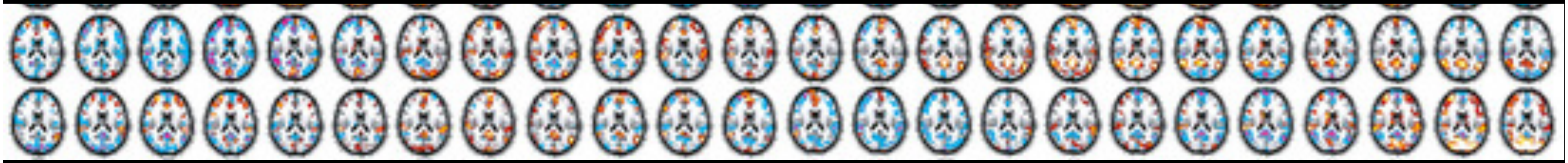
MATLAB TUTORIAL

How to Analyze fMRI on SPM

Independent Study in Psychology
Fall 2011

fMRI Datasets



Face fMRI Dataset:

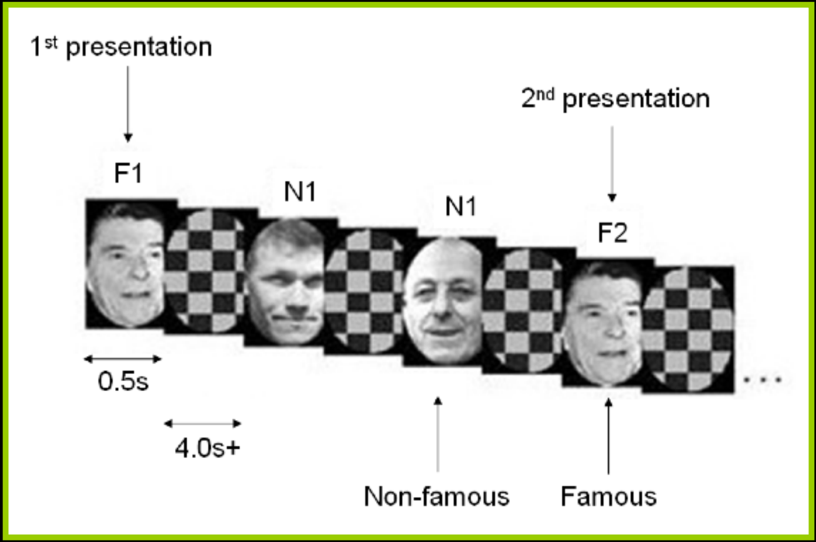
http://www.fil.ion.ucl.ac.uk/spm/data/face_rep/

Face Group fMRI Dataset:

http://www.fil.ion.ucl.ac.uk/spm/data/face_rfx/spm2_face_rfx.doc

Paradigm

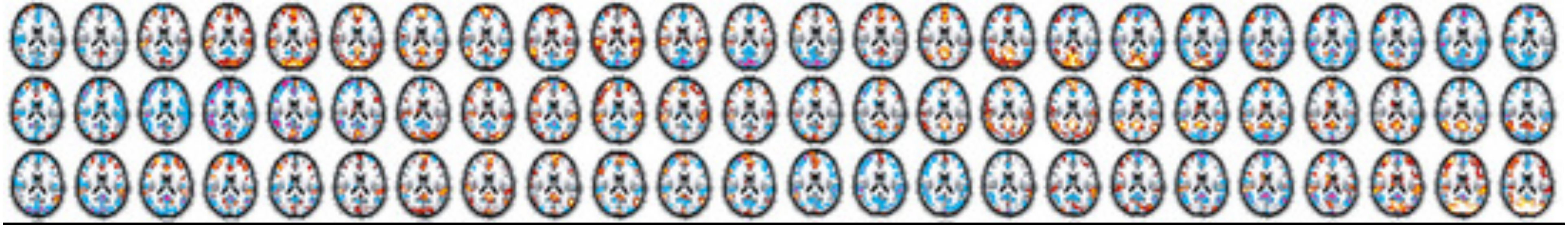
- Randomized presentation of 26 famous and 26 non-famous grayscale photographs
- Each face required a judgment denoting whether or not the face was famous



fMRI Data Collection

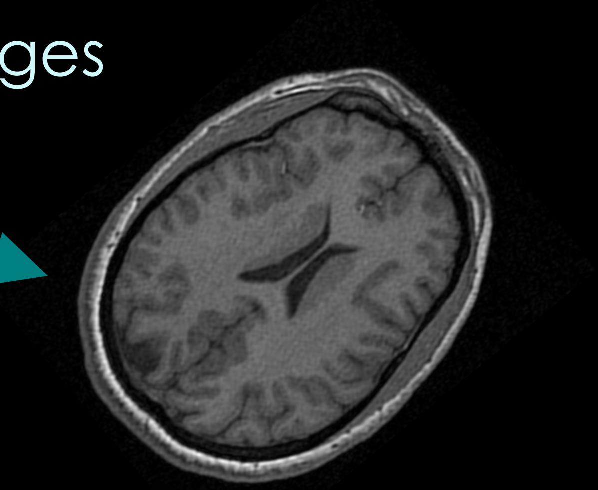
- Images were acquired using continuous Echo-Planar Imaging (EPI)
  - TE = 40 ms
  - TR = 2 s
  - 24 descending slices
    - 64 x 64 3 x 3 mm^2
    - 3 mm thick
    - 1.5 mm gap

fMRI First-Level Data Analysis

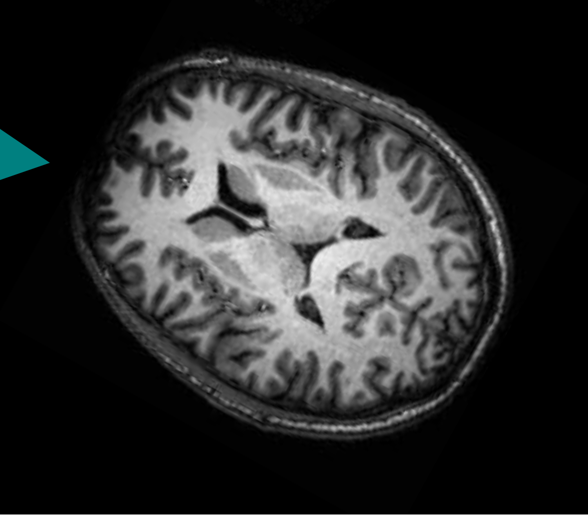


fMRI Data Files

- 351 Analyze format functional images
  - sM03953_0005_*.img



- Analyze format structural images
  - sM03953.img

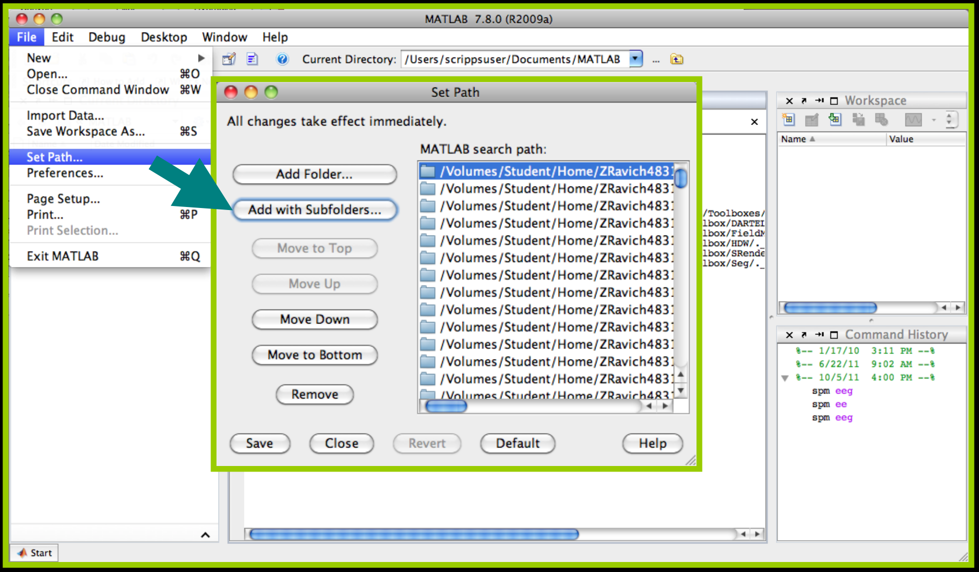


***Create 2 subdirectories:

1) jobs and 2) categorical***

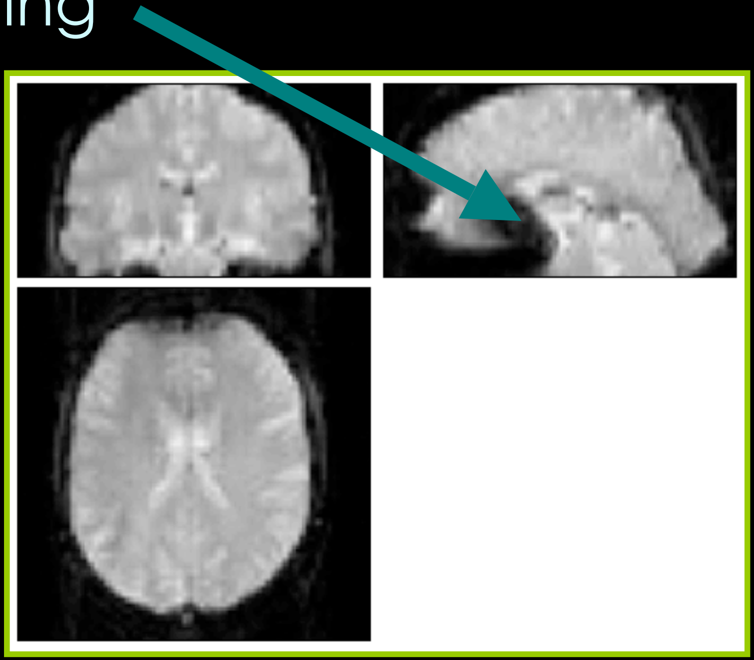
Step 1
Getting Started

- Open up MATLAB
- Go to “File” → “Set Path” → “Add with Subfolders” → Select the dataset folder (I.e., Home\ZoeRavich4831\MATLAB\Datasets)
  - “Do you want to save this path for future reference?”; Click “No”
- Go to the Command Window and type “spm fmri” to open up the fMRI GUI



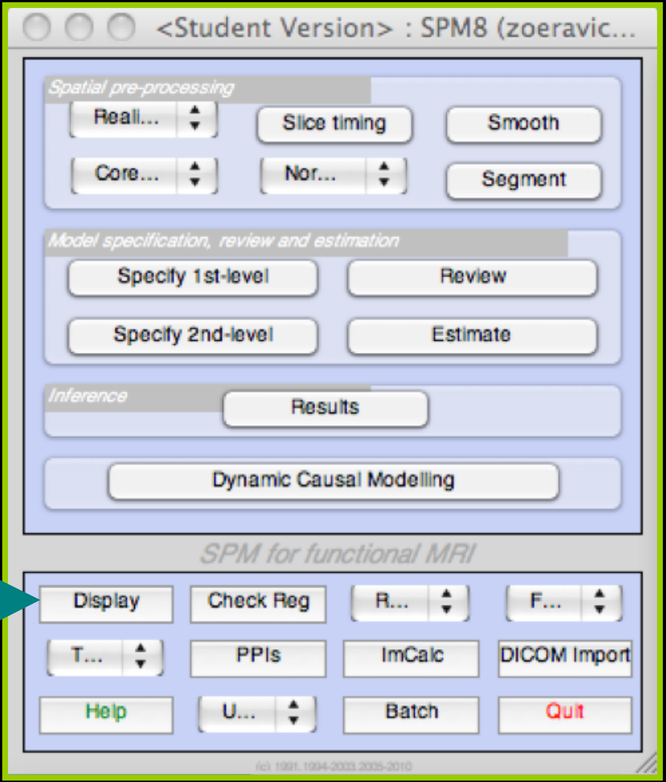
Step 2
Display

- Press the DISPLAY button
  - Select the first functional image
  - Note orbitofrontal and inferior temporal drop-out and ghosting

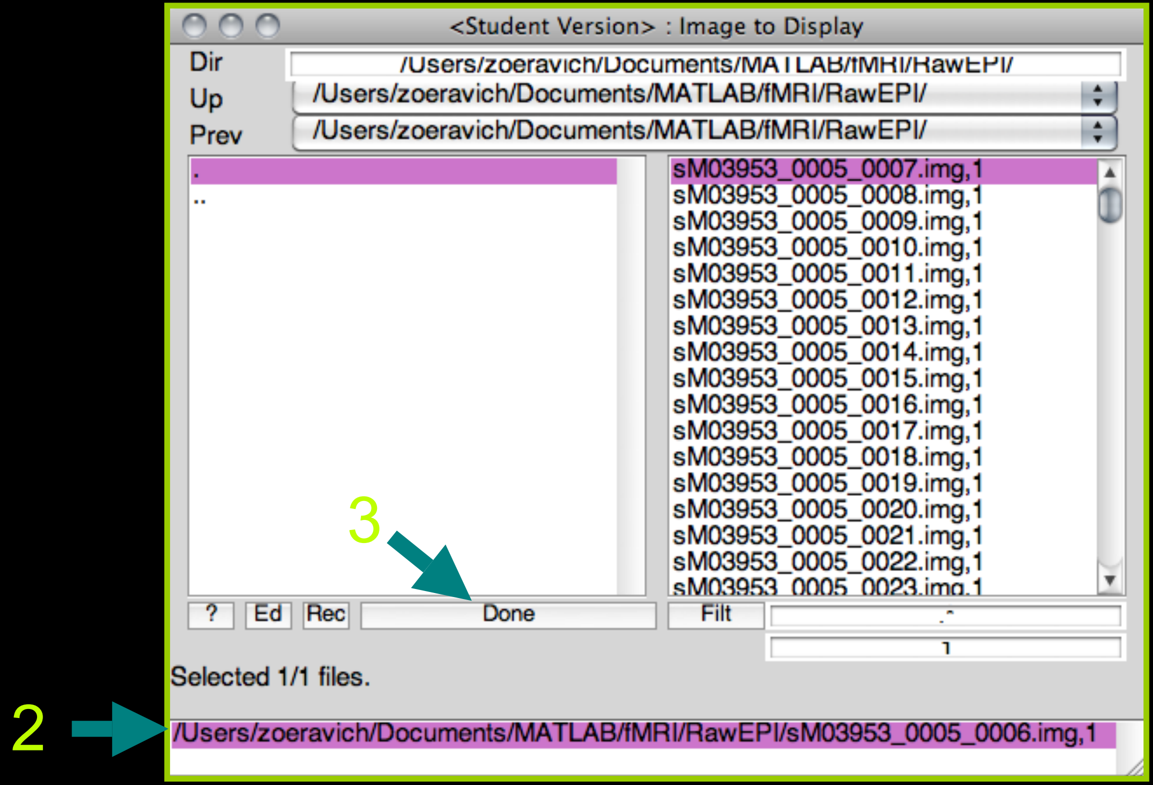


Step 2
Display

1



Step 2
Display



<Student Version> : Image to Display

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

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..

