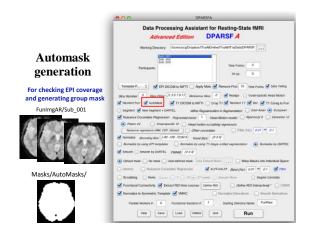


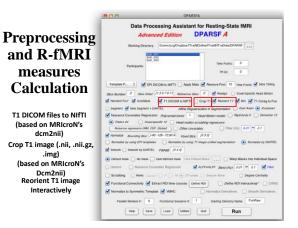
32 🍕



33 🍕





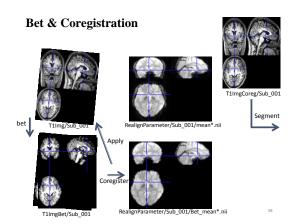




Workets #: 0 Functiona

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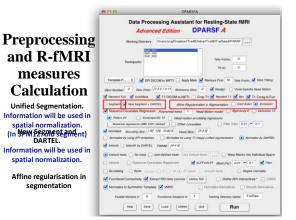




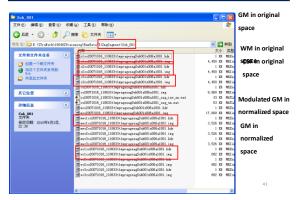
directly.

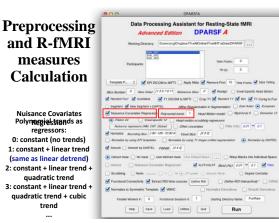
Coregister T1 image to functional space





By-Product: VBM

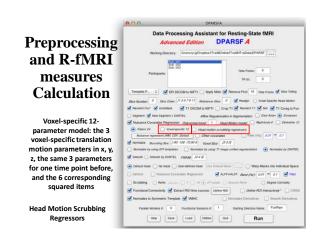


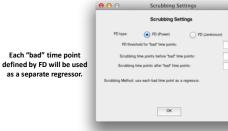


Preprocessing and R-fMRI measures Calculation

Head Motion regression model 6 head motion parameters Fistor 24-parameter motion parameters model: 6 head motion parameters, 6 head motion parameters one time point before, and the 12 corresponding squared items (Friston et al., 1996).







Scrubbing Settings	
Scrubbing Settings	
FD (Power) FD (Jenk	inson)
hold for "bad" time points:	0.5
time points before "bad" time points:	1
ime points after "bad" time points:	2
use each bad time point as a regressor.	
OK	

Table 3 Summary recommendations

- Summary recommendation
- Individual-level correction with the Fristme-24 model a recommended, Additionally, general-bed correction for mean FD is recommended, and removes the need for senabling.
 If group-level correction for mean FD is contraindicated or not parcific, then individual-level correction with senabling is recommended for PCC-FC, VMHC and Retis (not ALPF, AUF, DC^C).

Additional considerati

Yan et al., 2013, Neuroimage

- Additional considerations Inclusion of global signal regression at the individual-level produces robust re-ductions in the relationships between motion and R-MRI measures across par-ticipants particularly for measures without 2-standardization. The benefits of GSR need to be balanced against potential risks for introduction of artifact in the specific analyses employed. For studies limited to low motion datasets, the utility of higher-order Friston 24 model decreases. In this case, we recommend consideration of lower-arder model distributions. In this scale, we recommend consideration of lower-arder noted in starter/hwaite et al. (2013). AUFF apparent to be relatively insensitive to motion correction strategies in the present work. Prior work (Satterthwaite et al. 2012) has suggested greater sensitivity in higher motion populations, as such we recommend continued application of correction procedures at the present time. * Recommendations against scrubibing for AIFF and foLFF apply to commonly mployed TFI-based implementations (see Limitations and future directions section alternative).

employed PTI-based implementations (see Limitations and nuture discussor sectors for alternative). ⁸ Recommendations against scrubbing for DC were based on concerns regarding ins ability to compromise graph construction (see The ability of motion correction strate-gies to decreare residual reliationships between motion and R-MMI metrics at group-level scetion for demonstration).



