Functional Connectivity
using iRSFC toolbox

Sunghyon Kyeong, PhD.

Clinical Scientist @ Philips Korea

iRSFC

intuitive resting-state functional connectivity
(iRSFC) toolbox

Step 1 - Dataset and Directory

iRSFC intuitive resting-state functional connectivity (iRSFC) toolbox

Load subject's information

Subject List: Select Subject List File (subjlist.xls) [Select]

DATA path: Specify fMRI data folder [Select]

OUT path: Select a directory to save results [Select]

Subject List
피험자 리스트가 기록되어 있는 엑셀
데이터를 선택.
헤더가 **subject** 인 컬럼에 폴더명에
해당되는 피험자 이름을 기록.

subjname	Dx	Age	Sex
NOR001	1	20	1
NOR002	1	24	2
NOR003	1	28	1
NOR004	1	22	1
SPR001	2	27	2
SPR002	2	26	2
SPR003	2	20	1
SPR004	2	21	2

<Subject List 엑셀 파일 예시>

DATA path
데이터의 위치를 지정한다.
데이터는 다음과 같이 구조로
저장되어 있어야 함.
(DATA path)/NOR001/rest
(DATA path)/NOR002/rest

OUT path
분석결과 및 ROI mask가
저장될 위치를 지정.

Step 2 - Filter & Regressors

Prefix of preprocessed images
SPM8을 이용하여 전처리를 했다면 spatial preprocessing이 완료된
뇌영상 데이터에는 원래 뇌영상 데이터 이름 앞에 'sw' 또는 'swa' 가
prefix로 붙음.

fmri path:
fMRI데이터가 위치한 폴더 이름

Parameters for temporal preprocessing

Prefix of preprocessed images: swar   fmri path: rest

Regressors: 24 HM ☑ WM ☑ CSF ☐ GS ☑ CompCor 3

Dummy scans: 5   TR [s]: 2   Bandpass filter [Hz]: [0.009 0.08]

Regressors
resting state fMRI 데티어의
시계열 분석에서 confounding effects가 될
가능성이 있는 noise signal들을 제거해주는
역할.
Global Signal을 제거하느냐? 마느냐? 에 대
해서는 의견이 분분함.

Dummy Scan
자기장이 안정화
될때까지의 데이터를 분석에서
제외함. 초기 8~12s 정도.

TR [s]
fMRI 촬영에
사용된 TR을
초 단위로 입력

Bandpass Filter [Hz]
fMRI 촬영에 사용된
TR을 초 단위로 입력

Step 3 - Select ROIs

: Both atlas based and user defined ROIs can be used for the seed-based FC analysis.

Make ROI mask
sphere or box 모양의 ROI를 생성할 수 있음.
(MNI or Talairach coordinate 좌표 모두 사용 가능함.)

with Ctrl-key, select multiple ROIs

Select ROIs:

Precentral_L
Precentral_R
Frontal_Sup_L
Frontal_Sup_R
Frontal_Sup_Orb_L
Frontal_Sup_Orb_R
Frontal_Mid_L
Frontal_Mid_R
Frontal_Mid_Orb_L
Frontal_Mid_Orb_R
Frontal_Inf_Oper_L
Frontal_Inf_Oper_R
Frontal_Inf_Tri_L
Frontal_Inf_Tri_R
Frontal_Inf_Orb_L
Frontal_Inf_Orb_R
Rolandic_Oper_L
Rolandic_Oper_R
Supp_Motor_Area_L
Supp_Motor_Area_R
Olfactory_L
Olfactory_R
Frontal_Sup_Medial_L
Frontal_Sup_Medial_R
Frontal_Mid_Orb_L
Frontal_Mid_Orb_R
Rectus_L
Rectus_R
Insula_L
Insula_R

Utilities

(1a) | Make ROI mask | Extract Data From ROIs | Graph Analysis | Toolbox4

Seed regions of interests

AAL or Dosenbach

Brai **(2a)** | Select Atlas | [] | Select **(2b)**

ROI Images: | Select **(1b)**

(3) ☑ Seed ROI based FC | ☐ Compute A-matrix | ☐ Scrubbing: | 0.2

Select all

OK | Cancel

(1b): (1a)에서 생성한 이미지 형태의 ROI를 선택.
(1b)와 (2b)를 동시에 선택하는 것이 가능함.

Create ROIs

Make ROI mask
sphere or box 모양의 ROI를 생성할 수 있음.
(MNI or Talairach coordinate 좌표 모두 사용 가능함.)

Utilities

| Make ROI mask | Extract Data From ROIs | Graph Analysis | Toolbox4 |
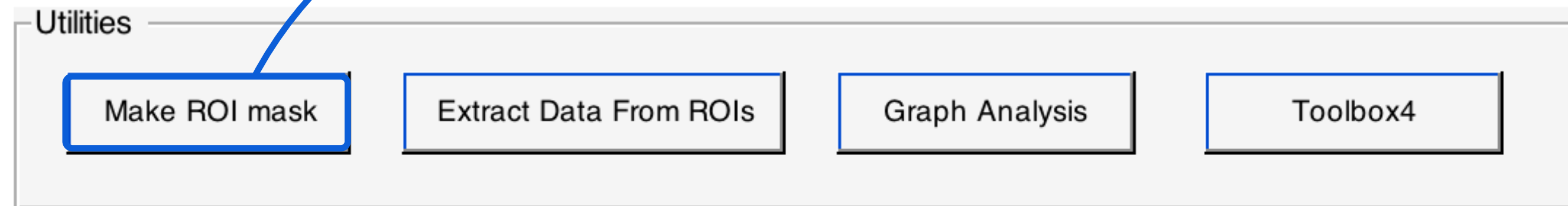
Step 4 - Run Analysis
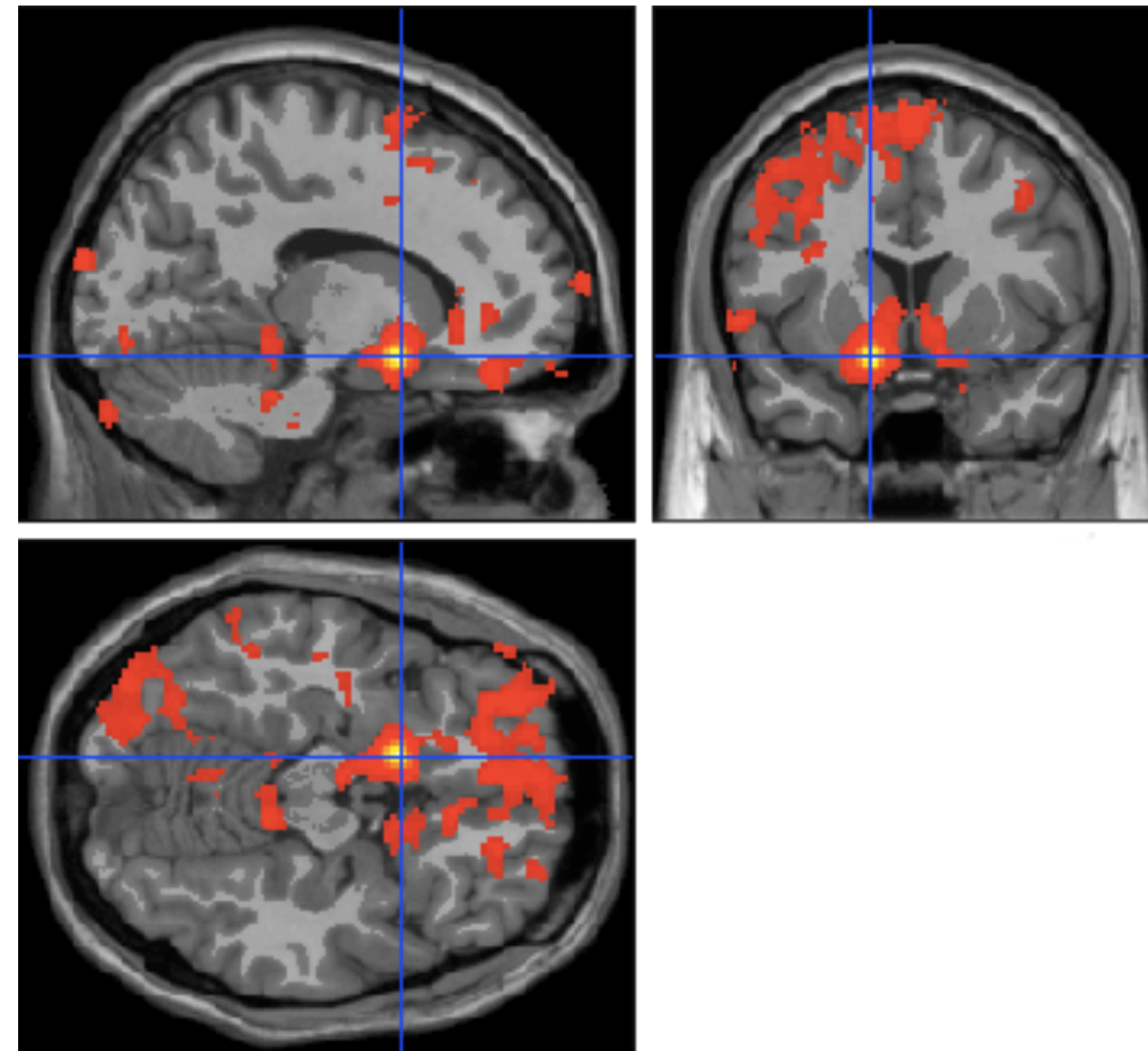
Temporal preprocessing

