Resting-state functional connectivity

Jun-Cheng Weng

14 July 2016

Outline

- Resting-state functional connectivity
  - SPM pre-processing (趙一平教授)
  - REST functional connectivity
  - REST mfALFF

1

Resting-state fMRI analysis tools

- SPM (Statistical Parametric Mapping)
  - Wellcome Trust Centre for Neuroimaging, UCL, UK
  - http://www.fil.ion.ucl.ac.uk/spm/software/
- FSL (FMRIB Software Library)
  - Oxford, UK
  - http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/
- AFNI (Analysis of Functional NeuroImages)
  - NIH, USA
  - http://afni.nimh.nih.gov/afni/download
- REST (Resting-State fMRI Data Analysis Toolkit)
  - Lab of Cognitive Neuroscience and Learning, Beijing Normal University, China
  - http://restfmri.net/forum/index.php

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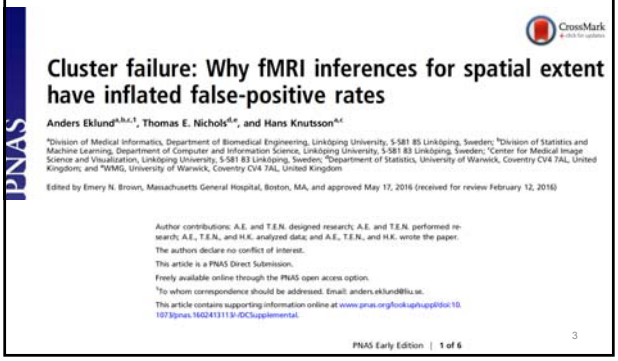
PNAS



PNAS

CrossMark

Cluster failure: Why fMRI inferences for spatial extent have inflated false-positive rates

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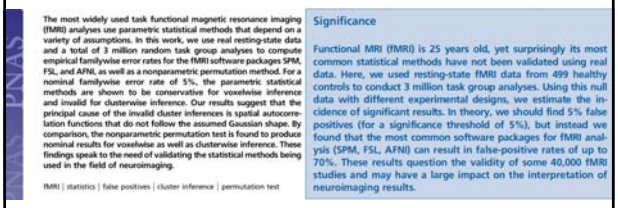
PNAS

- abstarct



PNAS

The most widely used task functional magnetic resonance imaging (fMRI) analyses use parametric statistical methods that depend on a variety of assumptions. In this work, we use real resting-state data and a total of 3 million random task group analyses to compute empirical familywise error rates for the fMRI software packages SPM, FSL, and AFNI, as well as a nonparametric permutation method. For a nominal familywise error rate of 5%, the parametric statistical methods are shown to be conservative for voxelwise inference and invalid for clusterwise inference. Our results suggest that the principal cause of the invalid cluster inferences is spatial autocorrelation functions that do not follow the assumed Gaussian shape. By comparison, the nonparametric permutation test is found to produce nominal results for voxelwise as well as clusterwise inference. These findings speak to the need of validating the statistical methods being used in the field of neuroimaging.

fMRI | statistics | false positives | cluster inference | permutation test

Significance

Functional MRI (fMRI) is 25 years old, yet surprisingly its most common statistical methods have not been validated using real data. Here, we used resting-state fMRI data from 499 healthy controls to conduct 3 million task group analyses. Using this null data with different experimental designs, we estimate the incidence of significant results. In theory, we should find 5% false positives (for a significance threshold of 5%), but instead we found that the most common software packages for fMRI analysis (SPM, FSL, AFNI) can result in false-positive rates of up to 70%. These results question the validity of some 40,000 fMRI studies and may have a large impact on the interpretation of neuroimaging results.

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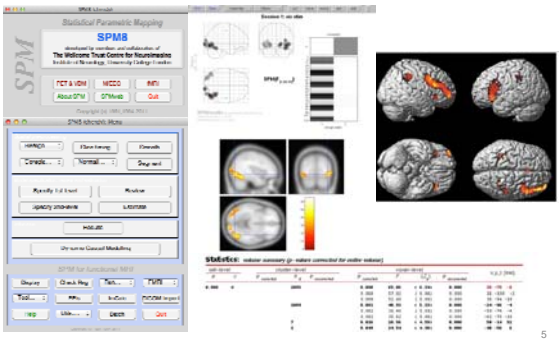
SPM (Statistical Parametric Mapping)