Mask based on segmentation or SPM apriori

- ۶ CompCor or mean [note: for CompCor, detrend (demean) and variance normalization will be applied before PCA, according to Behzadi et al., 2007]
- Global Signal based on Automask

Preprocessing and R-fMRI measures Calculation

Nuisance Regressors (WM, CSF, Global)

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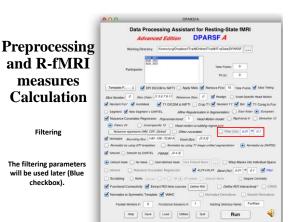
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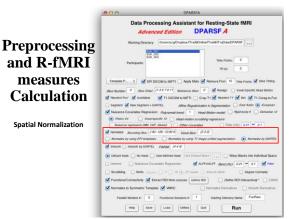
Advanced Edition

Preprocessing and R-fMRI measures Calculation

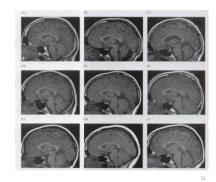
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Normalize



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 (hidden)

Normalize

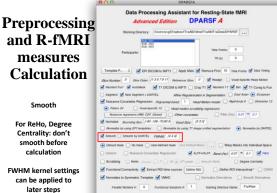
III. Normalize by using DARTEL

- 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

Huettel et al.,

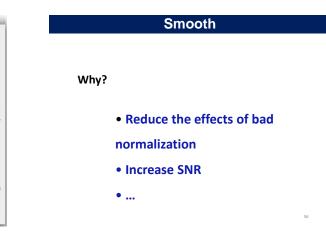
2004

DARTEL: Normalize to MNI space. The motion corrected functional volumes were spatially normalized to the MNI space using the normalization parameters estimated in DARTEL.



Hep Save Load Utilities Quit

Run

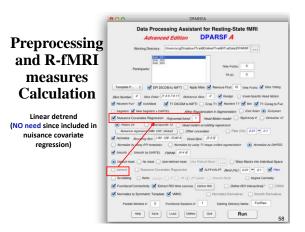


Mask

Default mask: SPM5 apriori mask (brainmask.nii) thresholded at 50%. User-defined mask

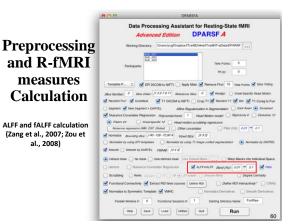
Warp the masks into individual space by the information of DARTEL or unified segmentation.

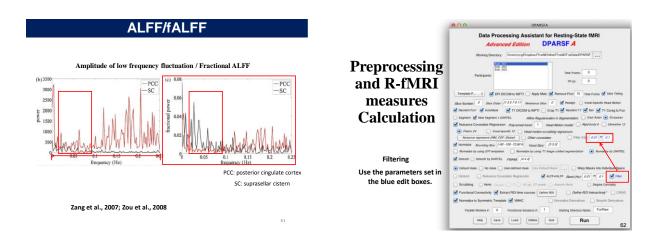
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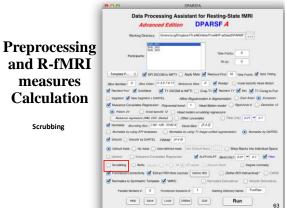


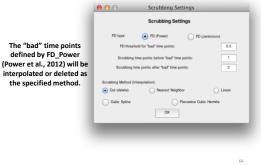
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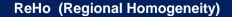
Hep Save Load Utilities Out Run



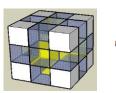








Zang YF, Jiang TZ, Lu YL, He Y, Tian LX (2004) Regional homogeneity approach to fMRI data analysis. Neuroimage 22: 394–400.





Zang et al., 2004

rr ~ ar 🖌 Filer

Preprocessing and R-fMRI measures Calculation

> Regional Homogeneity (ReHo) Calculation (Zang et al., 2004)

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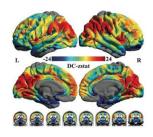


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Zuo et al., 2012

Preprocessing and R-fMRI measures Calculation

Functional

Connectivity (voxel-wise seed based correlation analysis)

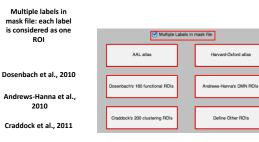
Extract ROI time courses (also for ROI-wise Functional Connectivity)

Define ROI

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Define ROI

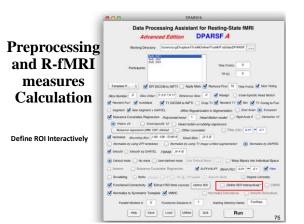


Define other ROIs

Define ROI

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Define ROI	Define ROI
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Define ROI

🕖 Define ROI Is	steractively	
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ROI Radius (nm. 101 mea	ns define for each R	3 seperately)
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0 means define ROI Radius for each ROI seperately

Define ROI

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Functional Connectivity

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

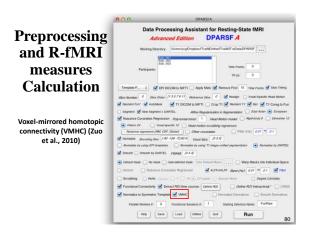
For ROI-wise results, please see {working directory}\Results\FunImgARCW*_ROISignals.