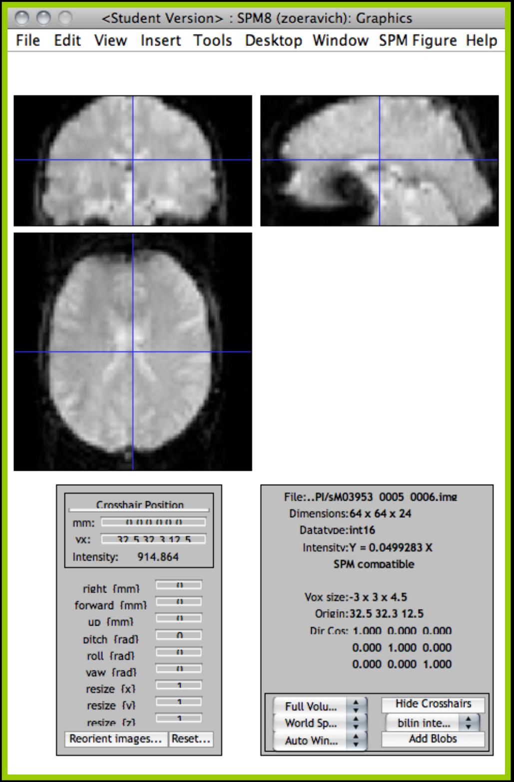
sM03953_0005_0007.img,1
sM03953_0005_0008.img,1
sM03953_0005_0009.img,1
sM03953_0005_0010.img,1
sM03953_0005_0011.img,1
sM03953_0005_0012.img,1
sM03953_0005_0013.img,1
sM03953_0005_0014.img,1
sM03953_0005_0015.img,1
sM03953_0005_0016.img,1
sM03953_0005_0017.img,1
sM03953_0005_0018.img,1
sM03953_0005_0019.img,1
sM03953_0005_0020.img,1
sM03953_0005_0021.img,1
sM03953_0005_0022.img,1
sM03953_0005_0023.img,1

.*
1

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0006.img,1

Step 2
Display



mm: 0.0 0.0 0.0
vx: 32.5 32.3 12.5
Intensity: 914.864

right {mm} 0
forward {mm} 0
up {mm} 0
pitch {rad} 0
roll {rad} 0
yaw {rad} 0
resize {x} 1
resize {y} 1
resize {z} 1

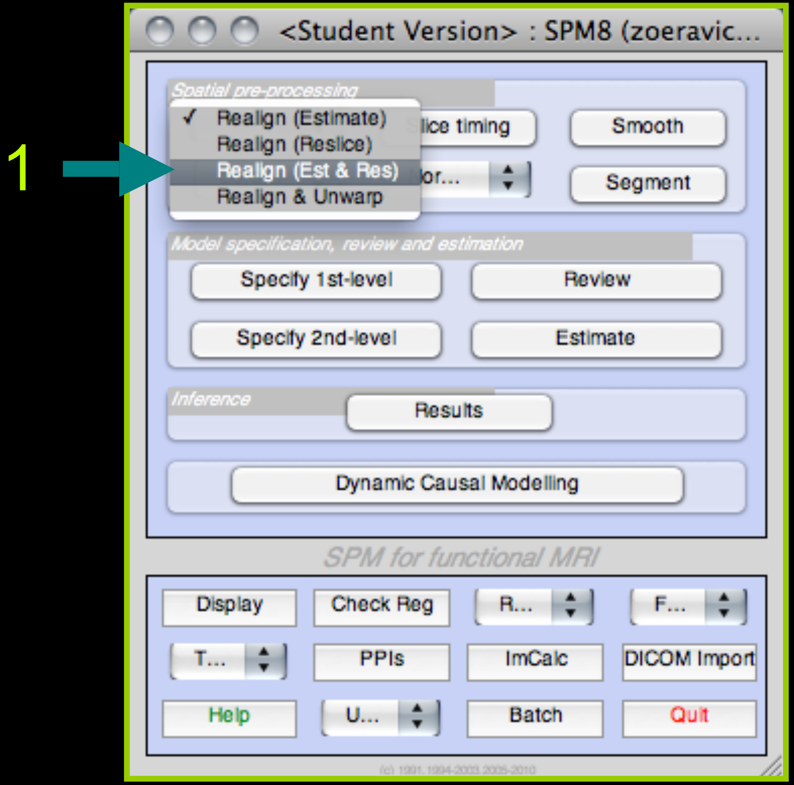
File:..PI/sM03953 0005 0006.img
Dimensions:64 x 64 x 24
Datatype:int16
Intensity:Y = 0.0499283 X
SPM compatible

Vox size:-3 x 3 x 4.5
Origin:32.5 32.3 12.5
Dir Cos: 1.000 0.000 0.000
0.000 1.000 0.000
0.000 0.000 1.000

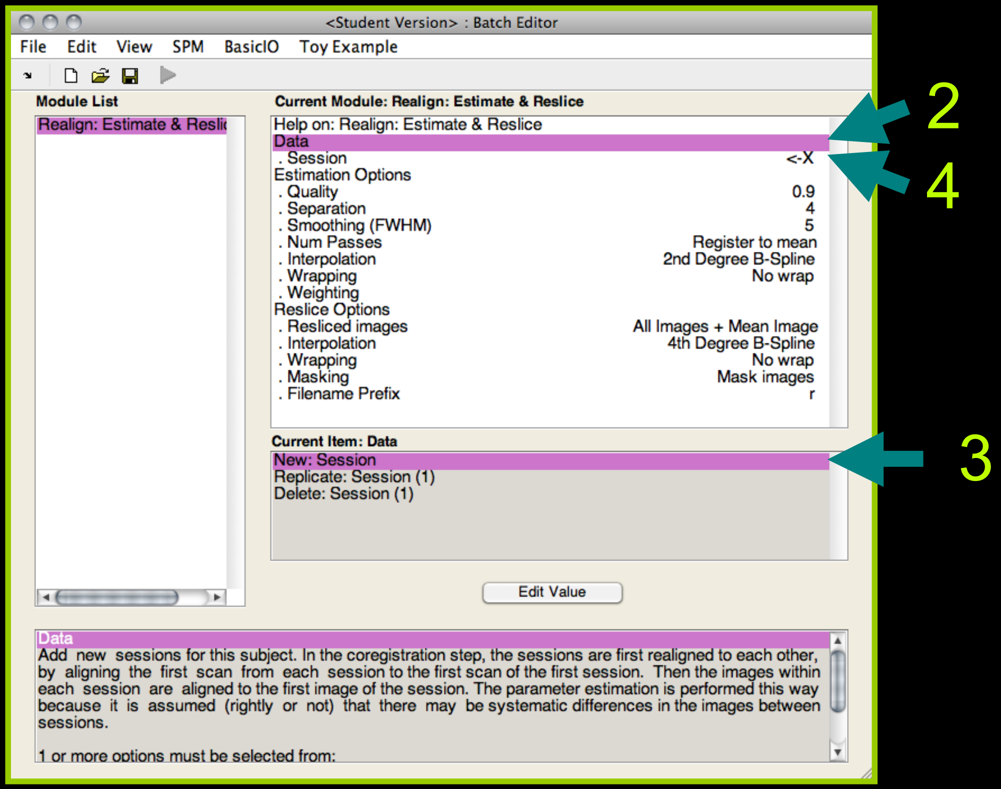
Step 3
Realignment

- Select REALIGN (EST & RES) from the “Realign” drop-down menu
  - Highlight “Data” and select “New Session”; then highlight the newly created “Session” option
  - Select “Specify Files” and choose all of the functional images using the filter ^s.*
  - Save the job as realign.mat
  - Press the “Run” button
- New files: rsM03953_0005_*.img, meansM03953_0005_0006.img (the mean image), and rp_sM03953_0005_0006.txt (the realignment parameters; copy into the DIR/jobs directory)

Step 3
Realignment



Step 3
Realignment



Current Module: Realign: Estimate & Reslice

Help on: Realign: Estimate & Reslice
Data
. Session <-X
Estimation Options
. Quality 0.9
. Separation 4
. Smoothing (FWHM) 5
. Num Passes Register to mean
. Interpolation 2nd Degree B-Spline
. Wrapping No wrap
. Weighting
Reslice Options
. Resliced images All Images + Mean Image
. Interpolation 4th Degree B-Spline
. Wrapping No wrap
. Masking Mask images
. Filename Prefix r

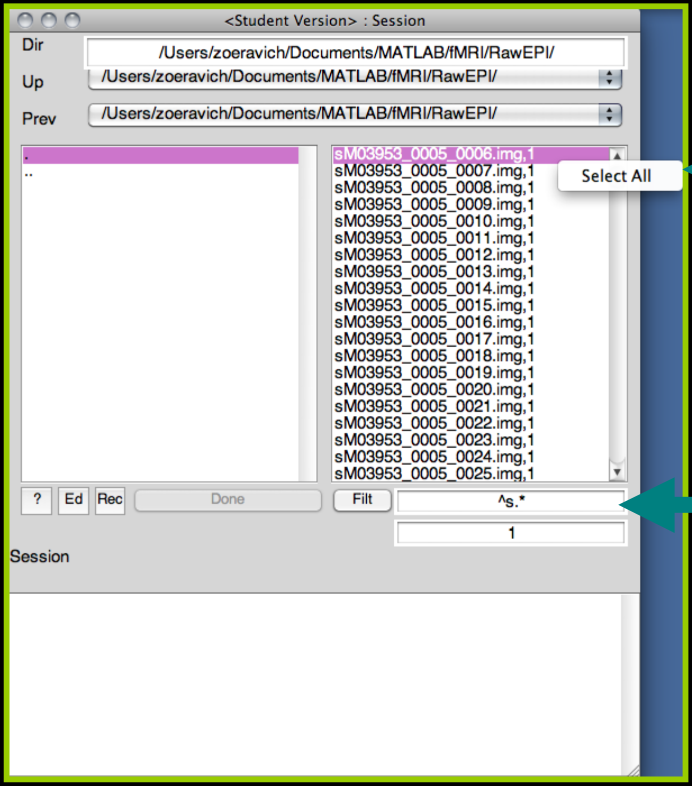
Current Item: Data

New: Session
Replicate: Session (1)
Delete: Session (1)

Data
Add new sessions for this subject. In the coregistration step, the sessions are first realigned to each other, by aligning the first scan from each session to the first scan of the first session. Then the images within each session are aligned to the first image of the session. The parameter estimation is performed this way because it is assumed (rightly or not) that there may be systematic differences in the images between sessions.

1 or more options must be selected from:

Step 3
Realignment



<Student Version> : Session

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

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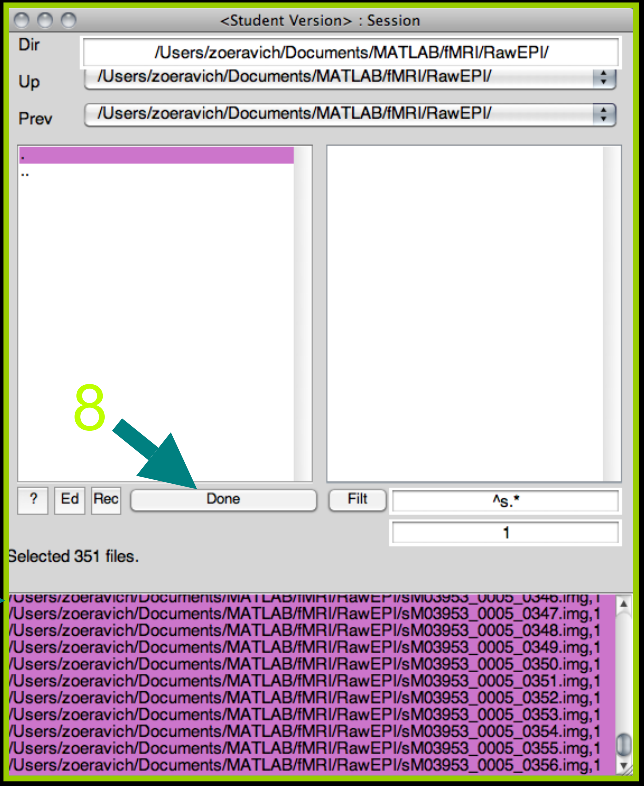
sM03953_0005_0006.img,1
sM03953_0005_0007.img,1
sM03953_0005_0008.img,1
sM03953_0005_0009.img,1
sM03953_0005_0010.img,1
sM03953_0005_0011.img,1
sM03953_0005_0012.img,1
sM03953_0005_0013.img,1
sM03953_0005_0014.img,1
sM03953_0005_0015.img,1
sM03953_0005_0016.img,1
sM03953_0005_0017.img,1
sM03953_0005_0018.img,1
sM03953_0005_0019.img,1
sM03953_0005_0020.img,1
sM03953_0005_0021.img,1
sM03953_0005_0022.img,1
sM03953_0005_0023.img,1
sM03953_0005_0024.img,1
sM03953_0005_0025.img,1
```

^s.*

1

Session



<Student Version> : Session

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

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```

^s.*

1

Selected 351 files.

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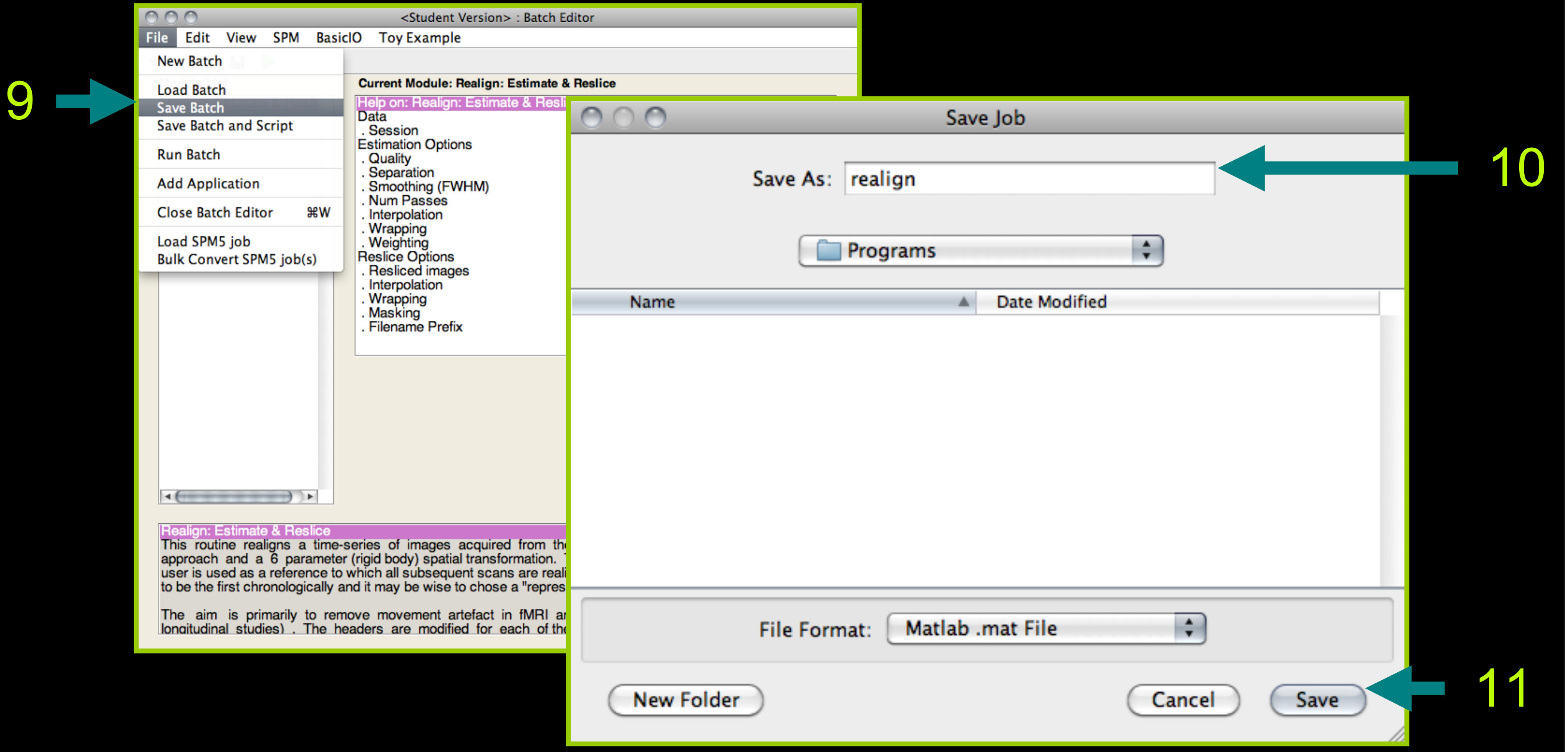
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0346.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0347.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0348.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0349.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0350.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0351.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0352.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0353.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0354.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0355.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_0356.img,1
```

Step 3
Realignment



Realign: Estimate & Reslice

This routine realigns a time-series of images acquired from th
approach and a 6 parameter (rigid body) spatial transformation.
user is used as a reference to which all subsequent scans are reali
to be the first chronologically and it may be wise to chose a "repres