Functional connectivity

Now, we have z-maps
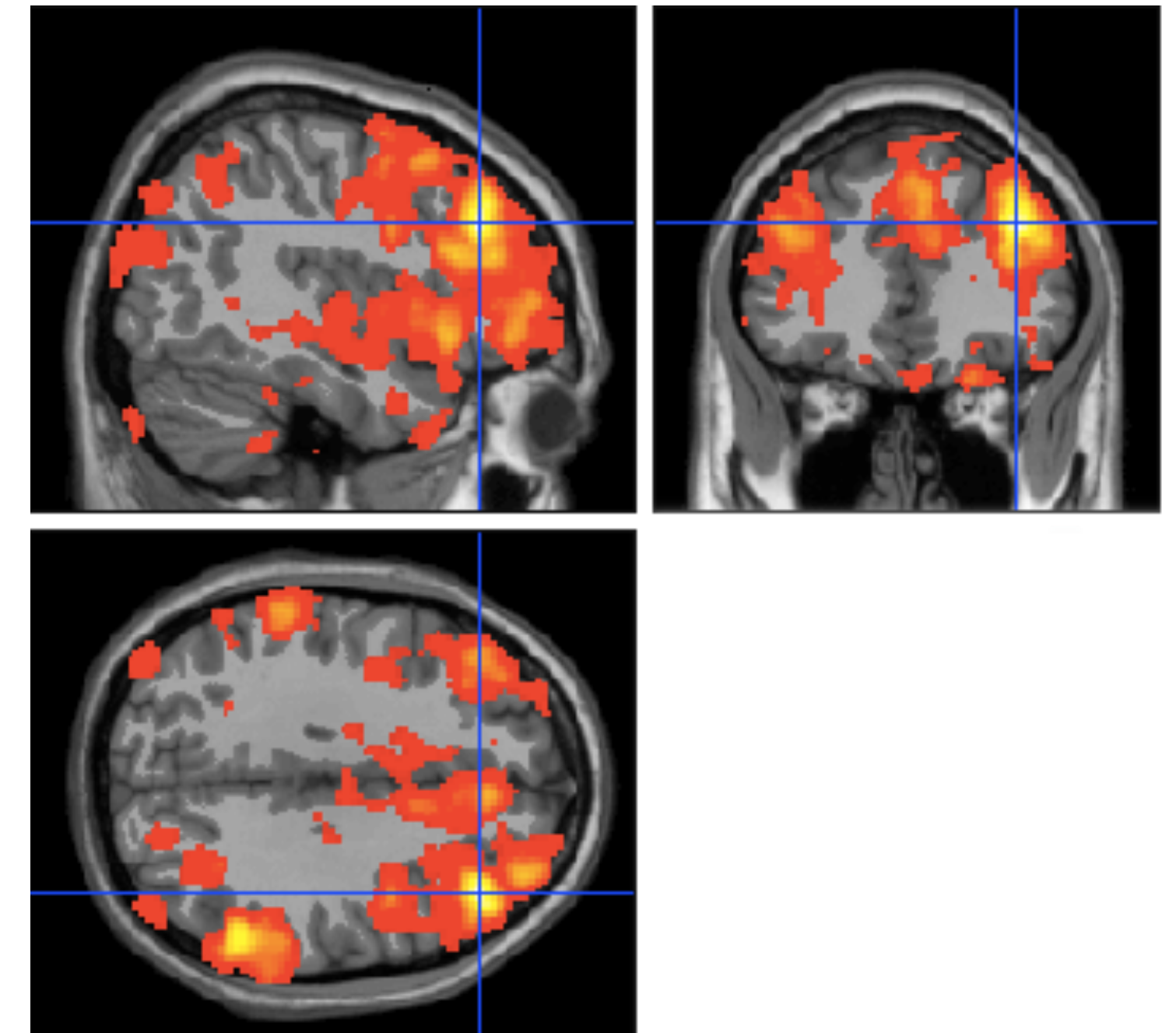
for each seed ROI and each subject