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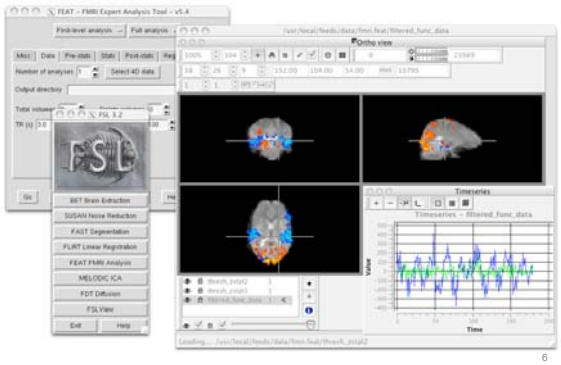
FSL (FMRIB Software Library)



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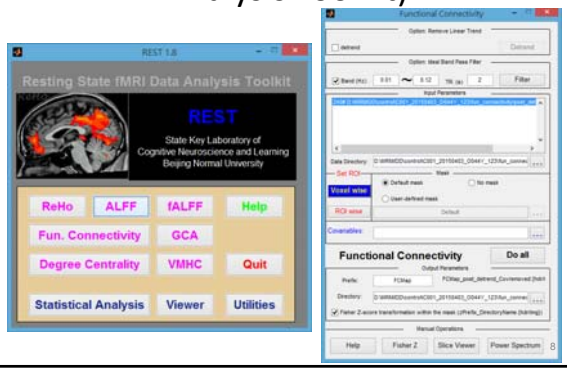
AFNI (Analysis of Functional NeuroImages)

7

REST (Resting-State fMRI Data Analysis Toolkit)



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Analysis tools comparison

	SPM	FSL	AFNI	REST
Features	最多人使用，資料分析流程易標準化且便於操作，但細節不易作修改	資料分析流程亦適合初學者，為一免費之工具，並可由介面或是指令兩方面著手	資料分析流程適合略懂Unix指令人員，每一步驟均可做調整，有較大之自由度	適合resting-state fMRI初學者，為一免費之工具
Operating system	Any OS with Matlab	Mac, Linux, Windows	Mac, Linux, some Matlab-compatible scripts	Any OS with Matlab
User interface	MATLAB scripts and button-press	Unix functions and GUI	Unix functions and GUI	MATLAB scripts and button-press

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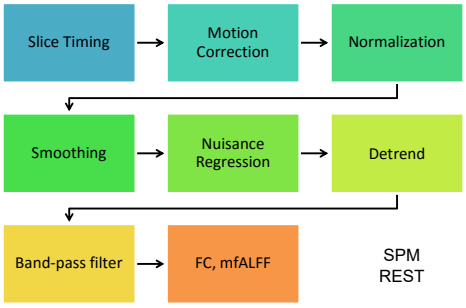
Pre-processing



REST 1.8
functional connectivity

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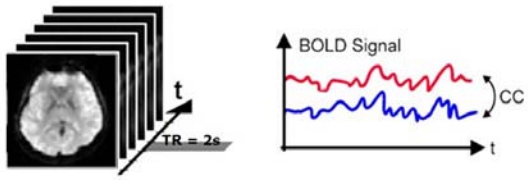
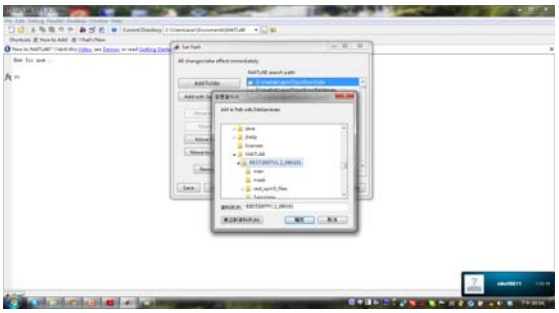
Functional connectivity

- Functional connectivity is defined as the temporal correlation between spatially defined brain regions.