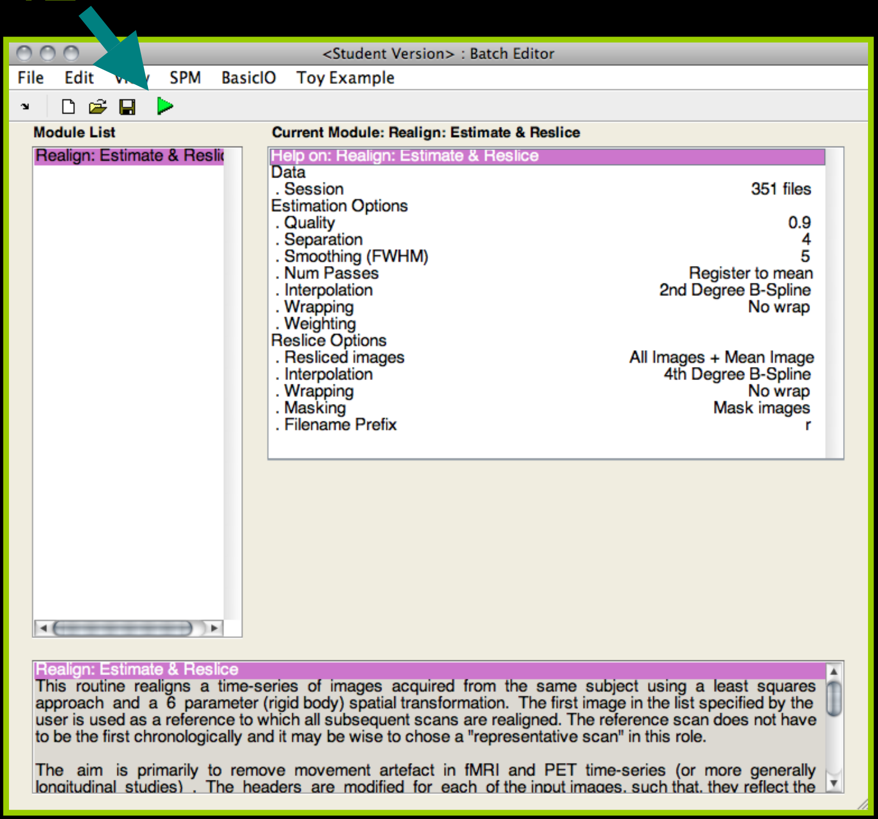
The aim is primarily to remove movement artefact in fMRI ar
longitudinal studies) . The headers are modified for each of th

Save As: realign

File Format: Matlab .mat File

Step 3
Realignment

12



Current Module: Realign: Estimate & Reslice

Help on: Realign: Estimate & Reslice

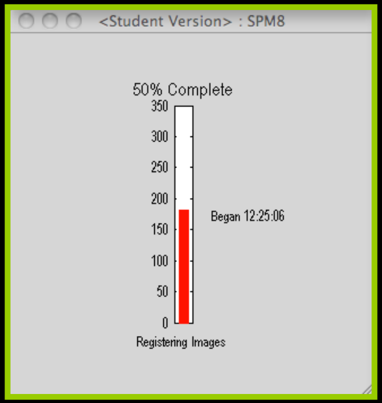
Data	
. Session	351 files
Estimation Options	
. Quality	0.9
. Separation	4
. Smoothing (FWHM)	5
. Num Passes	Register to mean
. Interpolation	2nd Degree B-Spline
. Wrapping	No wrap
. Weighting	
Reslice Options	
. Resliced images	All Images + Mean Image
. Interpolation	4th Degree B-Spline
. Wrapping	No wrap
. Masking	Mask images
. Filename Prefix	r

Realign: Estimate & Reslice

This routine realigns a time-series of images acquired from the same subject using a least squares approach and a 6 parameter (rigid body) spatial transformation. The first image in the list specified by the user is used as a reference to which all subsequent scans are realigned. The reference scan does not have to be the first chronologically and it may be wise to chose a "representative scan" in this role.

The aim is primarily to remove movement artefact in fMRI and PET time-series (or more generally longitudinal studies) . The headers are modified for each of the input images, such that, they reflect the

Processing…



Step 3
Realignment

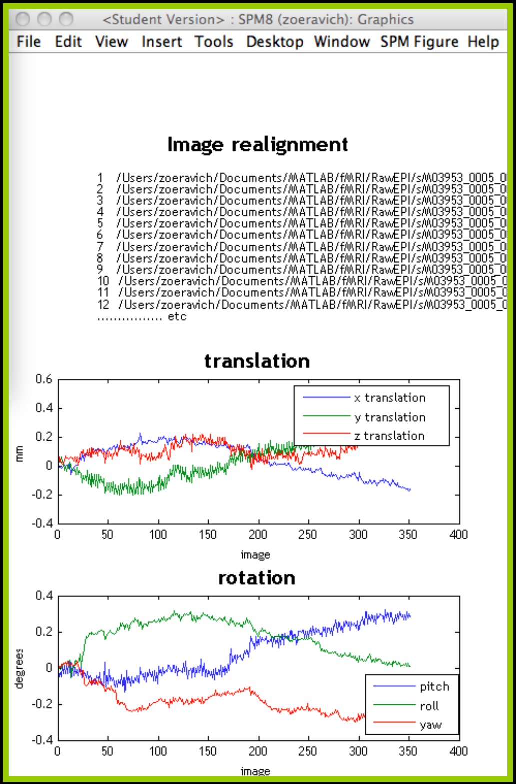


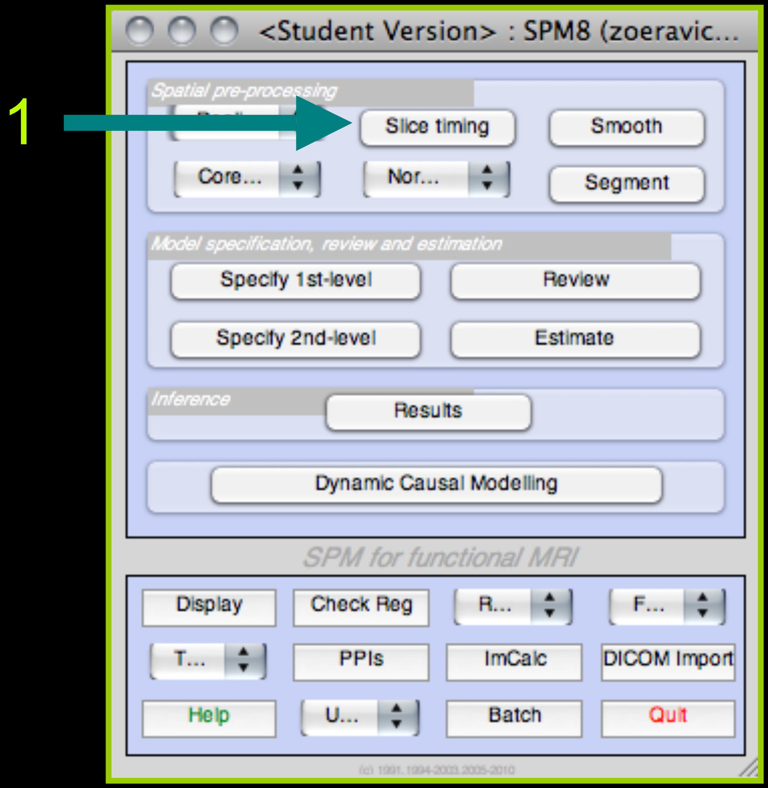
Image realignment

```
1   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
2   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
3   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
4   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
5   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
6   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
7   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
8   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
9   /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
10  /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
11  /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
12  /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/sM03953_0005_
................ etc
```

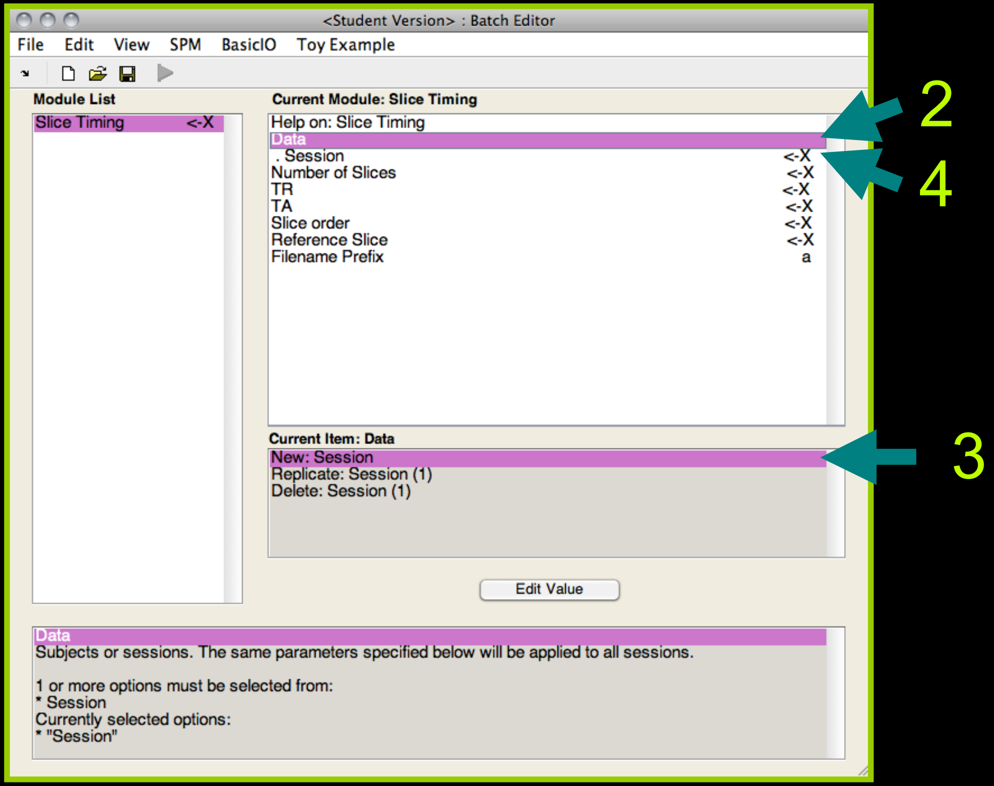
Step 4
Slice Timing Correction

- Press the SLICE TIMING button
  - Highlight “Data” and select “New Sessions”
  - Select “Specify Files” and choose all of the 351 realigned functional images using the filter ^r.*
    - “Number of Slices”; Type “24”
    - “TR”; Type “2”
    - “TA”; Type “2 - 2/24”
    - “Slice order”; Type “24:-1:1”
    - “Reference Slice”; Type “12”
  - Save the job as slice_timing.mat
  - Press the “Run” button
- New files: arsM03953_0005_*.img

Step 4
Slice Timing Correction



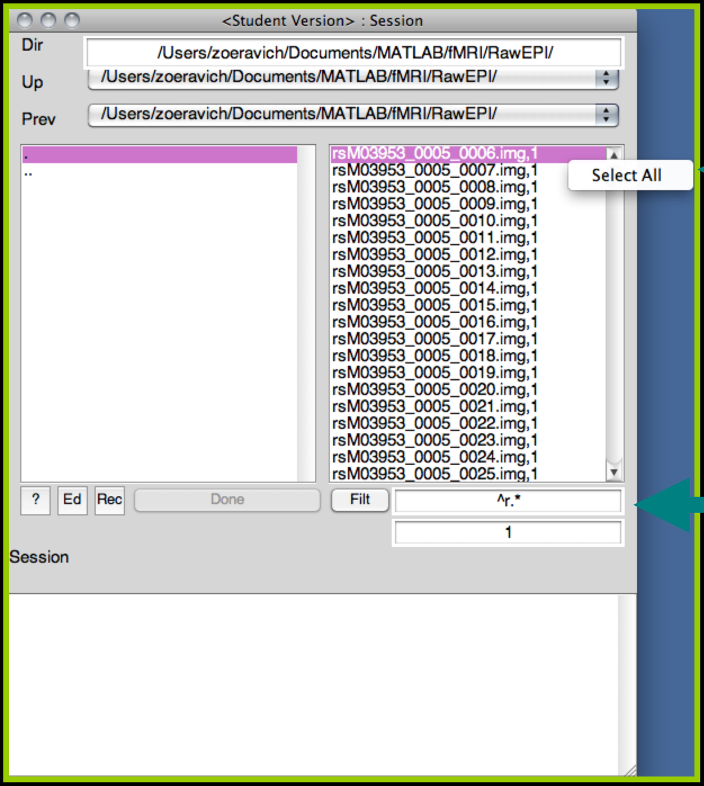
Step 4
Slice Timing Correction



Data
Subjects or sessions. The same parameters specified below will be applied to all sessions.

1 or more options must be selected from:
* Session
Currently selected options:
* "Session"

Step 4
Slice Timing Correction



Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

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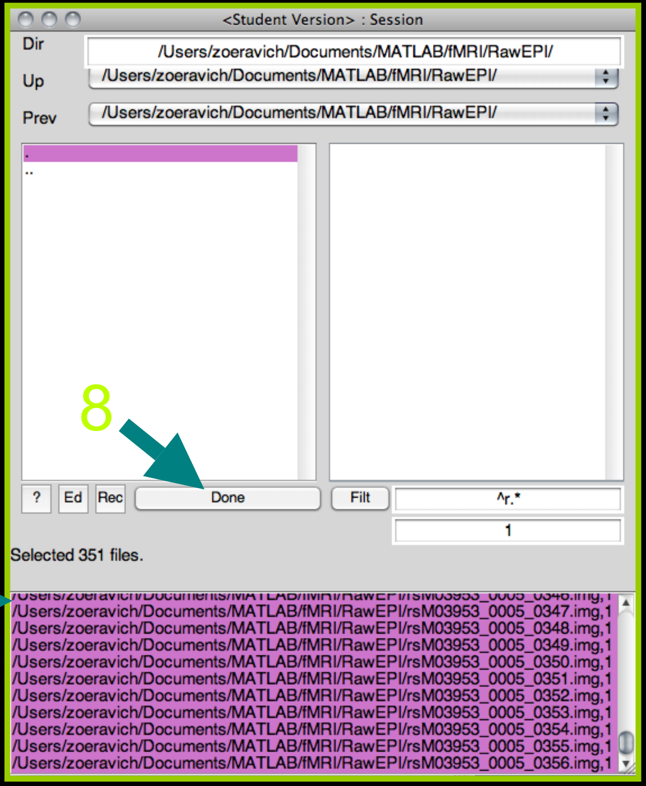
rsM03953_0005_0006.img,1
rsM03953_0005_0007.img,1
rsM03953_0005_0008.img,1
rsM03953_0005_0009.img,1
rsM03953_0005_0010.img,1
rsM03953_0005_0011.img,1
rsM03953_0005_0012.img,1
rsM03953_0005_0013.img,1
rsM03953_0005_0014.img,1
rsM03953_0005_0015.img,1
rsM03953_0005_0016.img,1
rsM03953_0005_0017.img,1
rsM03953_0005_0018.img,1
rsM03953_0005_0019.img,1
rsM03953_0005_0020.img,1
rsM03953_0005_0021.img,1
rsM03953_0005_0022.img,1
rsM03953_0005_0023.img,1
rsM03953_0005_0024.img,1
rsM03953_0005_0025.img,1
```

^r.*

1

Session



Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

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1

Selected 351 files.

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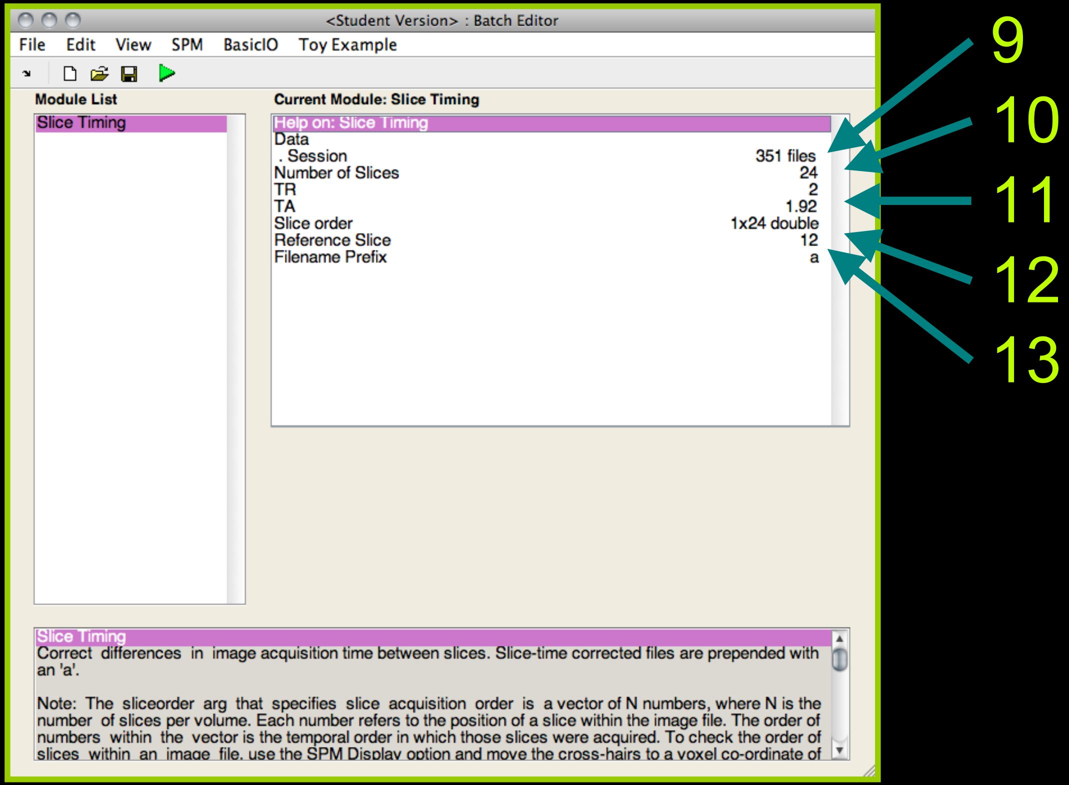
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0346.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0347.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0348.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0349.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0350.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0351.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0352.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0353.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0354.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0355.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/rsM03953_0005_0356.img,1
```