Preprocessing and R-fMRI measures Calculation

Voxel-mirrored homotopic connectivity (VMHC) (Zuo et al., 2010)

Prepare for VMHC: Further register to a symmetric template

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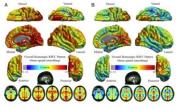


VMHC

- Get the T1 images in MNI space (e.g., wco*.img or wco*.nii under T1ImgNewSegment or T1ImgSegment) for each subject, and then create a mean T1 image template (averaged across all the subjects).
- 2) Create a symmetric T1 template by averaging the mean T1 template (created in Step 1) with it's flipped version (flipped over x axis).
- 3) Normalize the T1 image in MNI space (e.g., wco*.img or wco*.nii under T1ImgNewSegment or T1ImgSegment) for each subject to the symmetric T1 template (created in Step 2), and apply the transformations to the functional data (which have been normalized to MNI space beforehand). Please see a reference from Zuo et al., 2010.

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Gee et al., 2011

Zuo et al., 2010

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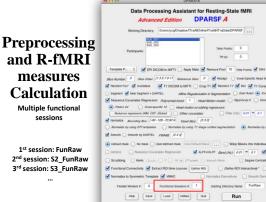
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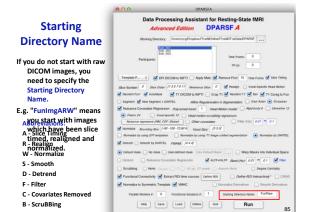
Preprocessing and R-fMRI measures Calculation

Parallel Workers (if parallel computing toolbox is installed)

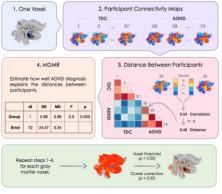
Each subject is distributed into a different worker. (Except DARTEL-Create Template)

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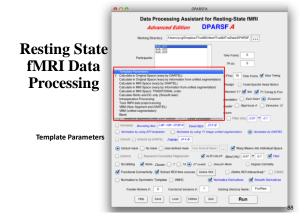


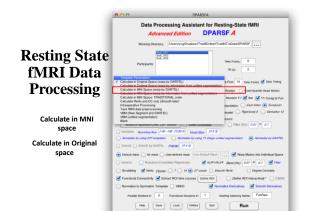


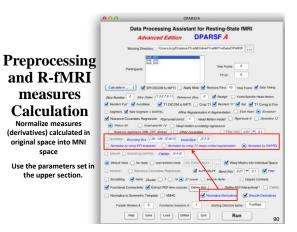
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matrix regression (Shehzad et al., 2014)	termates Boundary Box [44:167-7280 B Volad Style: [33:34] Nomatics by using EPTampians. Interaction by using T1 mage unified argumentation Second by DAVITL. FWeek [4:44]
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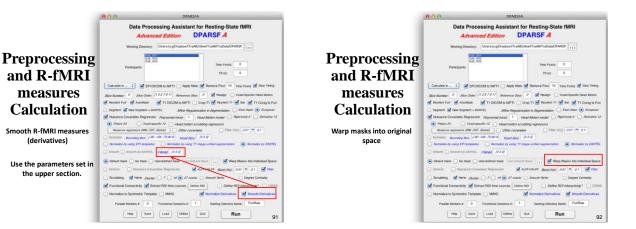


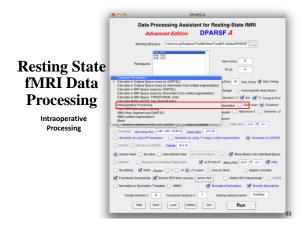
Shehzad et al., 2014. Neuroimage

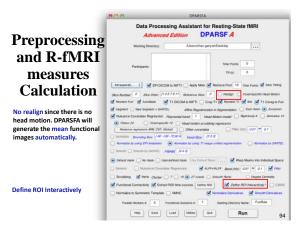


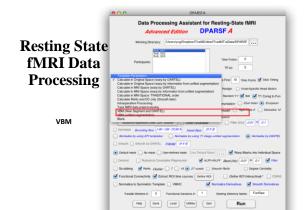


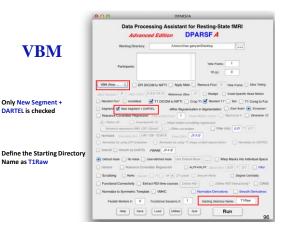


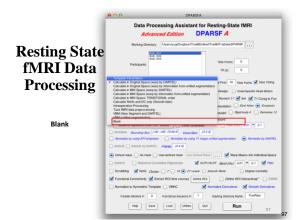




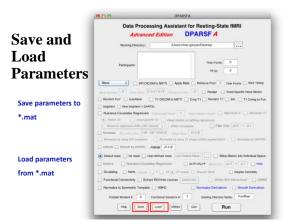








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Further Help



Acknowledgments

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Chinese Academy of Sciences

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Thanks for your attention!