PCC
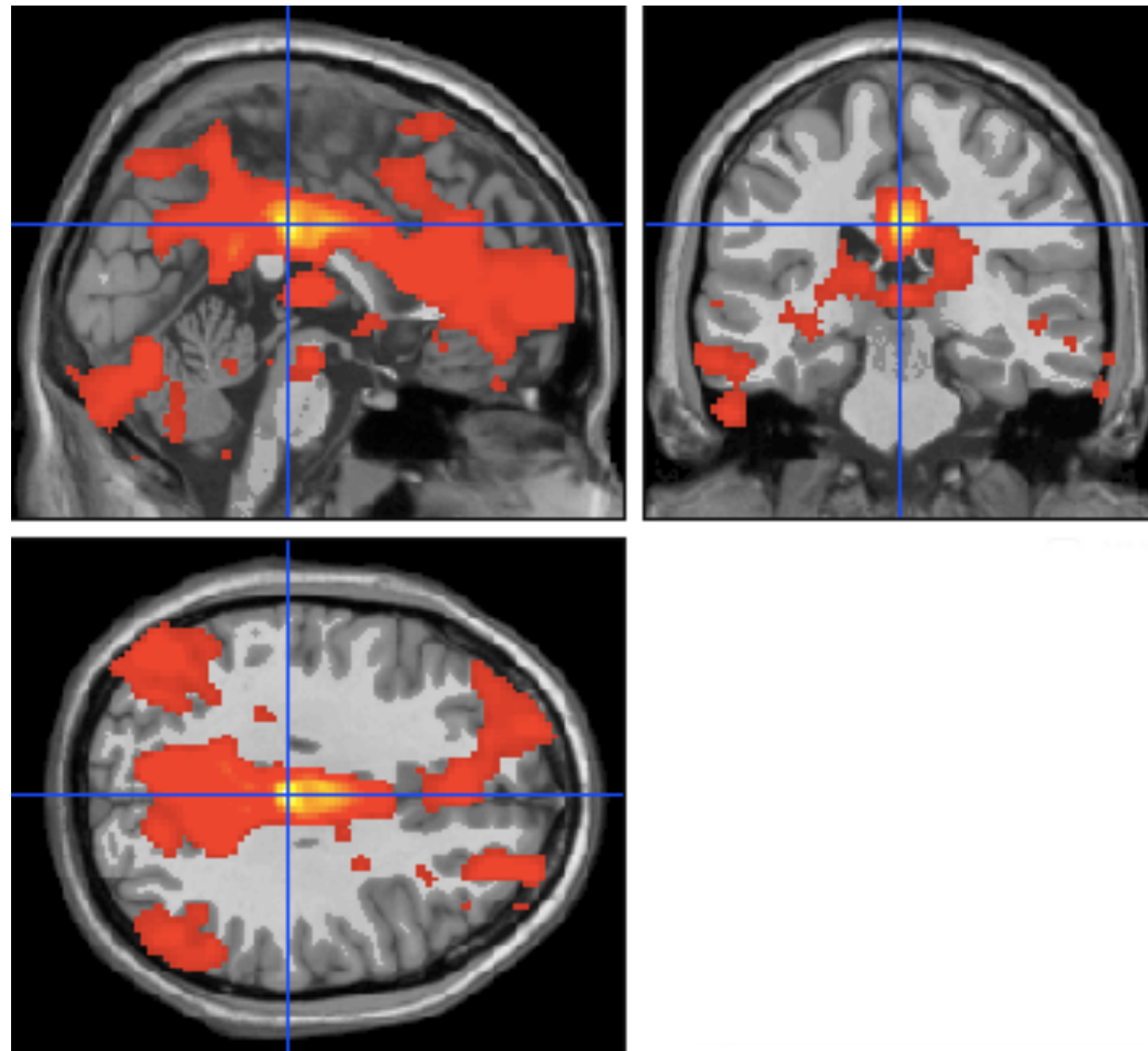
L NAcc

R DLPFC

Two-sample t-test

with covariates

Specify 2nd-level

Current Module: Factorial design specification

Help on: Factorial design specification
Directory ...g/Desktop/cbu/anova/
Design
. Two-sample t-test
.. Group 1 scans <-X
.. Group 2 scans <-X
.. Independence Yes
.. Variance Unequal
.. Grand mean scaling No
.. ANCOVA No
Covariates
. Covariate
.. Vector <-X
.. Name <-X
.. Interactions None
.. Centering Overall mean
Masking
. Threshold masking
.. None
. Implicit Mask Yes
. Explicit Mask
Global calculation
. Omit
Global normalisation
. Overall grand mean scaling
. Normalisation None

Covariates
covariate으로 입력할 변수의 갯수만큼
New:Covariate으로 선택
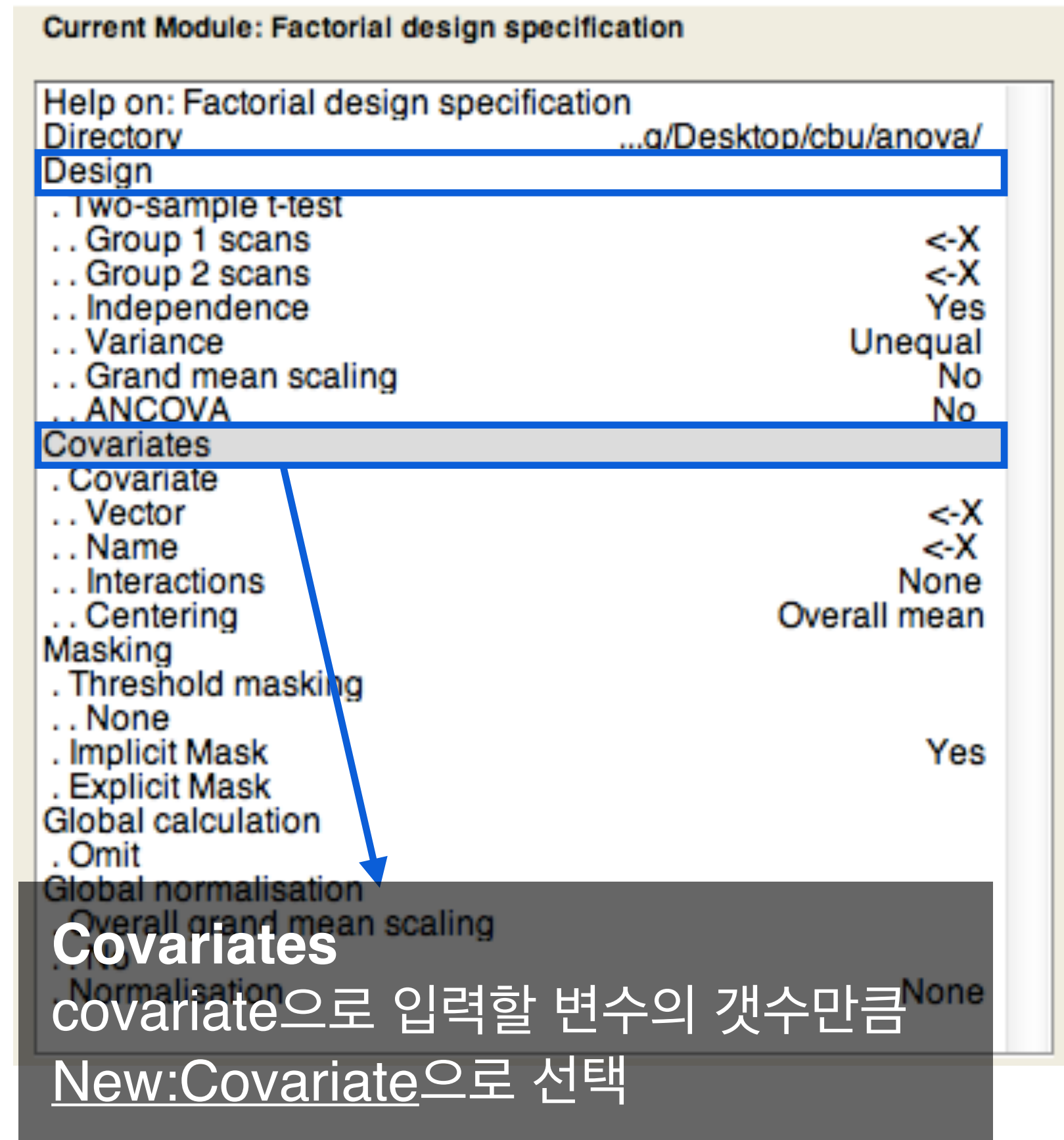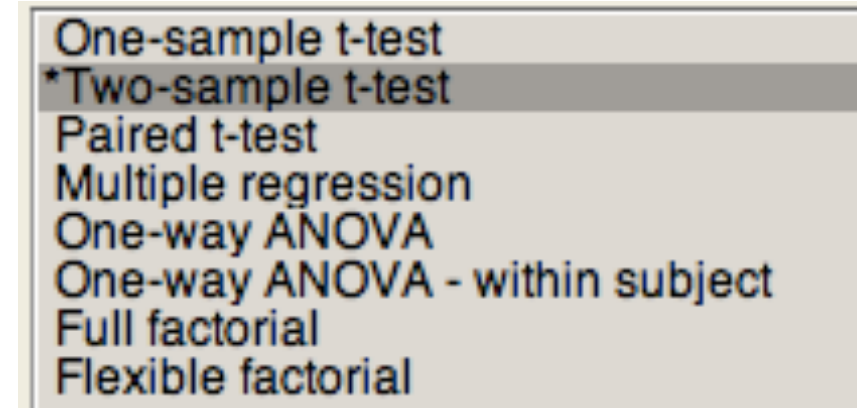
New: Covariate
Replicate: Covariate (1)
Replicate: Covariate (2)
Delete: Covariate (1)
Delete: Covariate (2)