Step 4
Slice Timing Correction



Slice Timing

Help on: Slice Timing

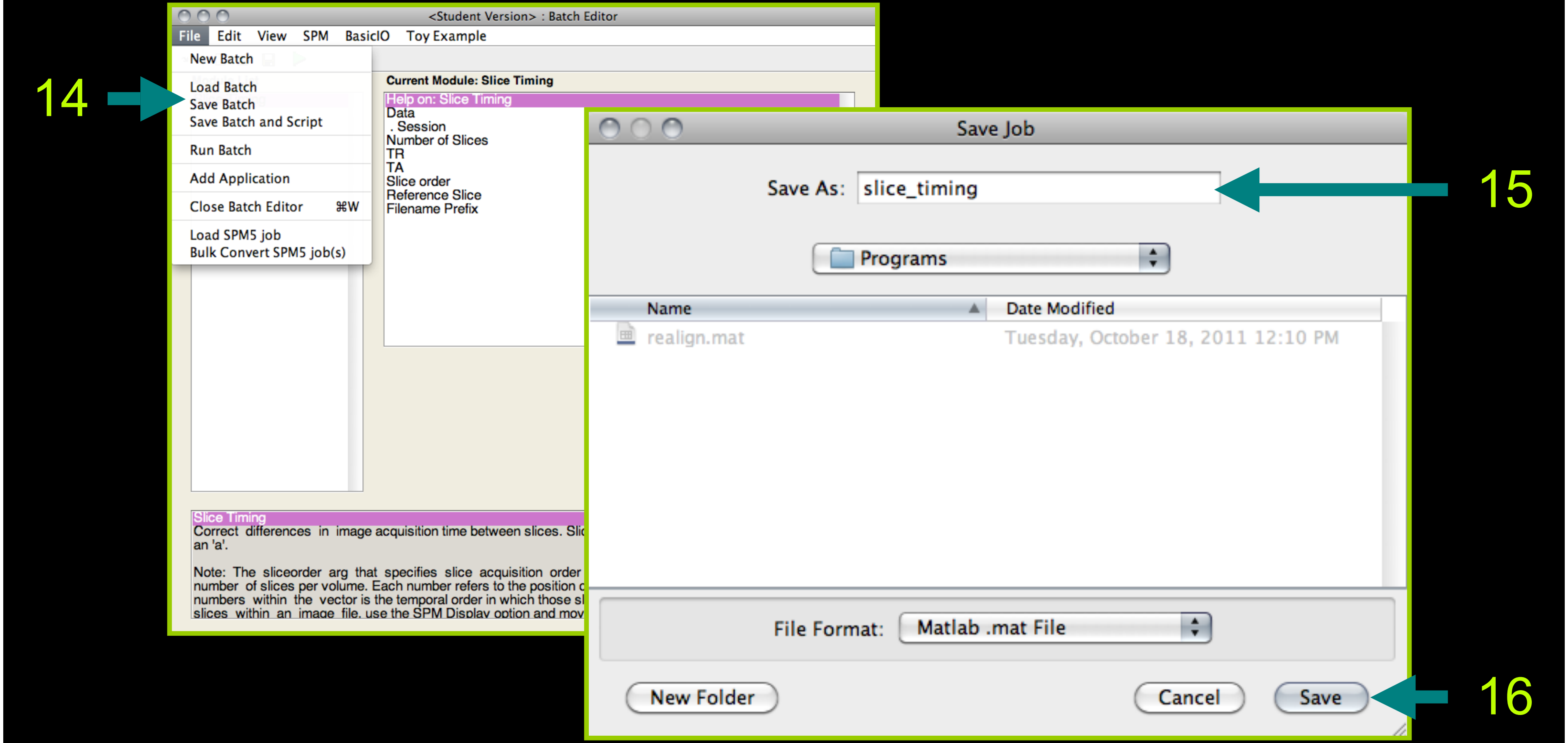
Data
. Session 351 files
Number of Slices 24
TR 2
TA 1.92
Slice order 1x24 double
Reference Slice 12
Filename Prefix a

Slice Timing

Correct differences in image acquisition time between slices. Slice-time corrected files are prepended with an 'a'.

Note: The sliceorder arg that specifies slice acquisition order is a vector of N numbers, where N is the number of slices per volume. Each number refers to the position of a slice within the image file. The order of numbers within the vector is the temporal order in which those slices were acquired. To check the order of slices within an image file, use the SPM Display option and move the cross-hairs to a voxel co-ordinate of

Step 4
Slice Timing Correction



Current Module: Slice Timing

Slice Timing
Correct differences in image acquisition time between slices. Slic
an 'a'.

Note: The sliceorder arg that specifies slice acquisition order
number of slices per volume. Each number refers to the position c
numbers within the vector is the temporal order in which those sl
slices within an image file. use the SPM Display option and mov

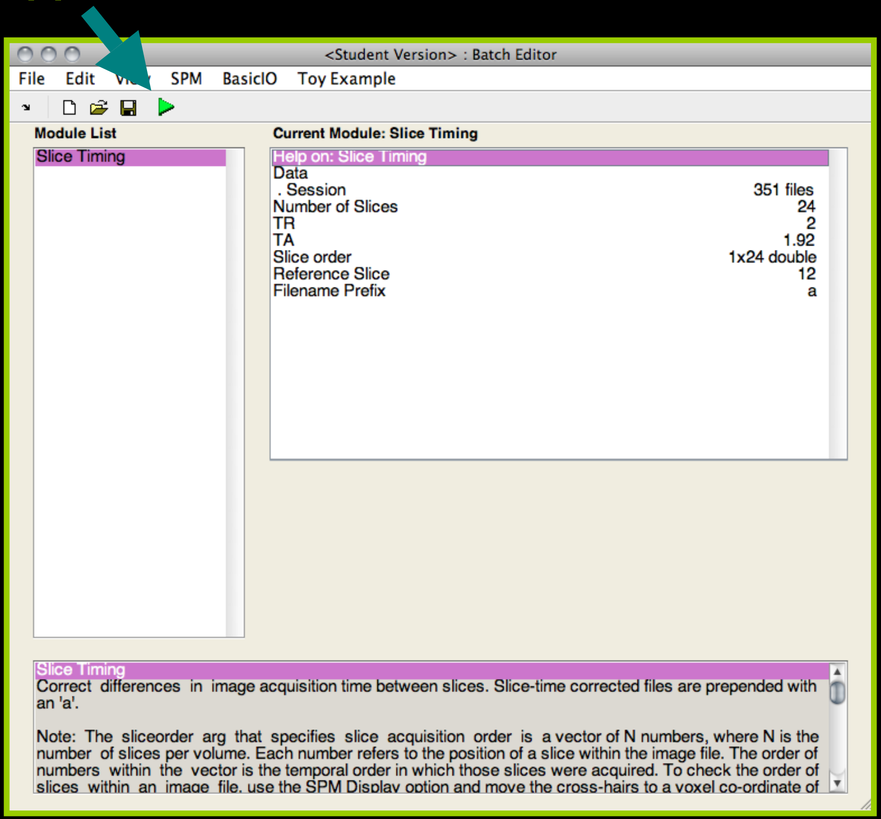
Save As: slice_timing

realign.mat Tuesday, October 18, 2011 12:10 PM

File Format: Matlab .mat File

Step 4
Slice Timing Correction

17



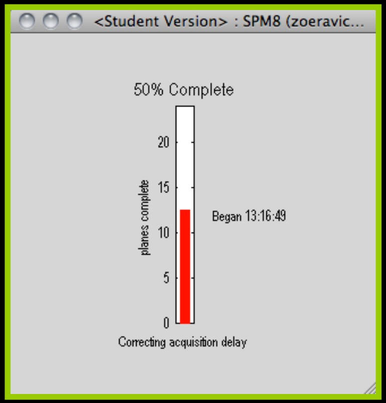
Data	
. Session	351 files
Number of Slices	24
TR	2
TA	1.92
Slice order	1x24 double
Reference Slice	12
Filename Prefix	a

Slice Timing

Correct differences in image acquisition time between slices. Slice-time corrected files are prepended with an 'a'.

Note: The sliceorder arg that specifies slice acquisition order is a vector of N numbers, where N is the number of slices per volume. Each number refers to the position of a slice within the image file. The order of numbers within the vector is the temporal order in which those slices were acquired. To check the order of slices within an image file, use the SPM Display option and move the cross-hairs to a voxel co-ordinate of

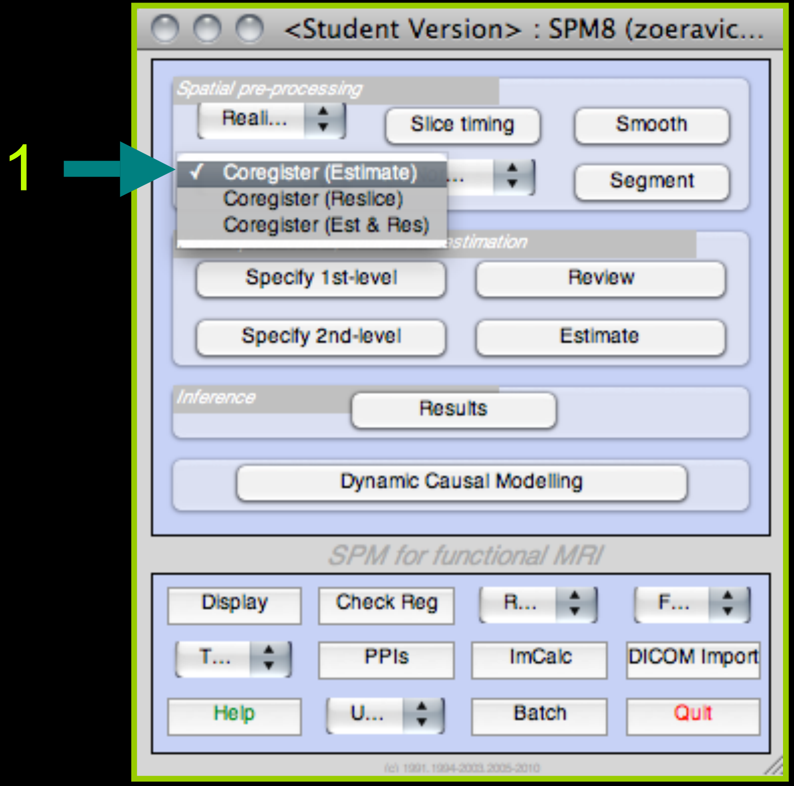
Processing…



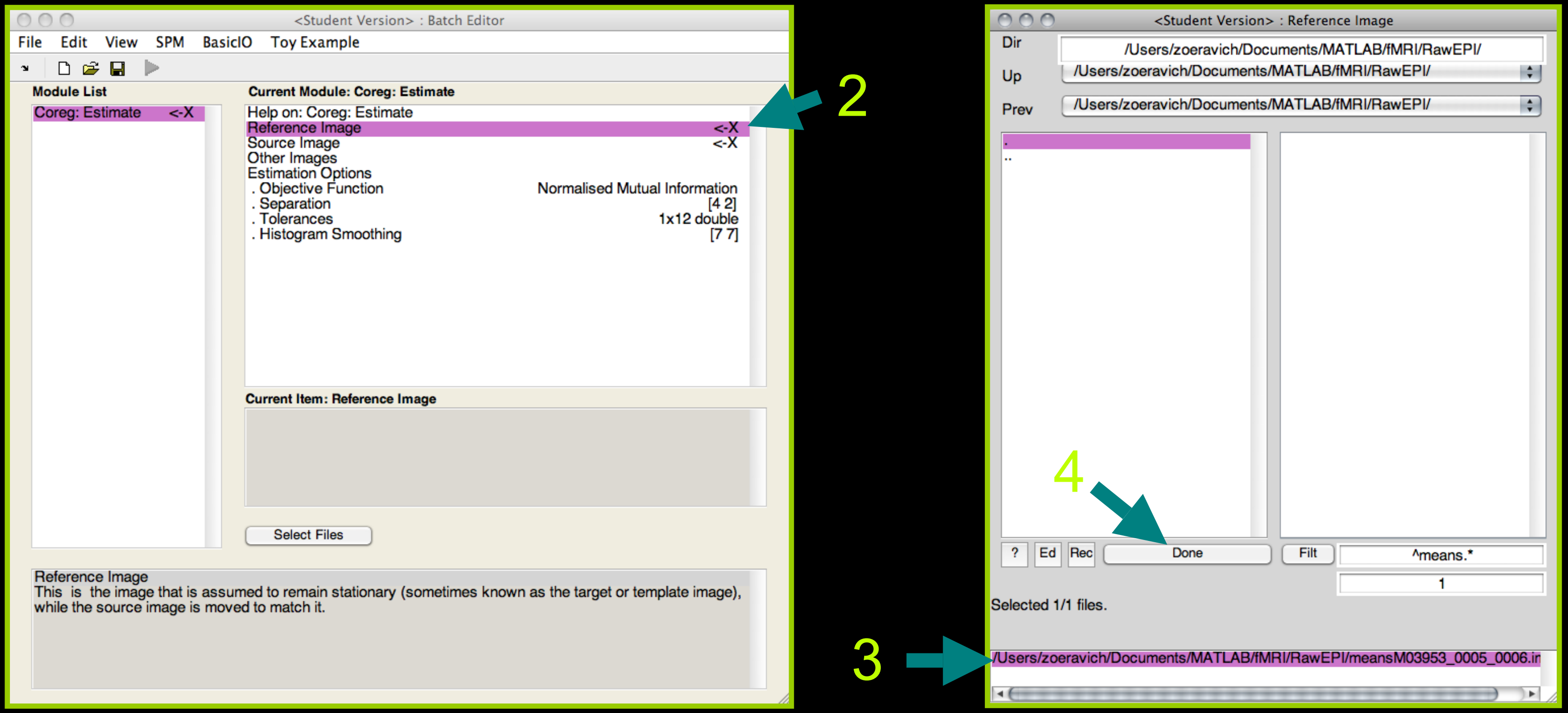
Step 5
Coregistration

- Select COREGISTER (ESTIMATE) from the “Coregister” drop-down menu
  - Highlight “Reference Image” and select the meansM03953_0007.img file
  - Highlight “Source Image” and select the sM03953_0007.img file
  - Save the job as coreg.mat
  - Press the “Run” button
- New files: sM03953_0007.img

Step 5
Coregistration



Step 5
Coregistration



Coreg: Estimate <-X

Current Module: Coreg: Estimate

Help on: Coreg: Estimate
Reference Image <-X
Source Image <-X
Other Images
Estimation Options
. Objective Function Normalised Mutual Information
. Separation [4 2]
. Tolerances 1x12 double
. Histogram Smoothing [7 7]

Current Item: Reference Image

Reference Image
This is the image that is assumed to remain stationary (sometimes known as the target or template image), while the source image is moved to match it.