File→Set path →Add with Subfolders →rest的資料夾→確定→Save→Close



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matlab輸入rest跑出一個視窗 點選Fun. Connectivity

14

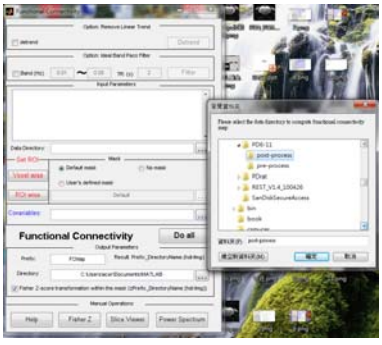
即出現rest分析視窗

15

點選Data Directory

16

點選post-process→確定

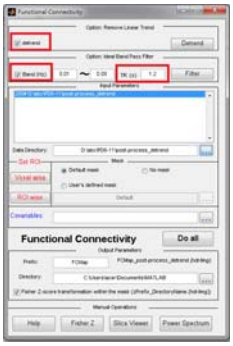


17

即出現欲處理的data共200張

18

勾選detrend→勾選Band(Hz)→
依實驗更改TR值(在此更改為1.2s)



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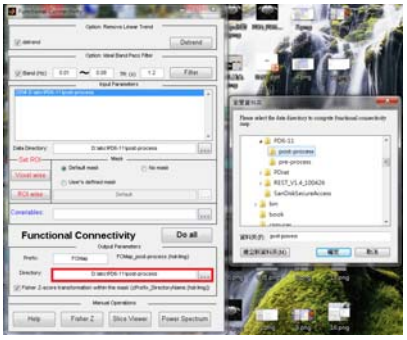
設定檔案儲存路徑
(post-process)



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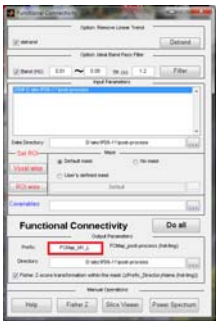
設定儲存檔案名稱
ex:如果找M1左邊
可將檔名設為FCMap_M1_L

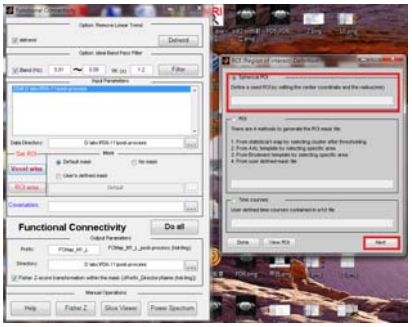


21

選取Voxel wise
(設定seed point)