Directory
결과 파일이 저장될 위치를 지정

Design
어떤 통계분석을 진행할지 선택함
choose Two-sample t-test

One-sample t-test
*Two-sample t-test
Paired t-test
Multiple regression
One-way ANOVA
One-way ANOVA - within subject
Full factorial
Flexible factorial

Group 1 scans
Group 1의 connectivity maps을 선택

Group 2 scans
Group 2의 connectivity maps을 선택

Vector
Group1 subjects의 covariates을 sequential 하게 입력하고 바로 뒤이어 Group2 subjects의 covariates을 입력

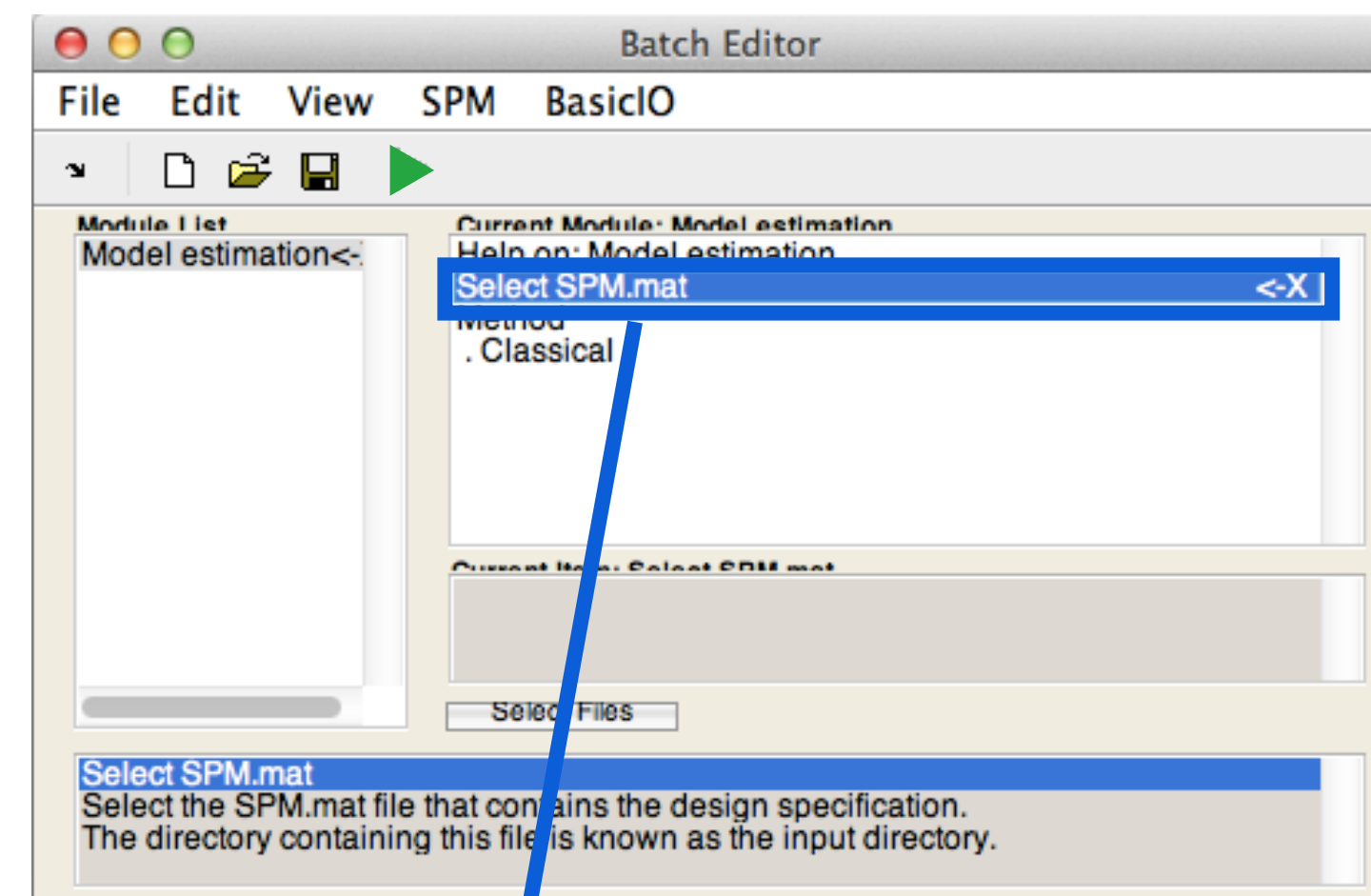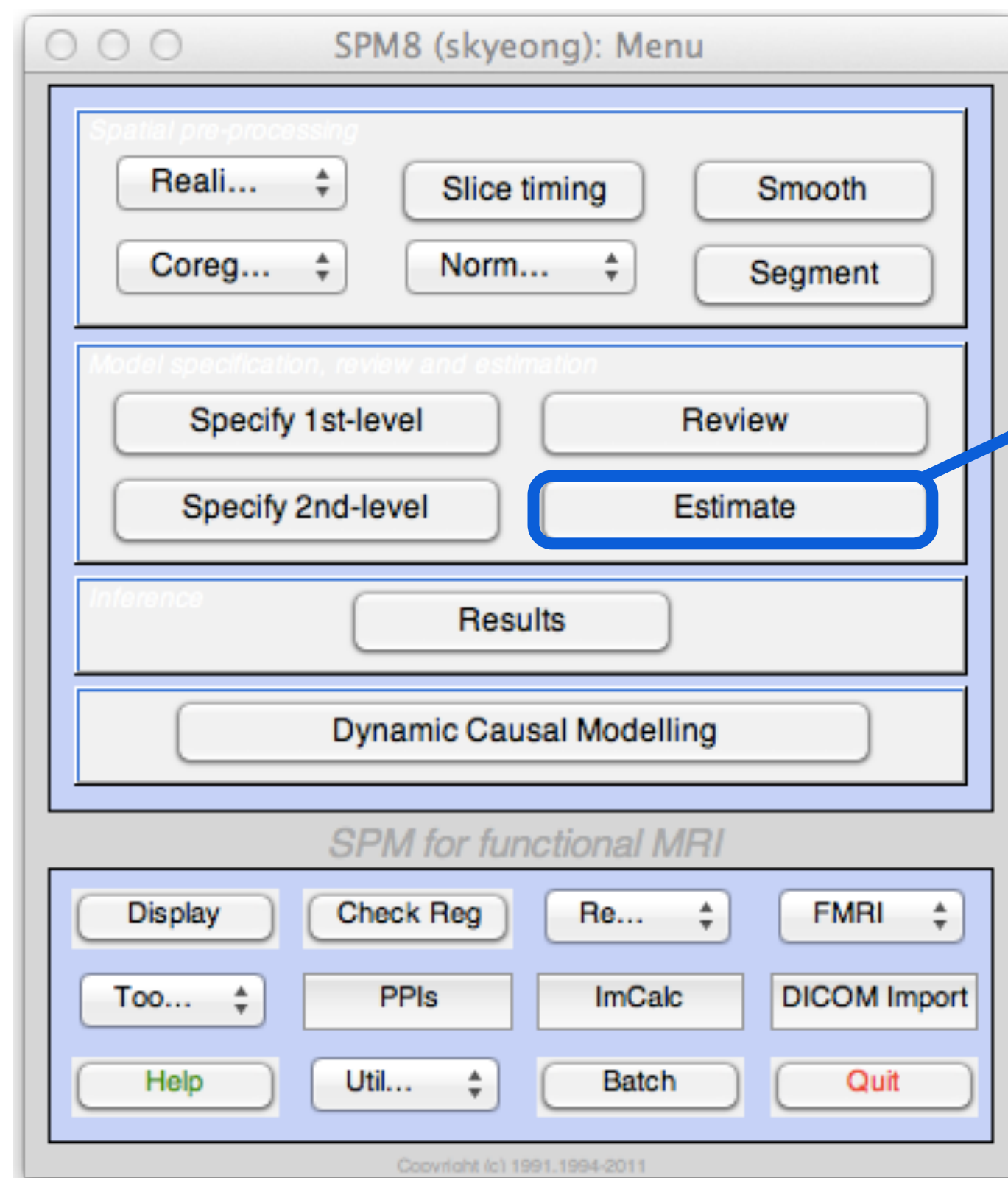27 25 29 43 39 41 57 24 29 24
ex) Age in Group 1, in Group 2