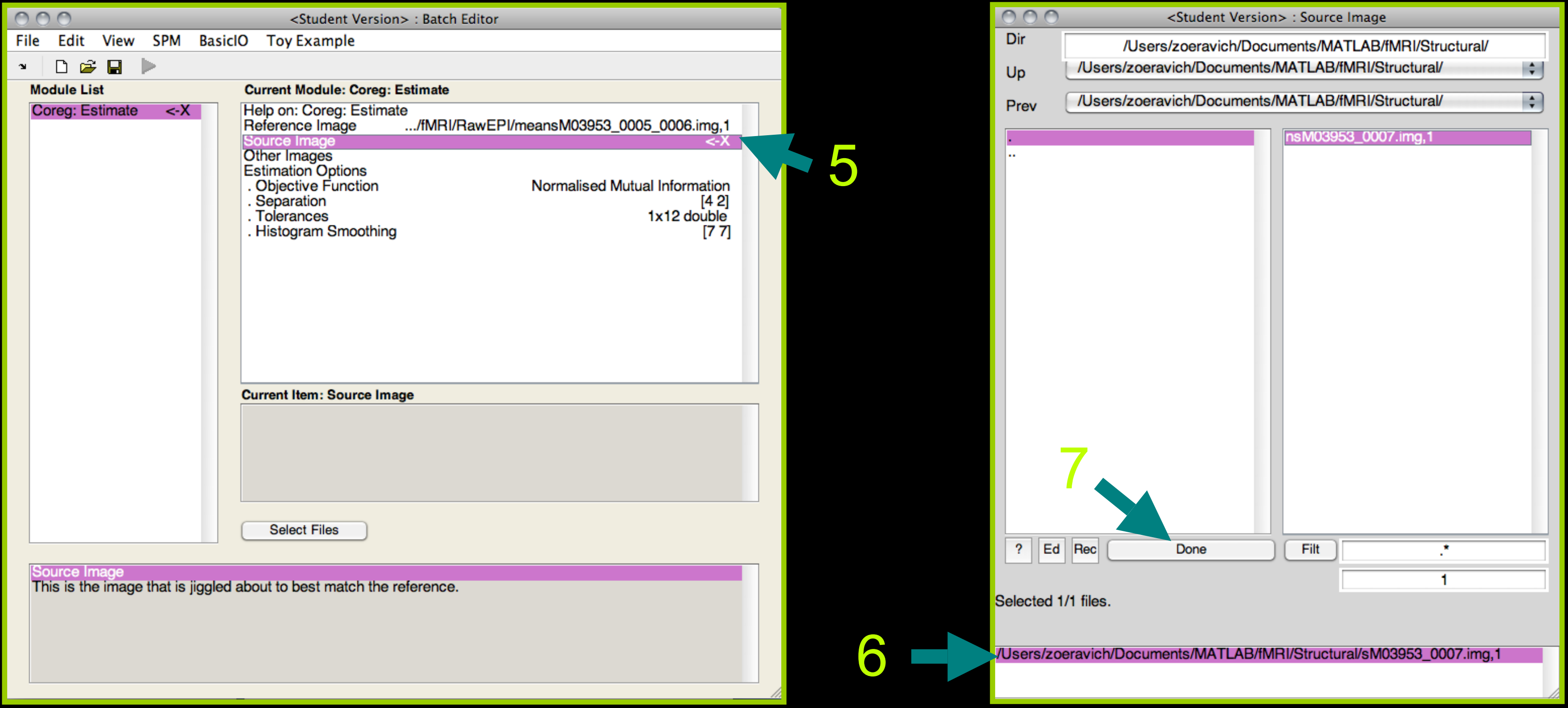
Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

^means.*
1

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/meansM03953_0005_0006.i

Step 5
Coregistration



Current Module: Coreg: Estimate

Help on: Coreg: Estimate
Reference Image ../fMRI/RawEPI/meansM03953_0005_0006.img,1
Source Image <-X
Other Images
Estimation Options
. Objective Function Normalised Mutual Information
. Separation [4 2]
. Tolerances 1x12 double
. Histogram Smoothing [7 7]

Current Item: Source Image

Source Image
This is the image that is jiggled about to best match the reference.

Dir /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Up /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

.
..

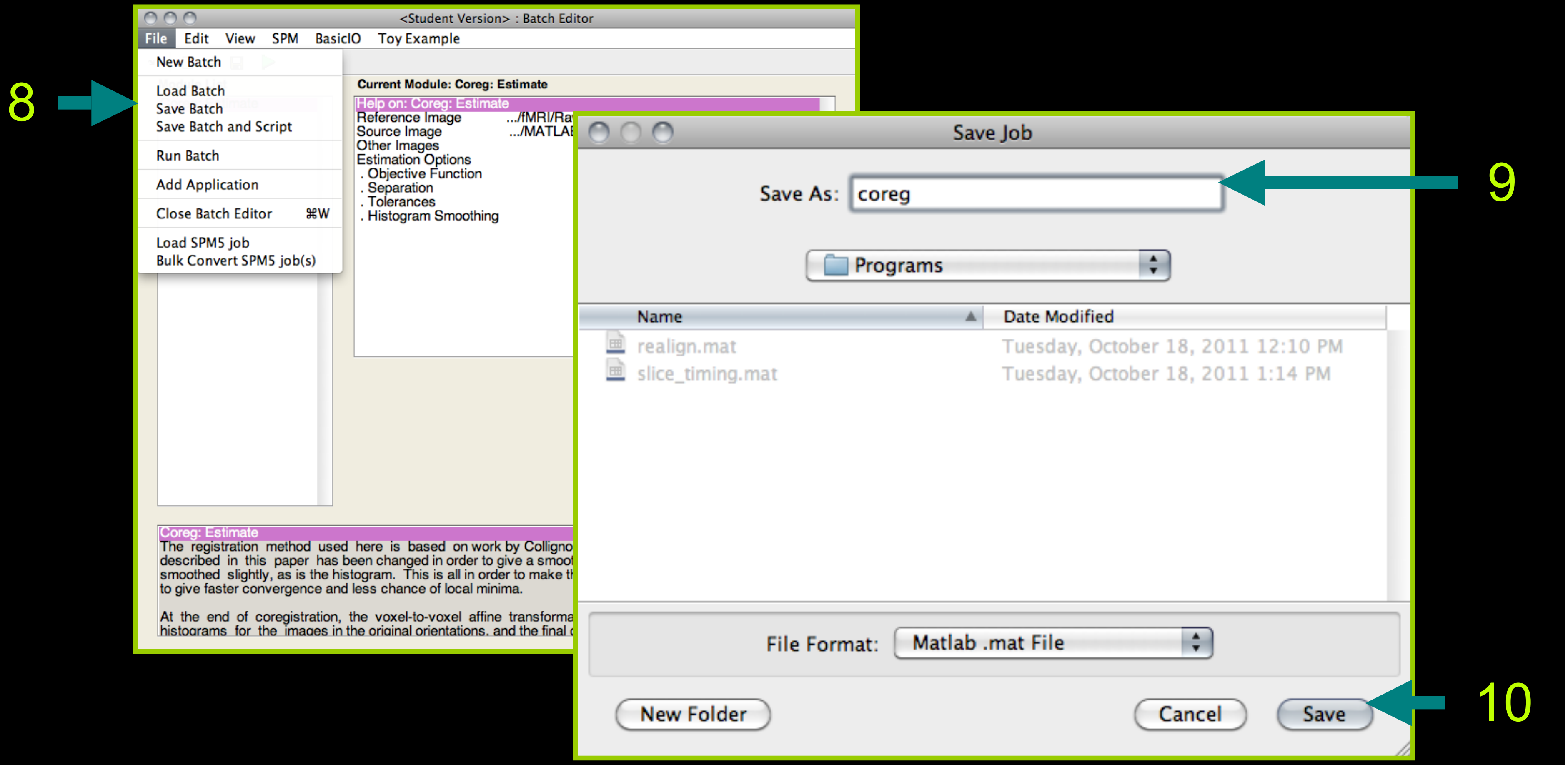
nsM03953_0007.img,1

Filt .*
1

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/sM03953_0007.img,1

Step 5
Coregistration



Reference Image .../fMRI/Ra

Source Image .../MATLAI

Coreg: Estimate

The registration method used here is based on work by Colligno described in this paper has been changed in order to give a smoot smoothed slightly, as is the histogram. This is all in order to make t to give faster convergence and less chance of local minima.

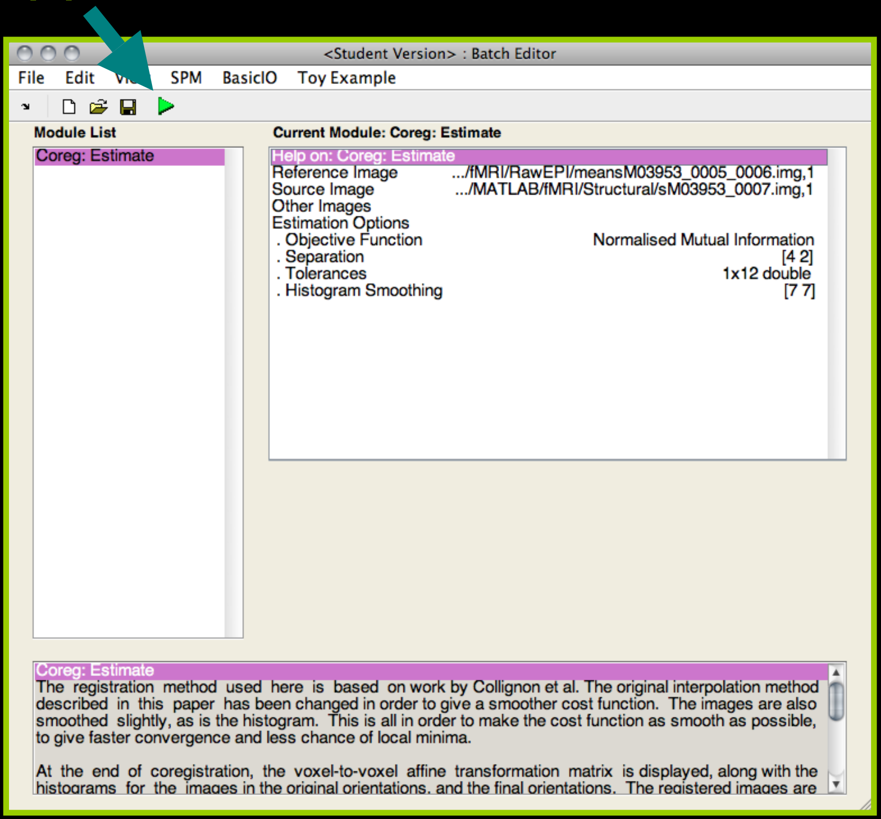
At the end of coregistration, the voxel-to-voxel affine transforma histograms for the images in the original orientations, and the final

Save As: coreg

File Format: Matlab .mat File

Step 5
Coregistration

11



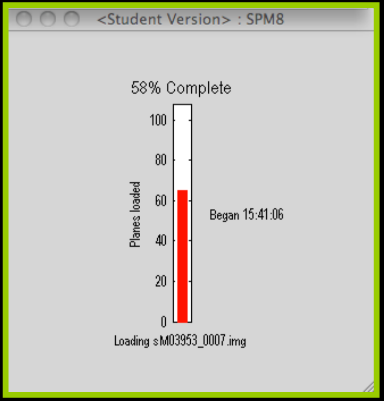
Reference Image	.../fMRI/RawEPI/meansM03953_0005_0006.img,1
Source Image	.../MATLAB/fMRI/Structural/sM03953_0007.img,1
Other Images	
Estimation Options	
. Objective Function	Normalised Mutual Information
. Separation	[4 2]
. Tolerances	1x12 double
. Histogram Smoothing	[7 7]

Coreg: Estimate

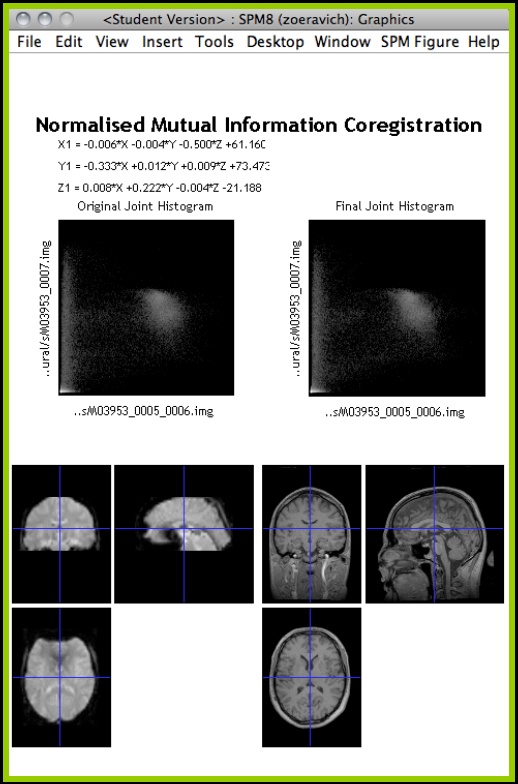
The registration method used here is based on work by Collignon et al. The original interpolation method described in this paper has been changed in order to give a smoother cost function. The images are also smoothed slightly, as is the histogram. This is all in order to make the cost function as smooth as possible, to give faster convergence and less chance of local minima.

At the end of coregistration, the voxel-to-voxel affine transformation matrix is displayed, along with the histograms for the images in the original orientations, and the final orientations. The registered images are

Processing…



Step 5
Coregistration



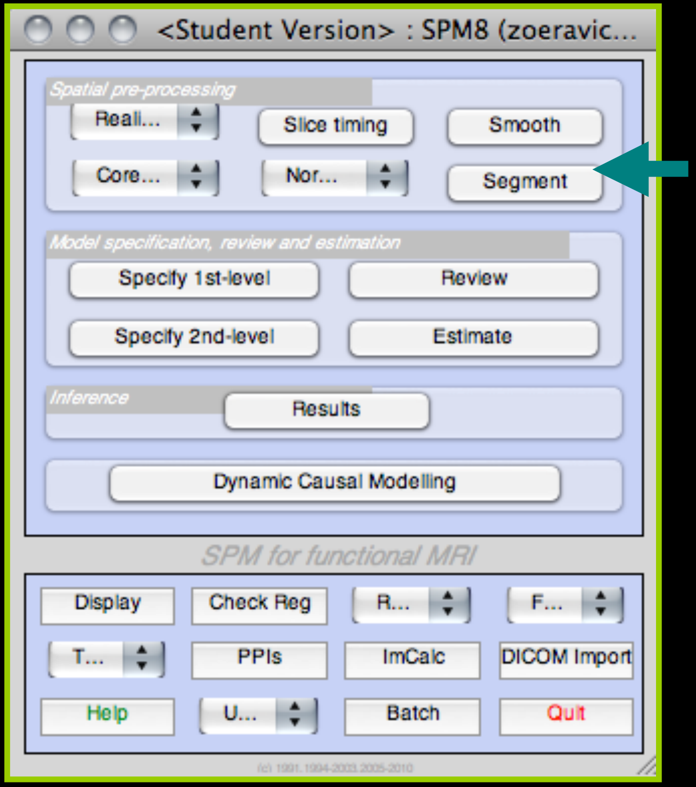
Normalised Mutual Information Coregistration

```
X1 = -0.006*X -0.004*Y -0.500*Z +61.160
Y1 = -0.333*X +0.012*Y +0.009*Z +73.473
Z1 = 0.008*X +0.222*Y -0.004*Z -21.188
```

Step 6
Segmentation

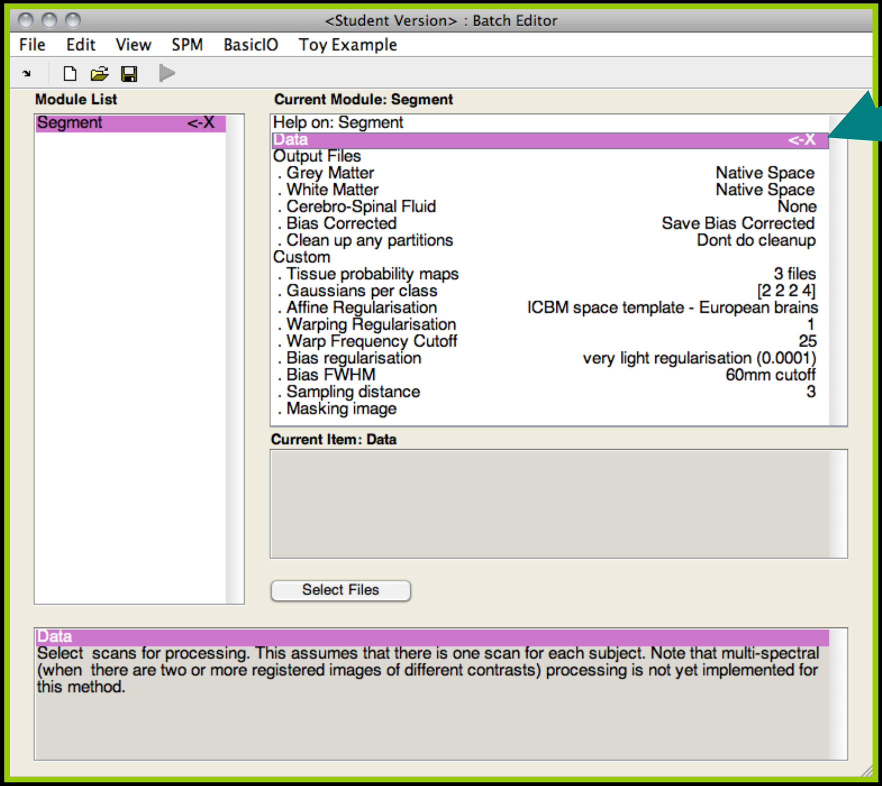
- Press the SEGMENT button
  - Highlight “Data” and select the coregistered sM03953_0007.img file
  - Save the job as segment.mat
  - Press the “Run” button
- New files: msM03953_0007.img, c*sM03953_0007.img (the gray matter and white matter images) and sM03953_0007_seg_sn.mat (the spatial normalisation)
- Press the CHECK REG button
  - Select the grey matter, white mater, and original structural images