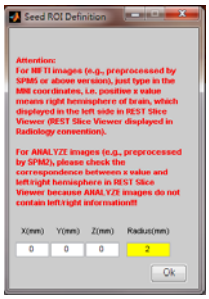
22

點選add ROI→Spherical ROI→Next



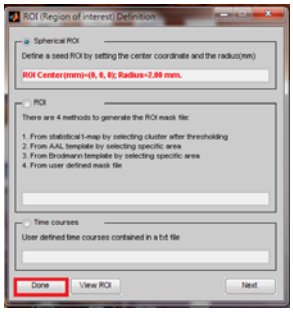
23

XYZ坐標可以先隨便輸入
Raudis則輸入2或3→Ok



24

按Done

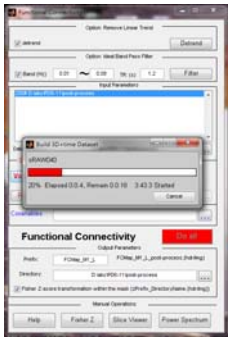


25

點選No mask→Do all

26

開始進行分析

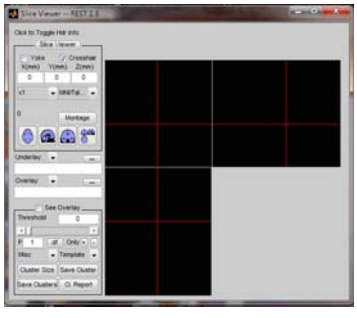


27

分析完成後Do all會恢復原本顏色

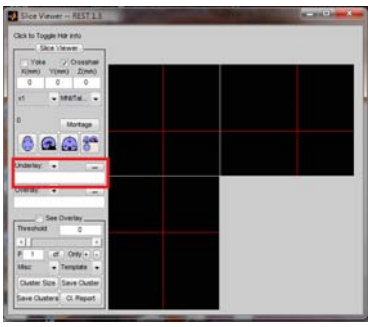
28

點Slice Viewer
即出現右邊的視窗



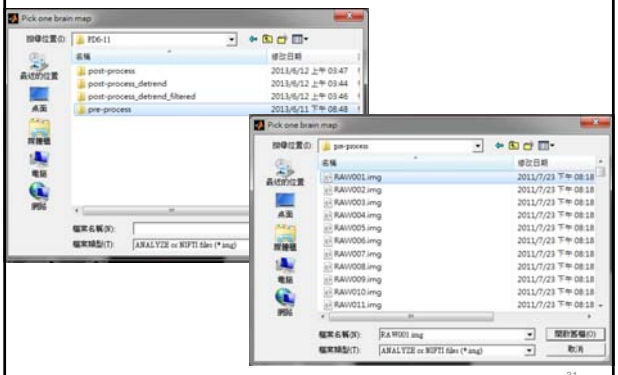
29

點Underlay



30

選擇pre-process裡任一張圖片

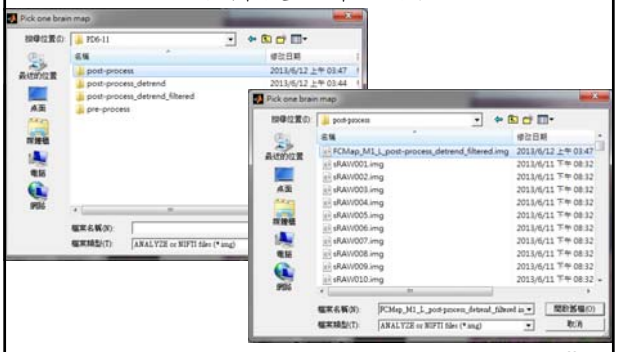


31

點Overlay

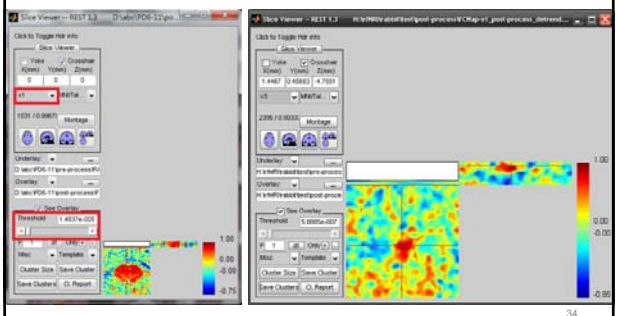
32

選擇post-process裡
經分析後之命名檔名



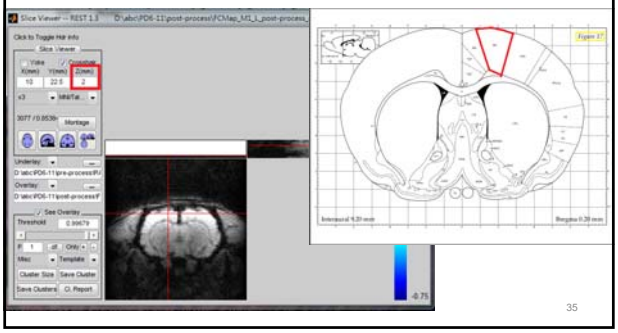
33

將x1改成x3圖會變大
將Threshold調至最右邊(最大值)
比較好搜尋坐標



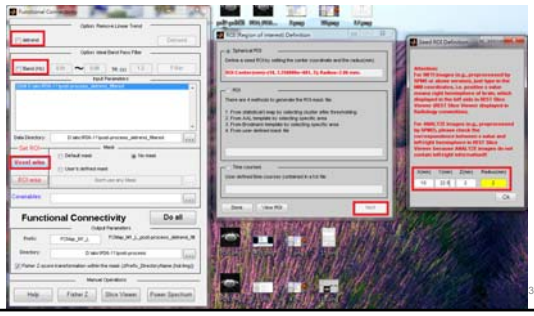
34

對照rat圖譜
發現z=2較容易找到M1
再點選左邊M1的大概位置



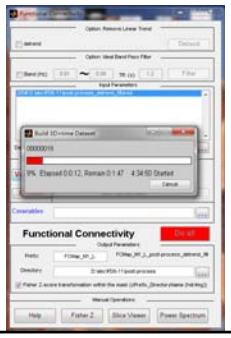
35