Name
Covariate의 이름 입력

모든 정보가 입력 되었으면 "▶Run Batch"를 클릭하여 프로그램을 실행한다.

Estimation of Parameters

**Specify 2nd-level 을 통해서
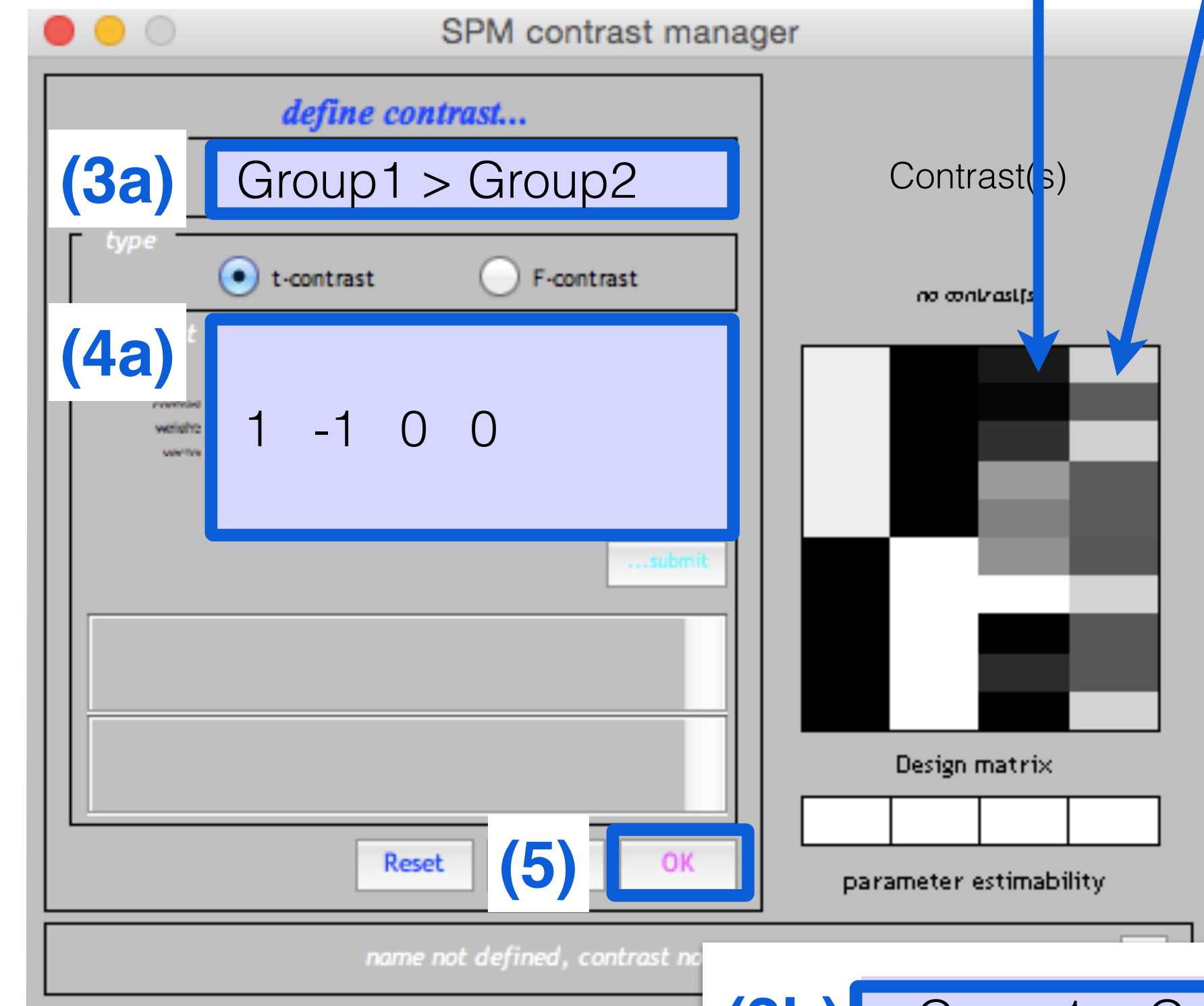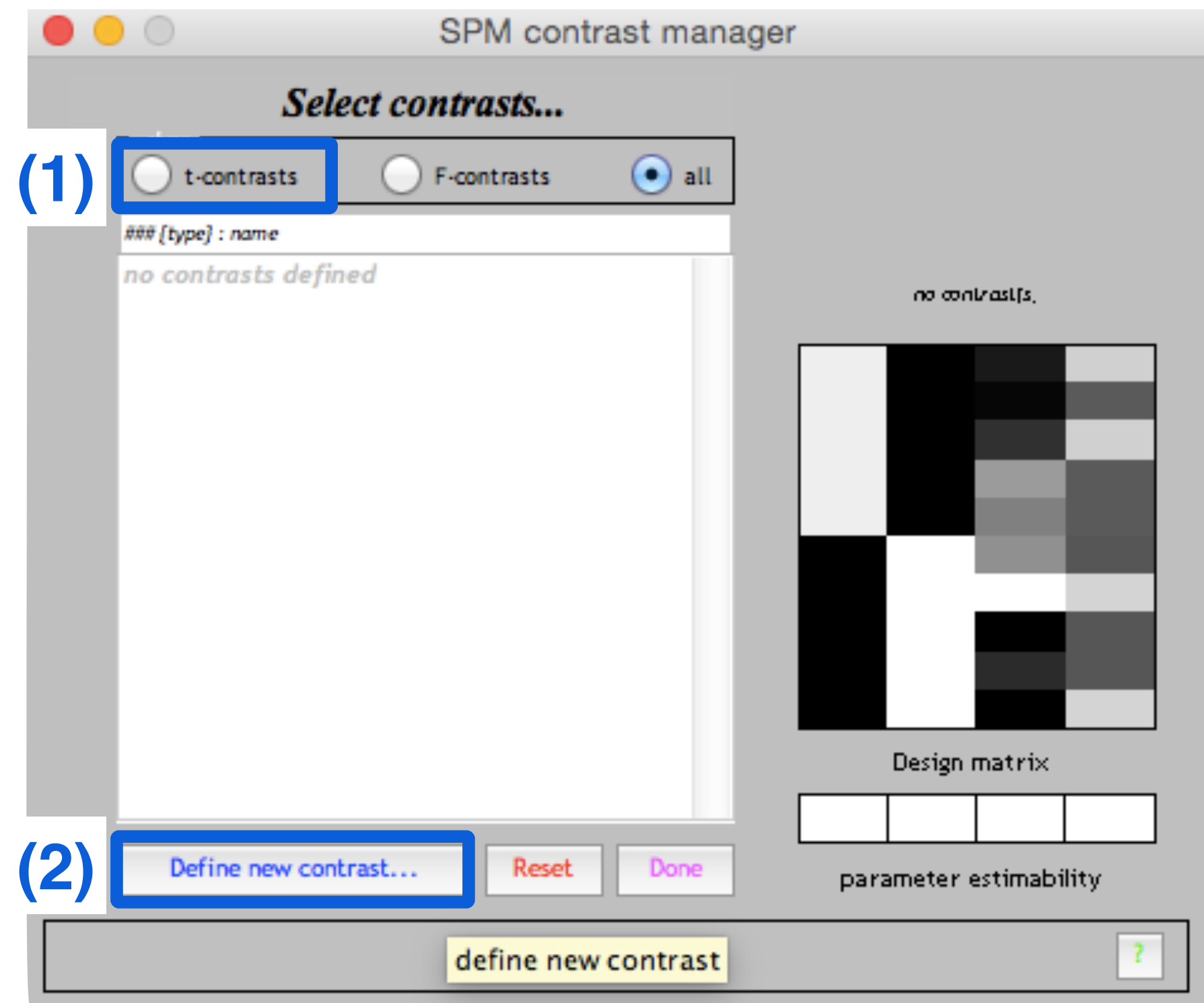구성한 General Linear Model의 parameter를 추정(계산)함.**