Step 6
Segmentation



1

Step 6
Segmentation



Current Module: Segment

Help on: Segment

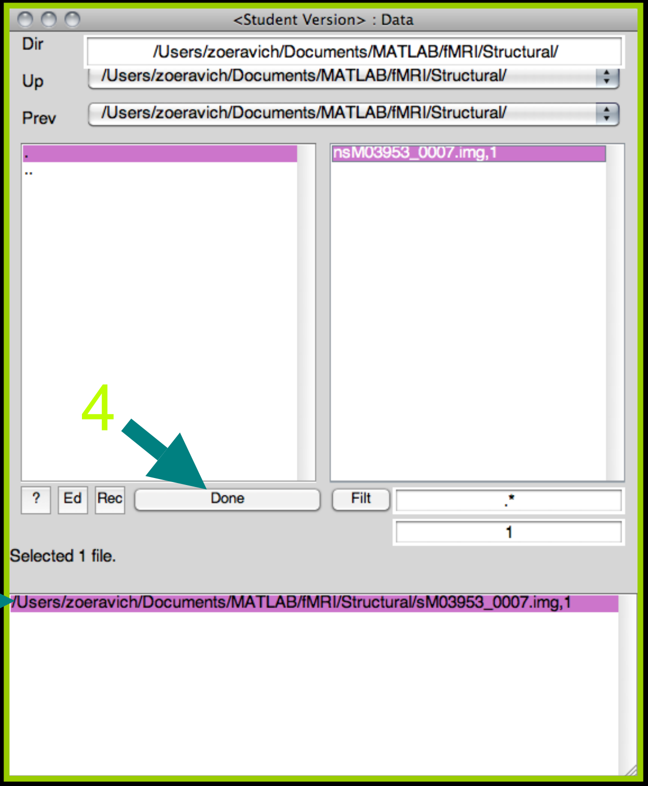
Data <-X

Output Files	
. Grey Matter	Native Space
. White Matter	Native Space
. Cerebro-Spinal Fluid	None
. Bias Corrected	Save Bias Corrected
. Clean up any partitions	Dont do cleanup
Custom	
. Tissue probability maps	3 files
. Gaussians per class	[2 2 2 4]
. Affine Regularisation	ICBM space template - European brains
. Warping Regularisation	1
. Warp Frequency Cutoff	25
. Bias regularisation	very light regularisation (0.0001)
. Bias FWHM	60mm cutoff
. Sampling distance	3
. Masking image	

Current Item: Data

Data

Select scans for processing. This assumes that there is one scan for each subject. Note that multi-spectral (when there are two or more registered images of different contrasts) processing is not yet implemented for this method.



Dir /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

Up /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

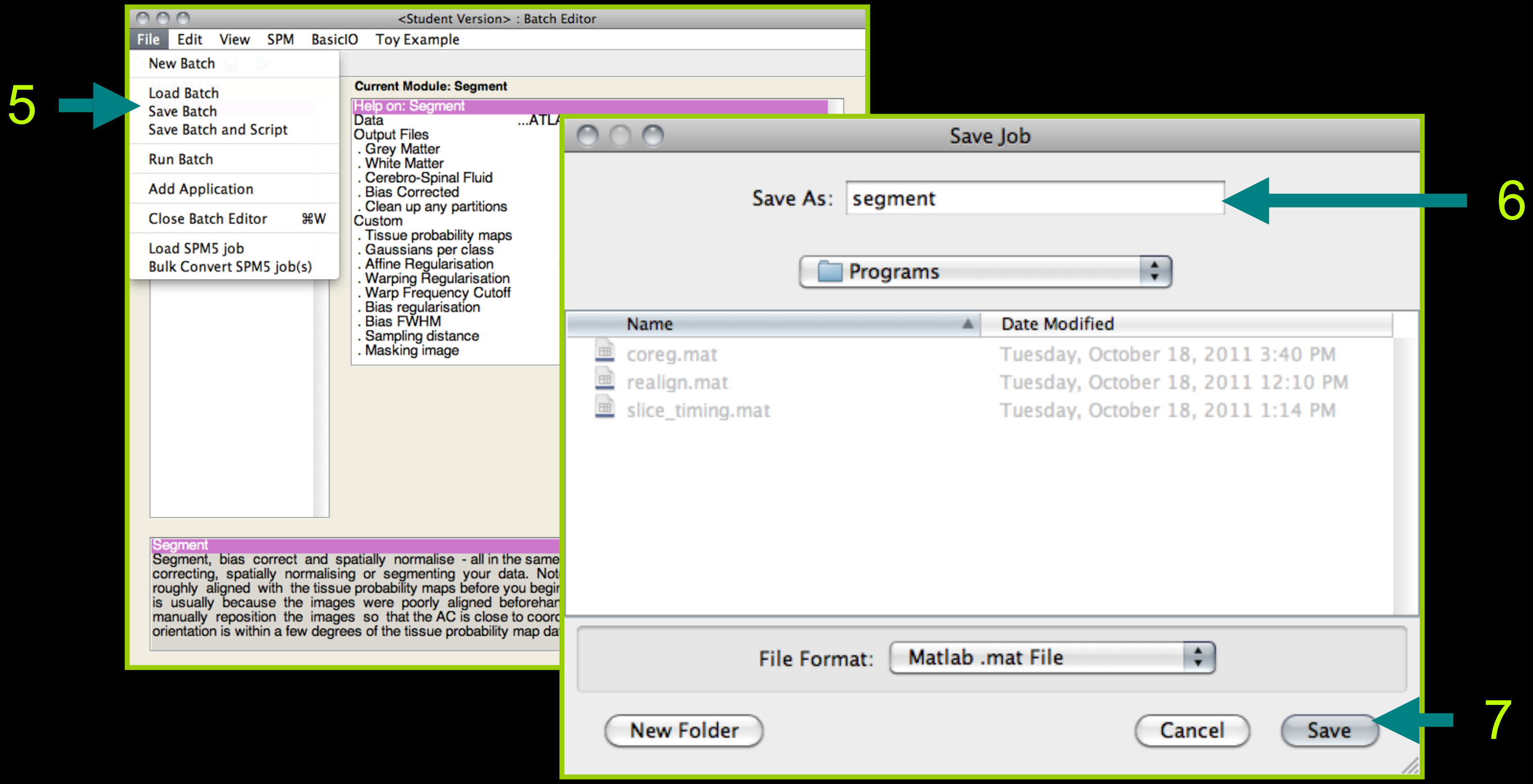
Prev /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

nsM03953_0007.img,1

Selected 1 file.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/sM03953_0007.img,1

Step 6
Segmentation



Segment, bias correct and spatially normalise - all in the same correcting, spatially normalising or segmenting your data. Not roughly aligned with the tissue probability maps before you begi is usually because the images were poorly aligned beforehar manually reposition the images so that the AC is close to coord orientation is within a few degrees of the tissue probability map da

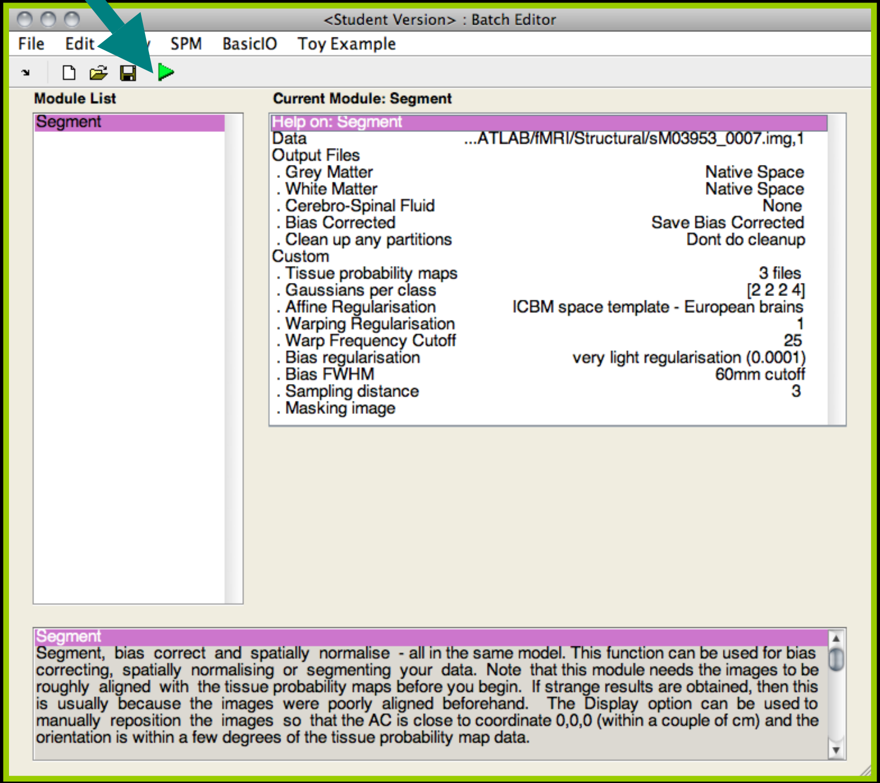
Save As: segment

Name	Date Modified
coreg.mat	Tuesday, October 18, 2011 3:40 PM
realign.mat	Tuesday, October 18, 2011 12:10 PM
slice_timing.mat	Tuesday, October 18, 2011 1:14 PM

File Format: Matlab .mat File

Step 6
Segmentation

8

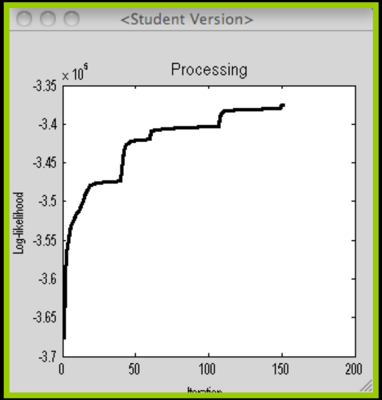


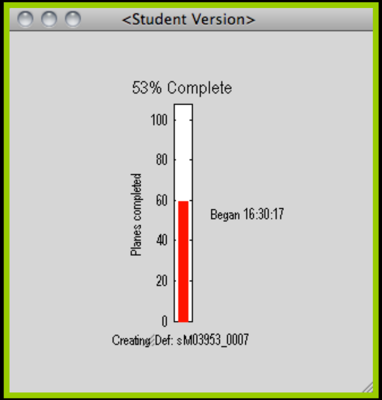
Data ...ATLAB/fMRI/Structural/sM03953_0007.img,1
Output Files
. Grey Matter Native Space
. White Matter Native Space
. Cerebro-Spinal Fluid None
. Bias Corrected Save Bias Corrected
. Clean up any partitions Dont do cleanup
Custom
. Tissue probability maps 3 files
. Gaussians per class [2 2 2 4]
. Affine Regularisation ICBM space template - European brains
. Warping Regularisation 1
. Warp Frequency Cutoff 25
. Bias regularisation very light regularisation (0.0001)
. Bias FWHM 60mm cutoff
. Sampling distance 3
. Masking image

Segment

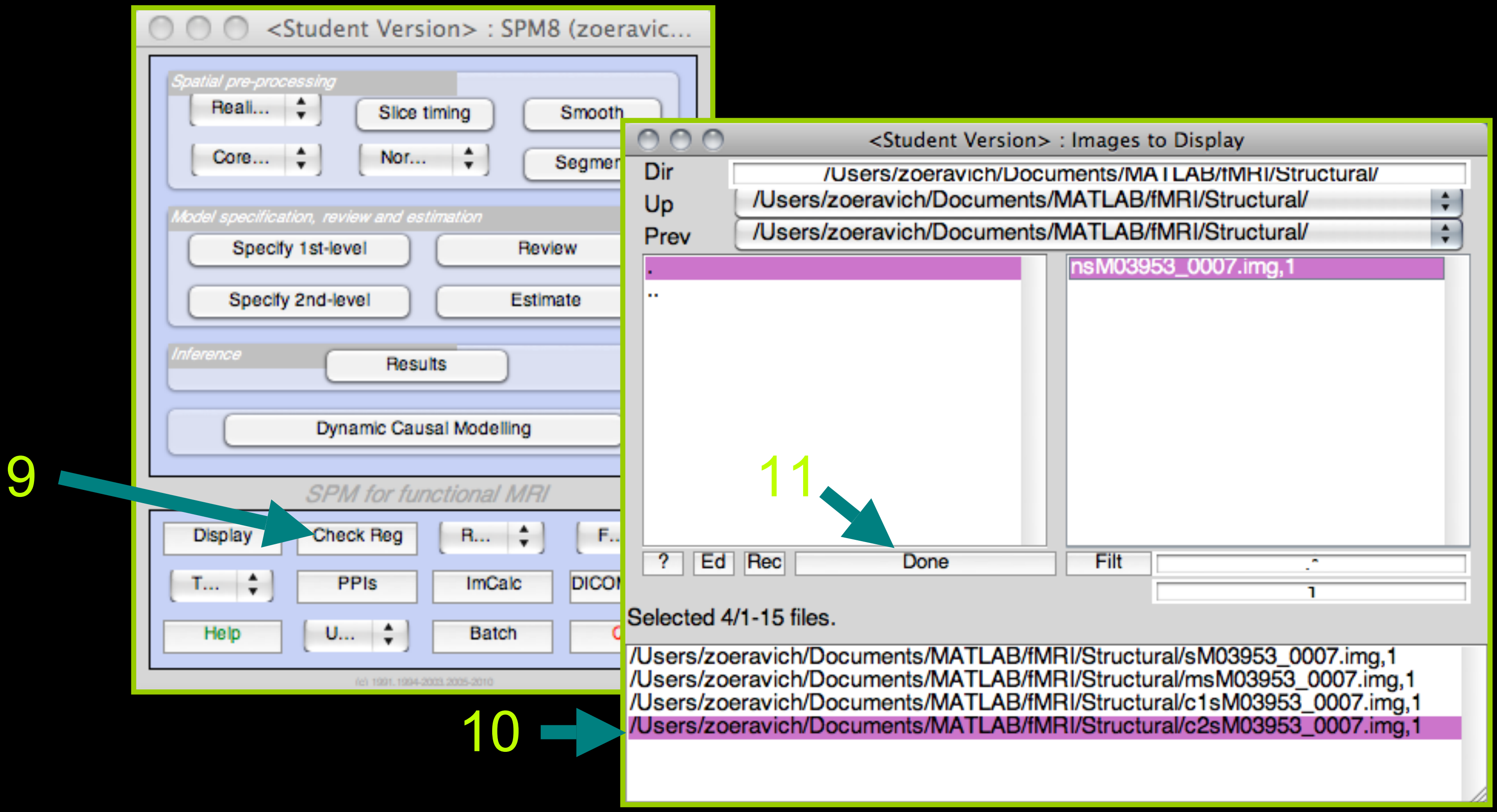
Segment, bias correct and spatially normalise - all in the same model. This function can be used for bias correcting, spatially normalising or segmenting your data. Note that this module needs the images to be roughly aligned with the tissue probability maps before you begin. If strange results are obtained, then this is usually because the images were poorly aligned beforehand. The Display option can be used to manually reposition the images so that the AC is close to coordinate 0,0,0 (within a couple of cm) and the orientation is within a few degrees of the tissue probability map data.