不要勾選detrend→
不要勾選Band(Hz)→
選取Voxel wise→Next→
輸入找到的M1坐標→Ok→Done



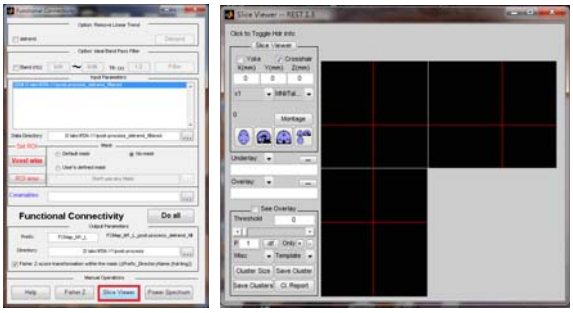
36

Do all即開始執行
(注意:不要勾選detrend和Band(Hz),
不然重新分析時,會從頭再跑一次)



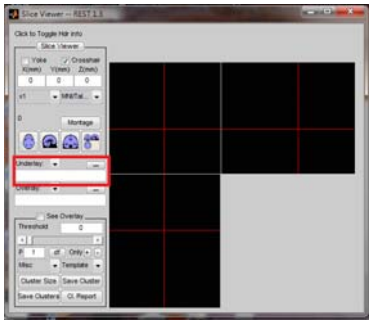
37

點Slice Viewer
即出現右邊的視窗



38

點Underlay



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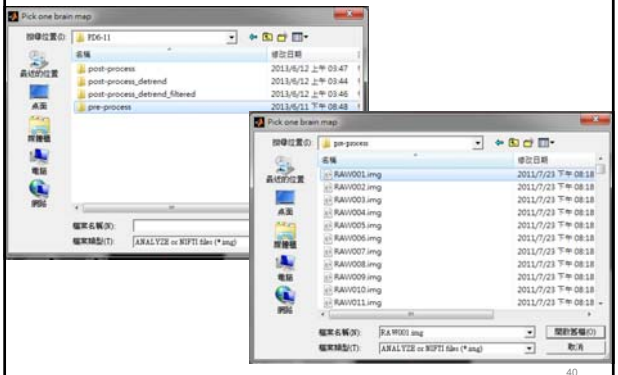
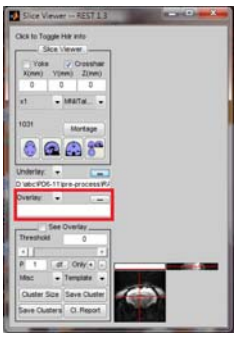
選擇pre-process裡任一張圖片



40

點Overlay



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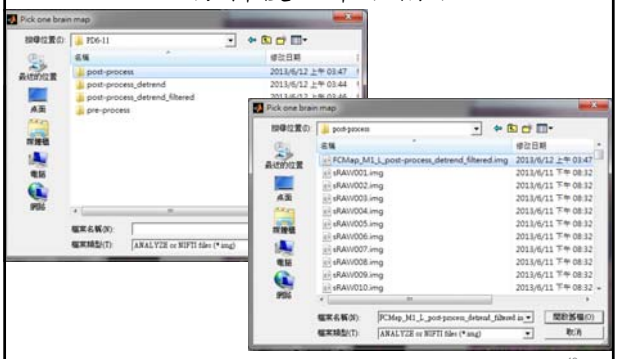
選擇post-process裡
經分析後之命名檔名



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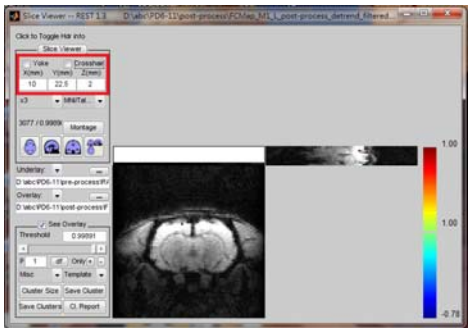
輸入剛剛設的左邊M1的坐標
即看到一個紅點(seed point)



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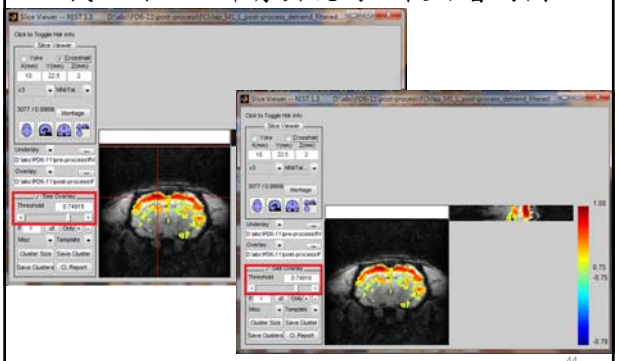
調整Threshold值
找M1和CPu都有出現的且較好看的圖