Select SPM.mat
Slide의 8페이지에서 지정했던 **Directory**에 생성된
SPM.mat 파일을 선택함.

▶Run Batch를 클릭하여 프로그램을 실행.

Contrast manager

Age   Sex

(1) t-contrasts   F-contrasts   all

(2) Define new contrast...

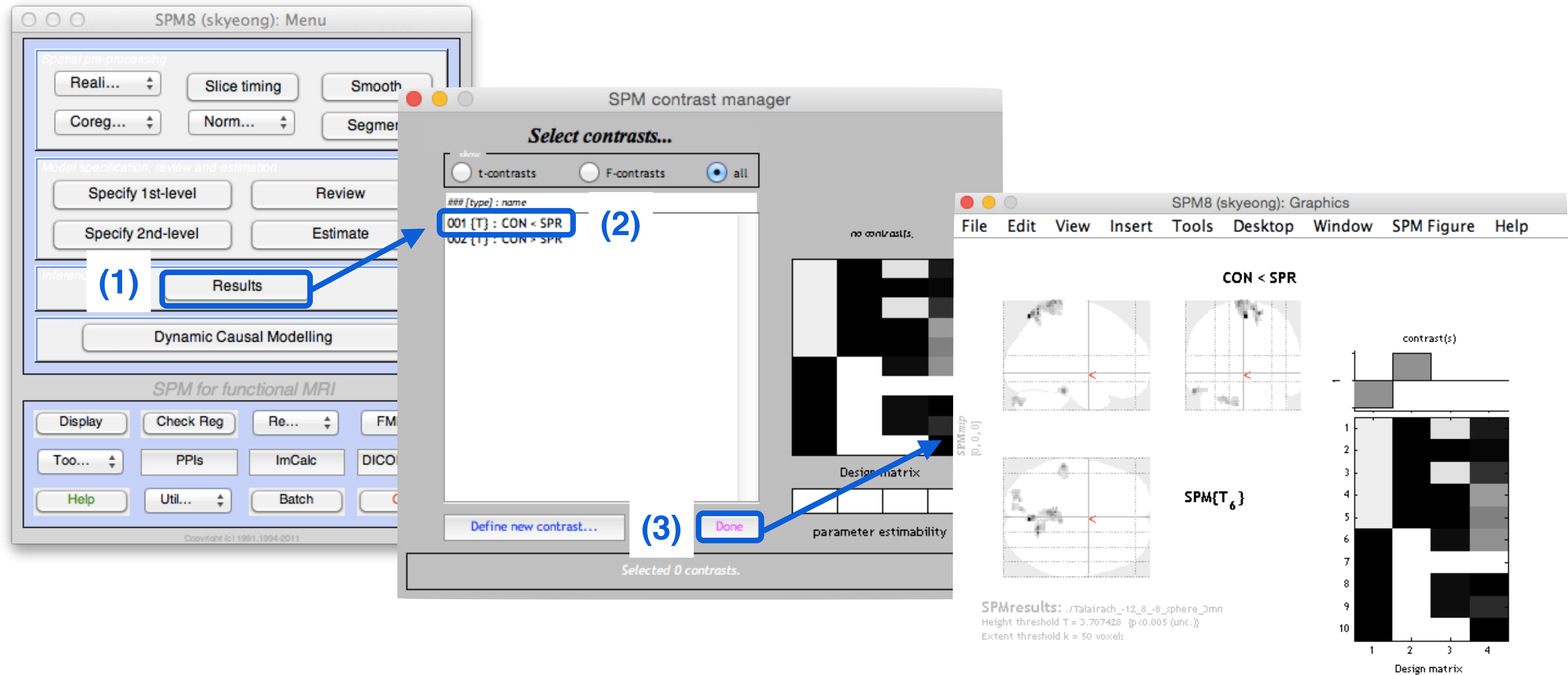(3a) Group1 > Group2

(4a) 1 -1 0 0

(5) OK

(3b) Group1 < Group2

(4b) -1 1 0 0

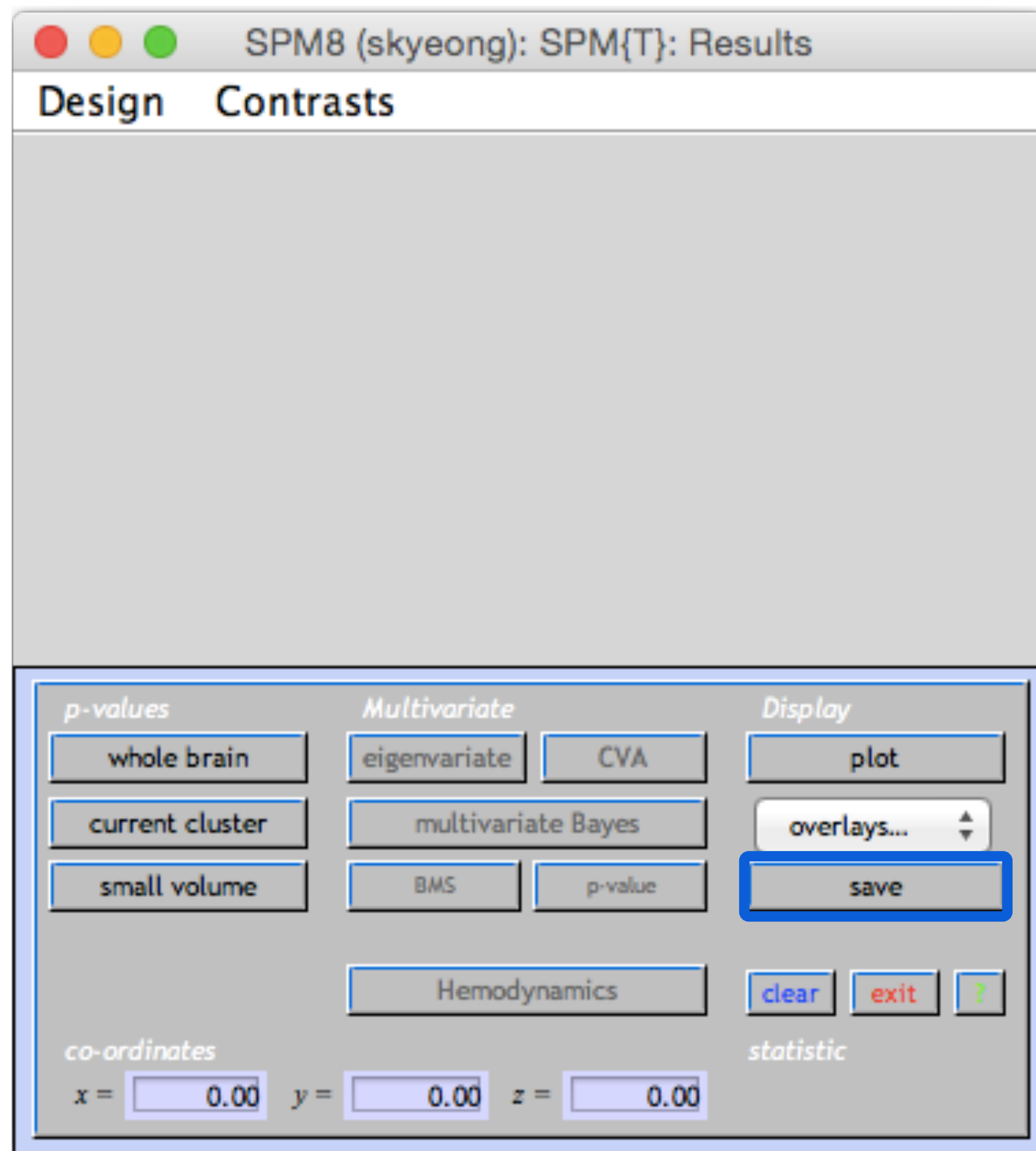Group1>Group2 contrast는 Group1에서
증가된 FC or Group2에서 감소된 FC를 의미함.

Correlation analysis
between FC and clinical scales

in Results

Save Results as MASK

To extract connectivity value in each cluster, regional clusters should be saved as mask image.

Extract FC using iRSFC
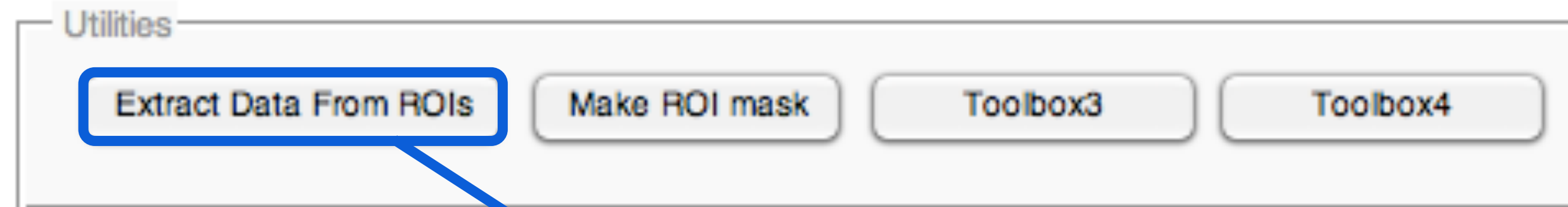
page 14에서 저장했던 mask image 를 선택함. 또는 Maks ROI mask를 통 해서 직접 그린 ROI를 선택할 수도 있음.

추출하고 싶은 데이터가 위치한 경로를 입력함. 데이터 구조는
다음과 같이 이루어져 있어야 함.

(Data path)\Lt_Amygdala\subj001.img
(Data path)\Lt_Amygdala\subj002.img
(Data path)\Lt_Amygdala\subj003.img