Processing…





Step 6
Segmentation



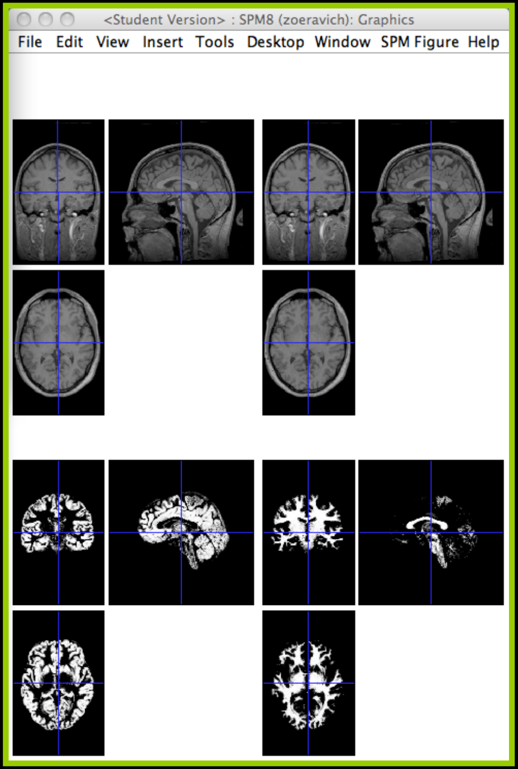
Dir: /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Up: /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Prev: /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

nsM03953_0007.img,1

Selected 4/1-15 files.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/sM03953_0007.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/Structural/msM03953_0007.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/Structural/c1sM03953_0007.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/Structural/c2sM03953_0007.img,1

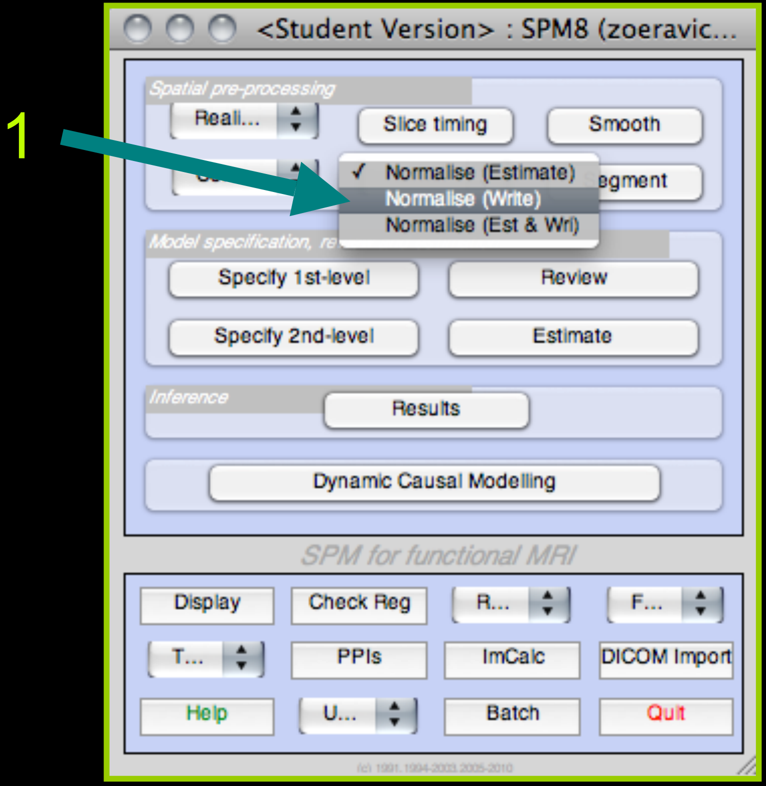
Step 6
Segmentation



Step 7
Normalise

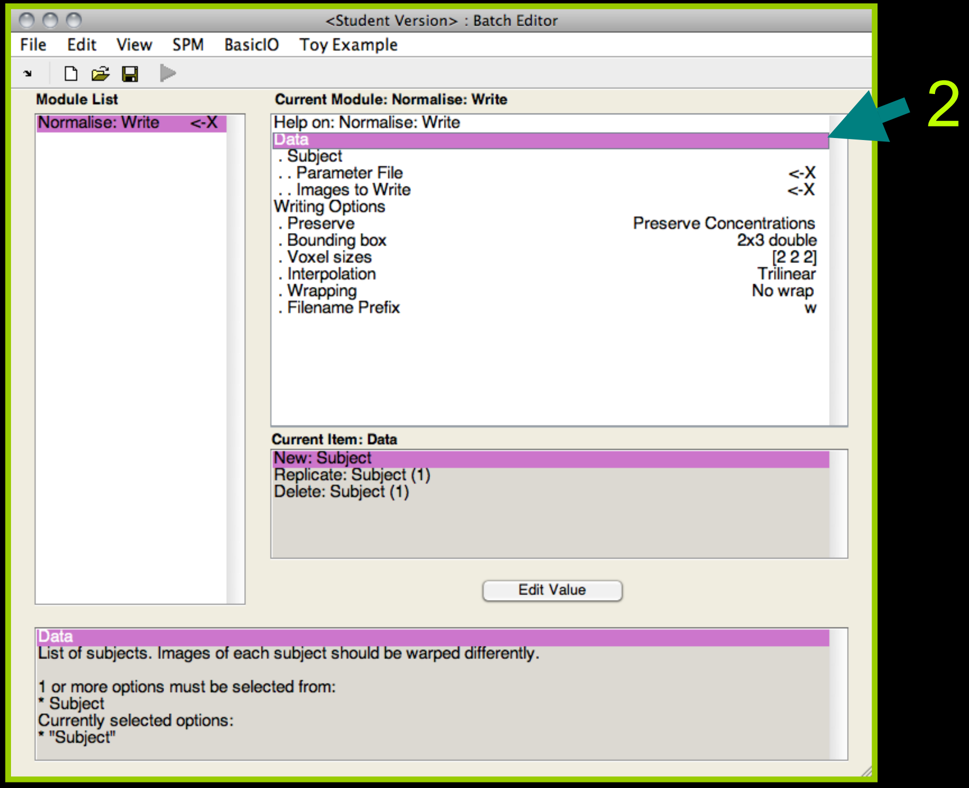
- Select NORMALISE (WRITE) from the “Normalise” drop-down menu
  - Highlight “Data” and select “New Subject”
  - Open “Subject”, highlight “Parameter File”, and select the sM03953_0007_seg_sn.mat file
  - Highlight “Images to Write” and select ^ar.* files as well as the meansM03953_0005_006.img file
  - Open “Writing Options” and change “Voxel sizes” to [3 3 3]
  - Save the job as normalise.mat
  - Press the “Run” button
- New files: warsM03953_0005_*.img

Step 7
Normalise



Step 7

Normalise



2

Current Module: Normalise: Write

```
Help on: Normalise: Write
Data
. Subject
. . Parameter File                                   <-X
. . Images to Write                                  <-X
Writing Options
. Preserve                       Preserve Concentrations
. Bounding box                               2x3 double
. Voxel sizes                                   [2 2 2]
. Interpolation                               Trilinear
. Wrapping                                      No wrap
. Filename Prefix                                     w
```

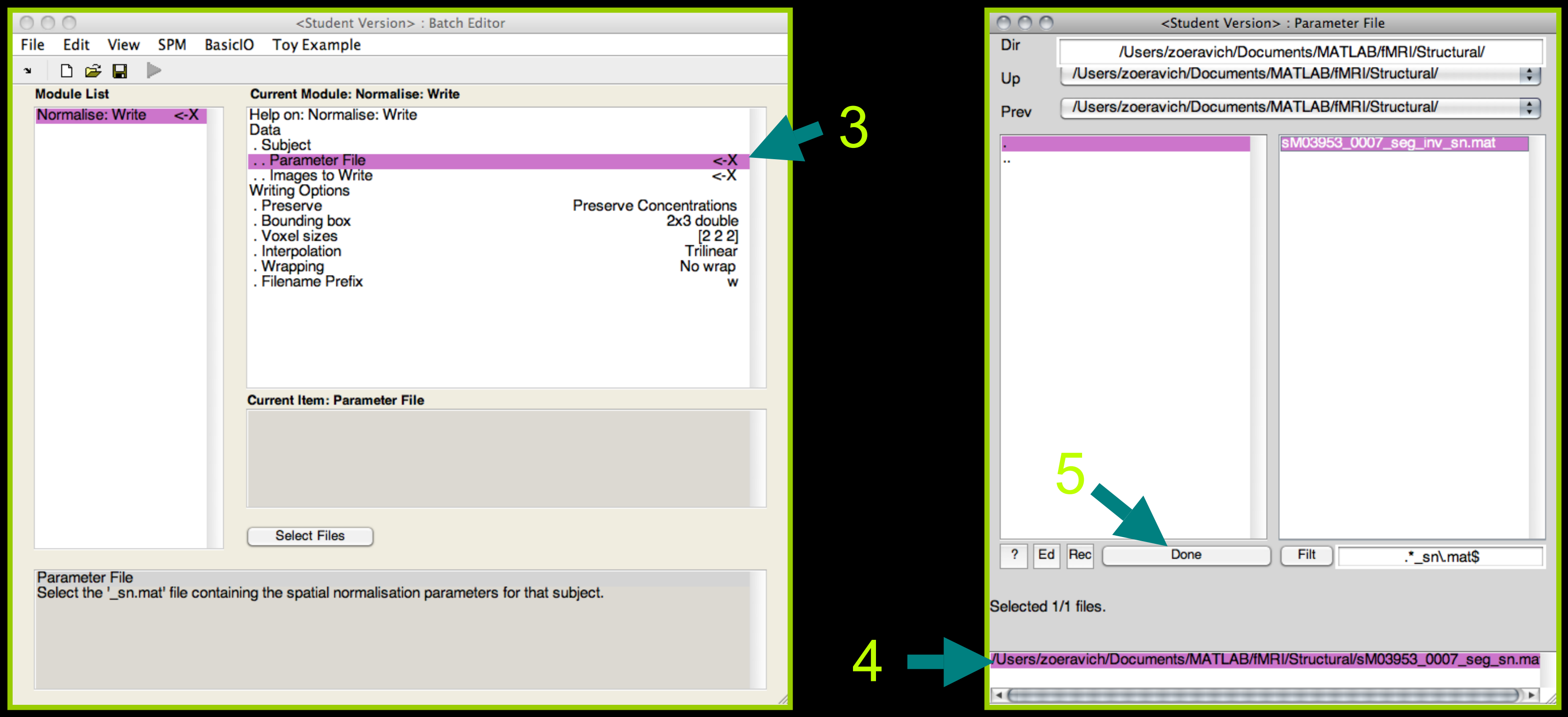
Current Item: Data

New: Subject
Replicate: Subject (1)
Delete: Subject (1)

Data
List of subjects. Images of each subject should be warped differently.

1 or more options must be selected from:
* Subject
Currently selected options:
* "Subject"

Step 7
Normalise



Current Module: Normalise: Write

Help on: Normalise: Write
Data
. Subject
. . Parameter File <-X
. . Images to Write <-X
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [2 2 2]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

Current Item: Parameter File

Parameter File
Select the '_sn.mat' file containing the spatial normalisation parameters for that subject.

Dir: /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Up: /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Prev: /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

.
..

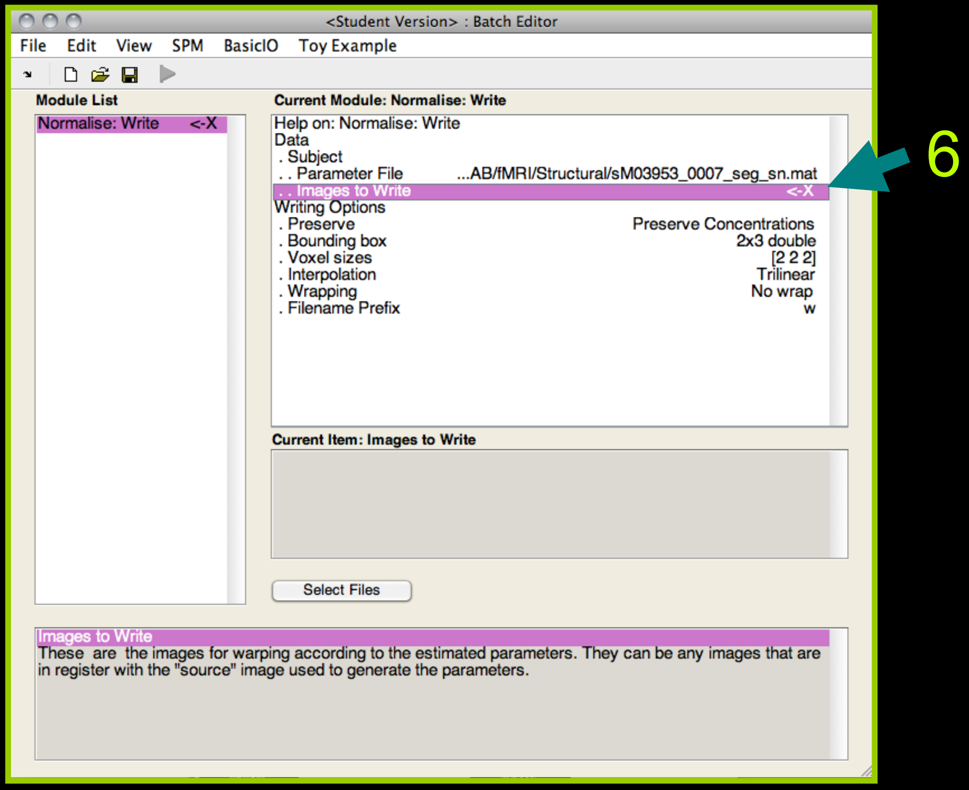
sM03953_0007_seg_inv_sn.mat

.*_sn\.mat$

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/sM03953_0007_seg_sn.ma

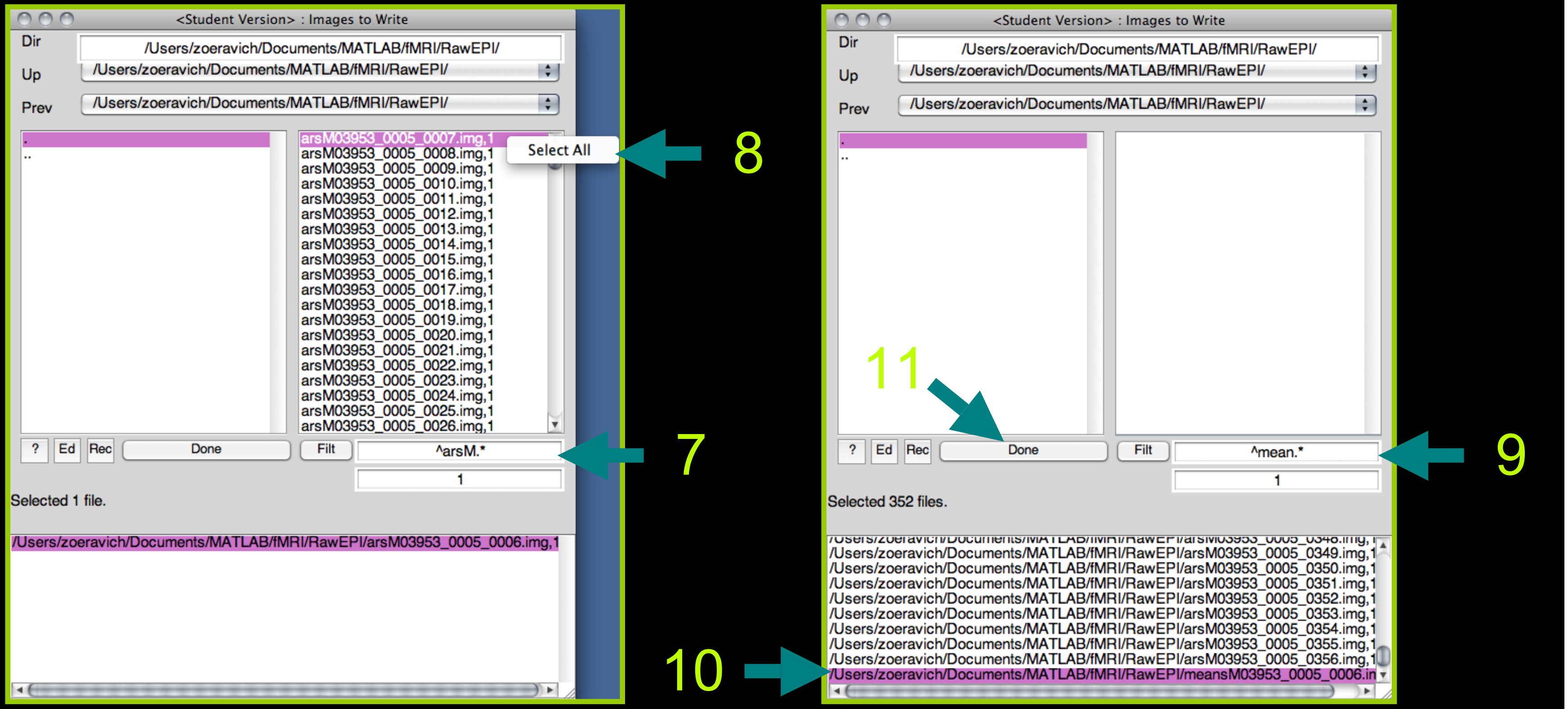
Step 7
Normalise



Help on: Normalise: Write
Data
. Subject
. . Parameter File ...AB/fMRI/Structural/sM03953_0007_seg_sn.mat
. . Images to Write <-X
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [2 2 2]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

Images to Write
These are the images for warping according to the estimated parameters. They can be any images that are in register with the "source" image used to generate the parameters.