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REST 1.8
mfALFF

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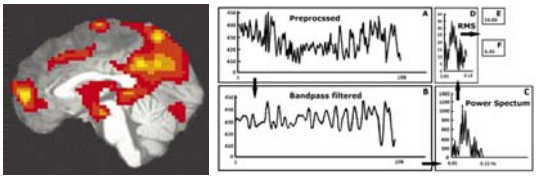
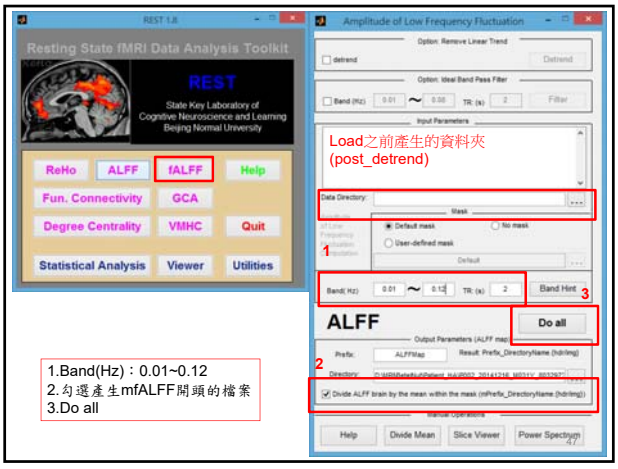
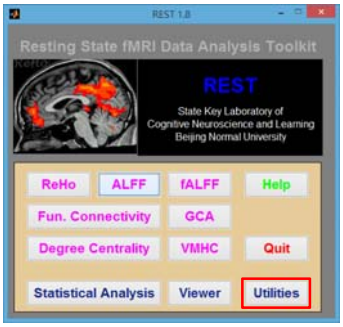
Mean fractional amplitude low frequency fluctuation (mfALFF)

- Slow fluctuations in activity are a fundamental feature of the resting brain, and their presence is key to determining correlated activity between brain regions and defining resting state networks

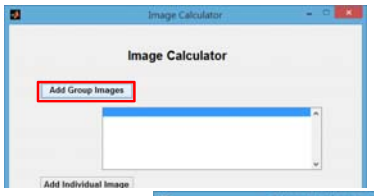


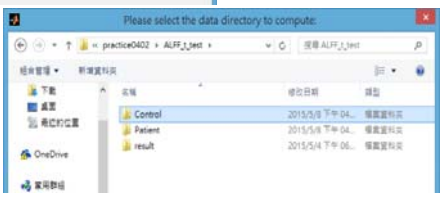


1.選Utilities
2.選REST Image Calculator



48





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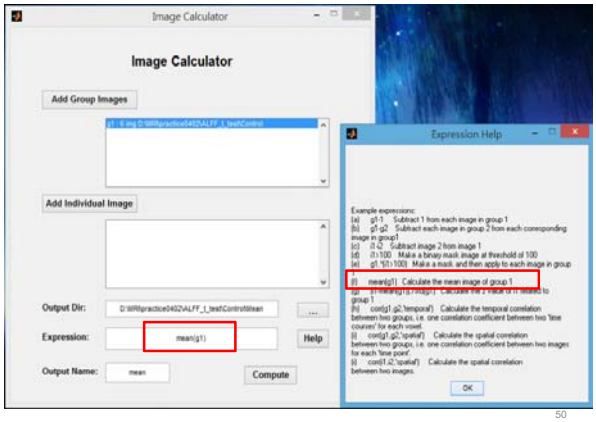
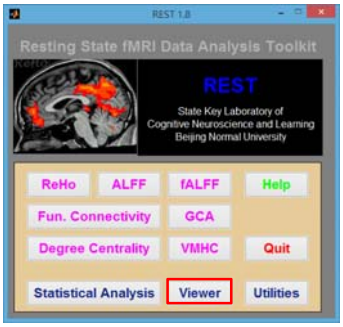


50



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選Template

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Take home message

- Resting-state functional connectivity
  - SPM pre-processing
  - REST functional connectivity
  - REST mfALFF

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