(Data path)\Lt_Amygdala\subj004.img

결과 파일이 저장될 폴더를 선택함.

Example of extracted FC

open tables.csv file which was saved in (Output path)

| filename	cl01	cl02	cl03	cl04
zscore_Talairach_-12_8_-8_sphere_3mm_CON1	-0.8	-1.3	-0.61	-0.84
zscore_Talairach_-12_8_-8_sphere_3mm_CON2	-2.48	-3.64	-1.13	-0.79
zscore_Talairach_-12_8_-8_sphere_3mm_CON3	-1.1	-1.6	0.36	-0.34
zscore_Talairach_-12_8_-8_sphere_3mm_CON4	-0.66	-2.83	-2.14	-1.6
zscore_Talairach_-12_8_-8_sphere_3mm_CON5	-1.05	-2.2	-1.24	-1.81
zscore_Talairach_-12_8_-8_sphere_3mm_PAT1	1.36	0.82	0.93	2.09
zscore_Talairach_-12_8_-8_sphere_3mm_PAT2	3.53	2.07	1.37	1.01
zscore_Talairach_-12_8_-8_sphere_3mm_PAT3	-0.79	0.23	1.55	1.4
zscore_Talairach_-12_8_-8_sphere_3mm_PAT4	1.51	0.25	2.2	2.45
zscore_Talairach_-12_8_-8_sphere_3mm_PAT5	1.85	0.28	5.19	2.75

ROI connectivity Analysis

Create ROIs

Make ROI mask
sphere or box 모양의 ROI를 생성할 수 있음.
(MNI or Talairach coordinate 좌표 모두 사용 가능함.)

Utilities

| Extract Data Fro... (1) | Make ROI mask | Toolbox2 |
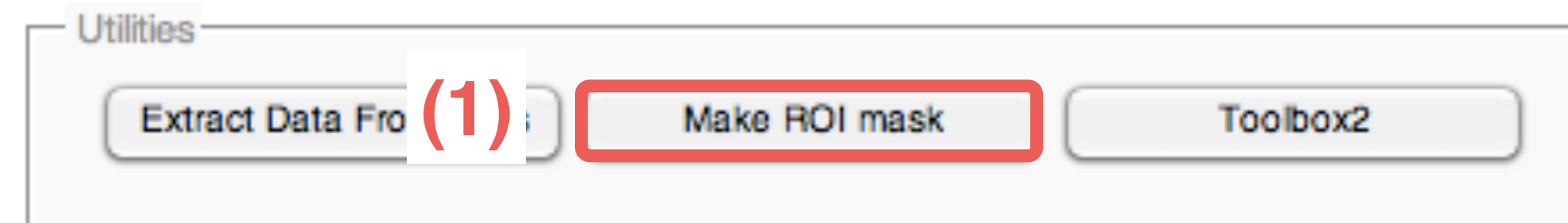
Region of Interest	x	y	z
Left TPJ	-50	-31	23
Left ACC	-7	21	36
Left Broca's Area	-41	12	14
Left Amygdala	-24	-5	-18
Left Insula	-36	8	4
Right TPJ	50	-31	23
Right ACC	7	21	36
Right Homotopy of Broca's Area	41	12	14
Right Amygdala	24	-5	-18
Right Insula	36	8	4

iRSFC Utility

Create ROI mask

(2) OUT path — Specify output directory

Coordinate System: MNI coordinate (3)

ROI Shape: sphere (4)

Center [x,y,z]: ex) [30,1,3] (5)

Radius [mm]: 4 (6)

Create ROI mask (7)
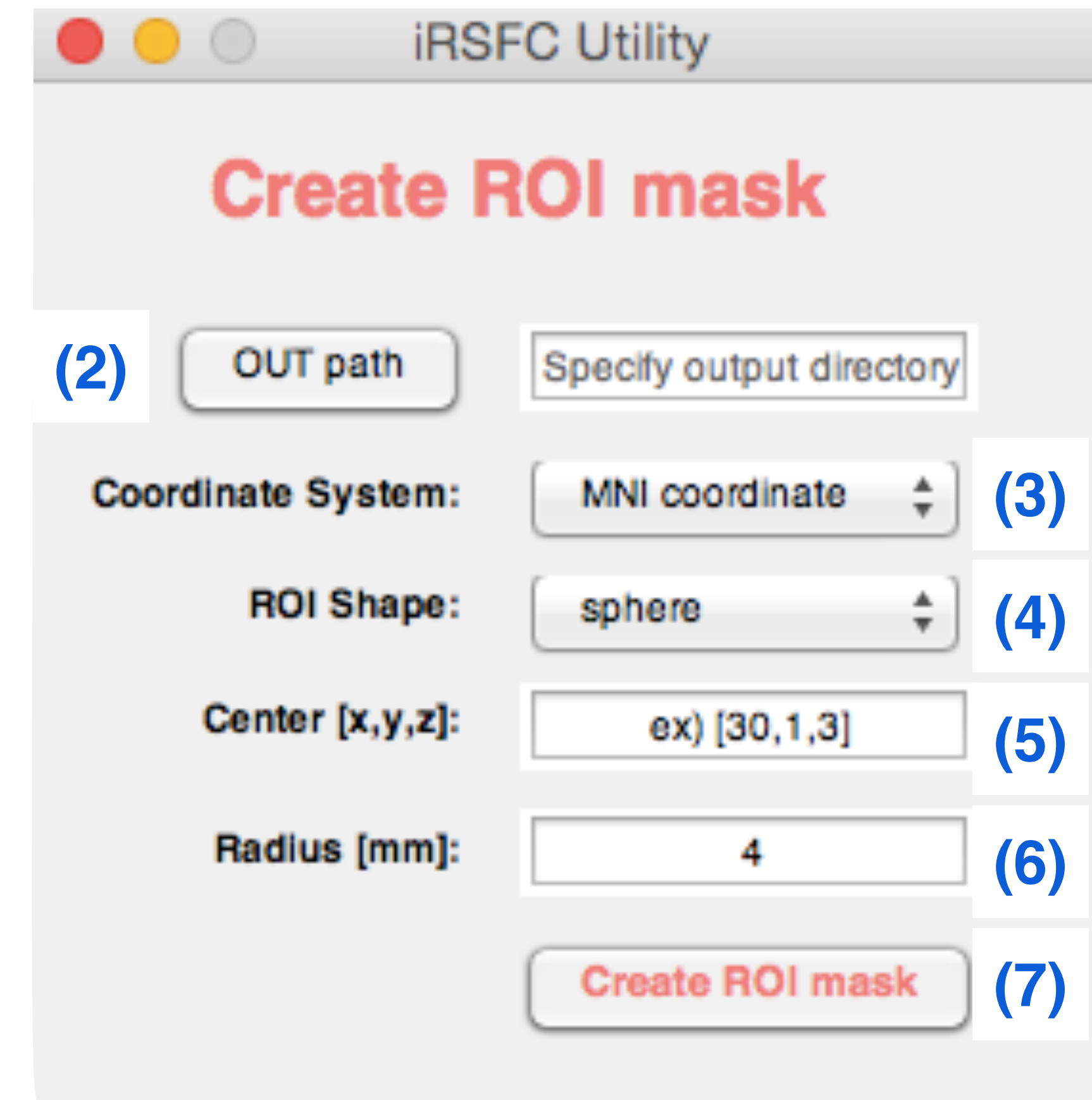
Reference for ROIs, A. Vercammen et al. BIOL PSYCHIATRY 2010 67:912-918, http://neuro.imm.dtu.dk/services/jerne/ninf/voi.html

Step 4 - Run Analysis

Check OUTPUT

node number	ROI file name
1	Lt_ACC
2	Lt_Amyg
3	Lt_Broca
4	Lt_Insula
5	Lt_TPJ
6	Rt_ACC
7	Rt_Amyg
8	Rt_Broca
9	Rt_Insula
10	Rt_TPJ

subjname	ROI_1-2	ROI_1-3	ROI_1-4	ROI_1-5	ROI_1-6	ROI_1-7
CON1-20130825-KSK	0.068	0.408	0.818	0.123	0.957	-0.048
CON2-20130825-KKM	-0.164	0.577	0.62	0.051	0.753	-0.05
CON3-20130901-KMY	-0.28	0.081	0.202	-0.006	0.684	-0.392
CON4-20130929-KSB	0.02	0.146	0.739	0.095	0.371	-0.131
CON5-20131006-HTH	-0.245	0.039	0.1	0.154	0.203	-0.156
SPR1-20130901-CCS	0.058	0.229	0.514	0.301	0.577	-0.006
SPR2-20130901-OKS	0.218	-0.236	-0.262	0.128	0.264	-0.187
SPR3-20130901-BY	-0.017	0.033	0.021	-0.215	0.342	-0.081
SPR4-20131013-SSH	0.069	0.115	0.372	0.207	0.625	0.131
SPR5-20130929-YMJ	0.225	0.275	0.663	0.046	0.624	0.01

References for Atlas

- **AAL Atlas** (*n*=116)

  N. Tzourio-Mazoyer *et al.* (2002), Automated Anatomical Labeling of Activations in SPM Using a Macroscopic Anatomical Parcellation of the MNI MRI Single-Subject Brain, NeuroImage 15, 273-289 (2002)

- **Dosenbach Atlas** (*n*=160)

  Nico U. F. Dosenbach *et al.* (2010), Prediction of Individual Brain Maturity Using fMRI, *Science* 329:5997 pp.1358-1361.

  n=160, sphere shape, radius =5 mm, minimum distances between ROI center = 10 mm, no overlap among ROIs