Step 7
Normalise



<Student Version> : Images to Write

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

```
.
..
```

```
arsM03953_0005_0007.img,1
arsM03953_0005_0008.img,1
arsM03953_0005_0009.img,1
arsM03953_0005_0010.img,1
arsM03953_0005_0011.img,1
arsM03953_0005_0012.img,1
arsM03953_0005_0013.img,1
arsM03953_0005_0014.img,1
arsM03953_0005_0015.img,1
arsM03953_0005_0016.img,1
arsM03953_0005_0017.img,1
arsM03953_0005_0018.img,1
arsM03953_0005_0019.img,1
arsM03953_0005_0020.img,1
arsM03953_0005_0021.img,1
arsM03953_0005_0022.img,1
arsM03953_0005_0023.img,1
arsM03953_0005_0024.img,1
arsM03953_0005_0025.img,1
arsM03953_0005_0026.img,1
```

Filt ^arsM.*

1

Selected 1 file.

```
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0006.img,1
```

<Student Version> : Images to Write

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

```
.
..
```

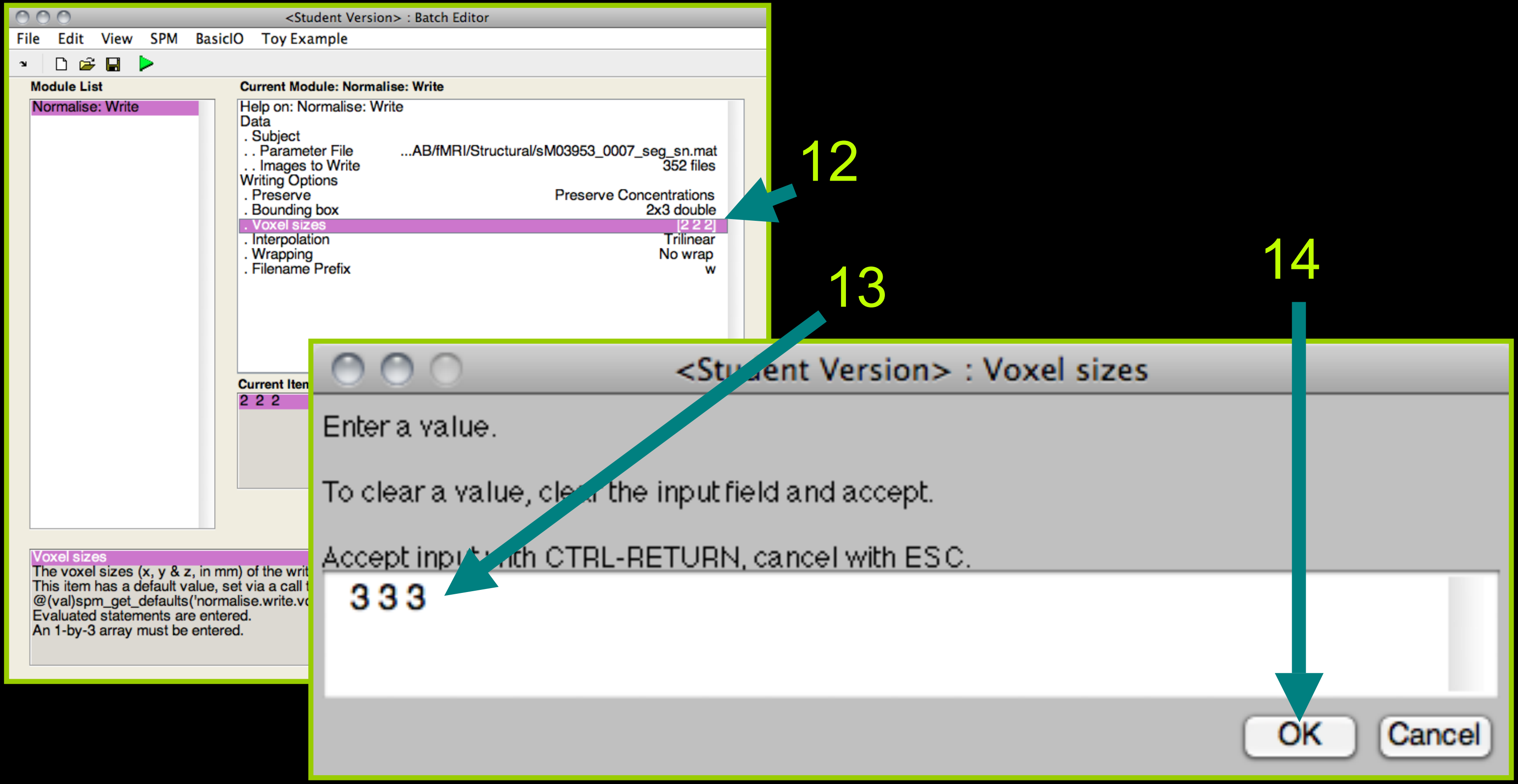
Filt ^mean.*

1

Selected 352 files.

```
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0349.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0350.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0351.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0352.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0353.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0354.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0355.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/arsM03953_0005_0356.img,1
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/meansM03953_0005_0006.in
```

Step 7
Normalise



Help on: Normalise: Write
Data
. Subject
. . Parameter File ...AB/fMRI/Structural/sM03953_0007_seg_sn.mat
. . Images to Write 352 files
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [2 2 2]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

2 2 2

Voxel sizes
The voxel sizes (x, y & z, in mm) of the writ
This item has a default value, set via a call t
@(val)spm_get_defaults('normalise.write.vo
Evaluated statements are entered.
An 1-by-3 array must be entered.

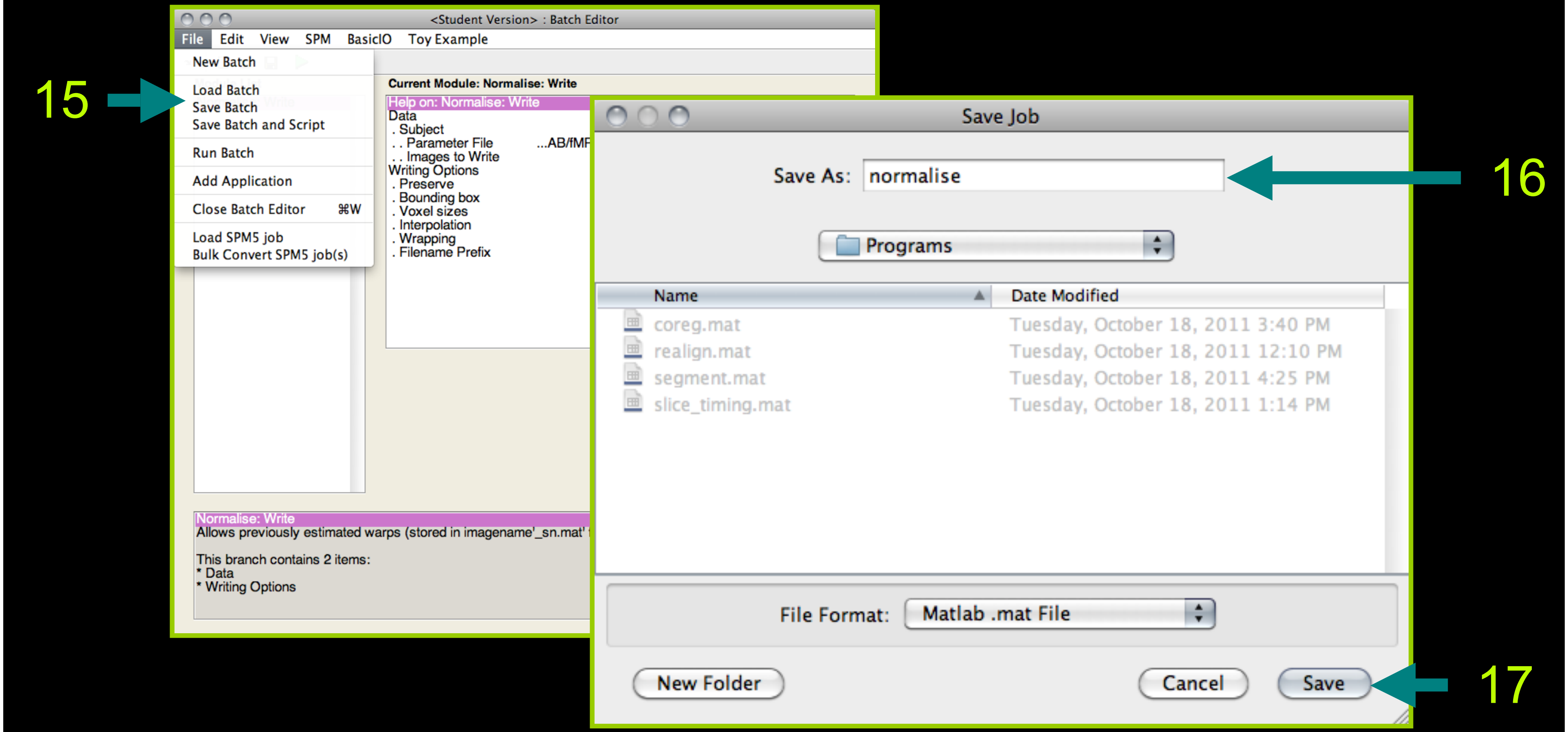
Enter a value.

To clear a value, clear the input field and accept.

Accept input with CTRL-RETURN, cancel with ESC.

3 3 3

Step 7
Normalise



Current Module: Normalise: Write

Help on: Normalise: Write
Data
. Subject
. . Parameter File ...AB/fMR
. . Images to Write
Writing Options
. Preserve
. Bounding box
. Voxel sizes
. Interpolation
. Wrapping
. Filename Prefix

Normalise: Write
Allows previously estimated warps (stored in imagename'_sn.mat'

This branch contains 2 items:
* Data
* Writing Options

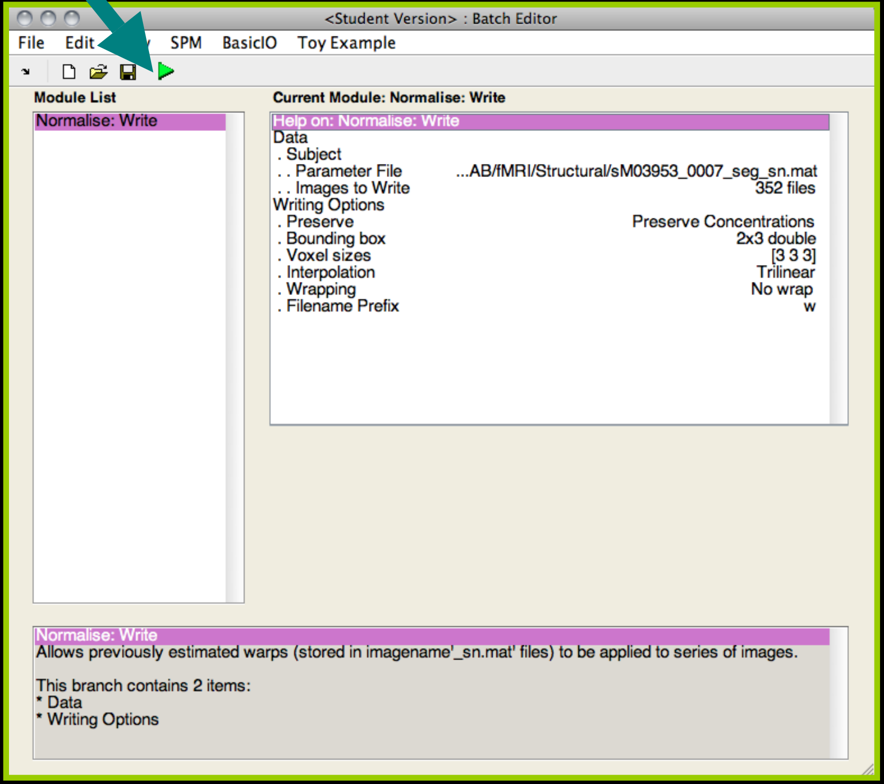
Save As: normalise

Name	Date Modified
coreg.mat	Tuesday, October 18, 2011 3:40 PM
realign.mat	Tuesday, October 18, 2011 12:10 PM
segment.mat	Tuesday, October 18, 2011 4:25 PM
slice_timing.mat	Tuesday, October 18, 2011 1:14 PM

File Format: Matlab .mat File

Step 7
Normalise

18



Normalise: Write

Current Module: Normalise: Write

Help on: Normalise: Write

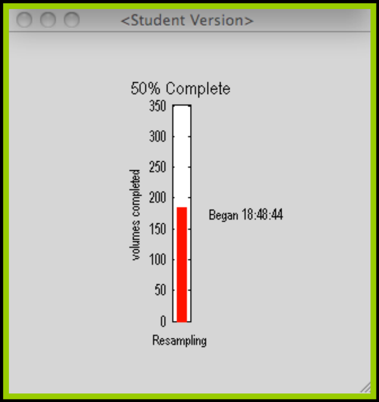
```
Data
. Subject
. . Parameter File        ...AB/fMRI/Structural/sM03953_0007_seg_sn.mat
. . Images to Write                                            352 files
Writing Options
. Preserve                                      Preserve Concentrations
. Bounding box                                              2x3 double
. Voxel sizes                                                  [3 3 3]
. Interpolation                                              Trilinear
. Wrapping                                                     No wrap
. Filename Prefix                                                    w
```

Normalise: Write

Allows previously estimated warps (stored in imagename'_sn.mat' files) to be applied to series of images.

This branch contains 2 items:
* Data
* Writing Options

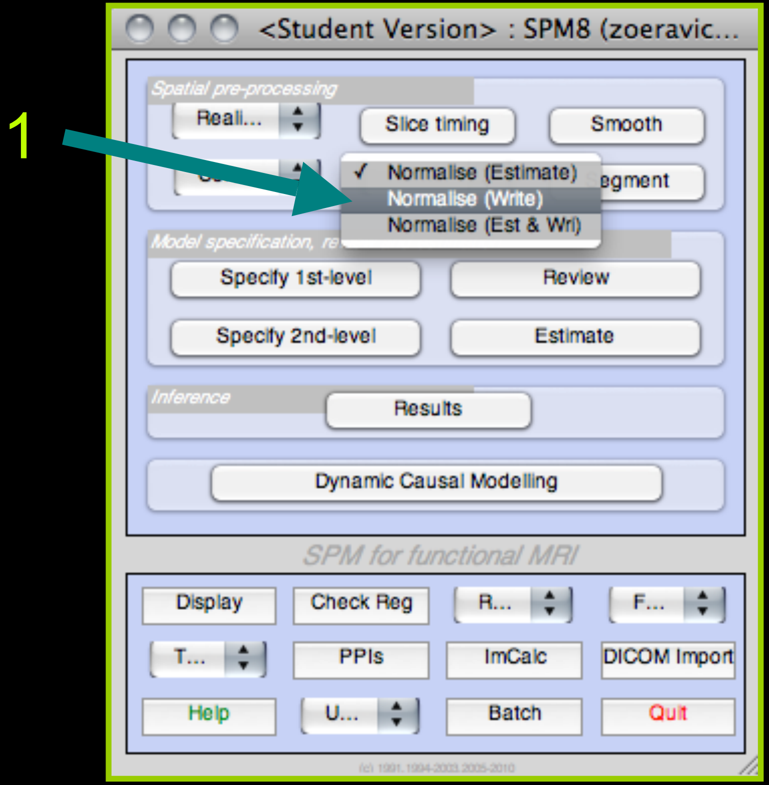
Processing…



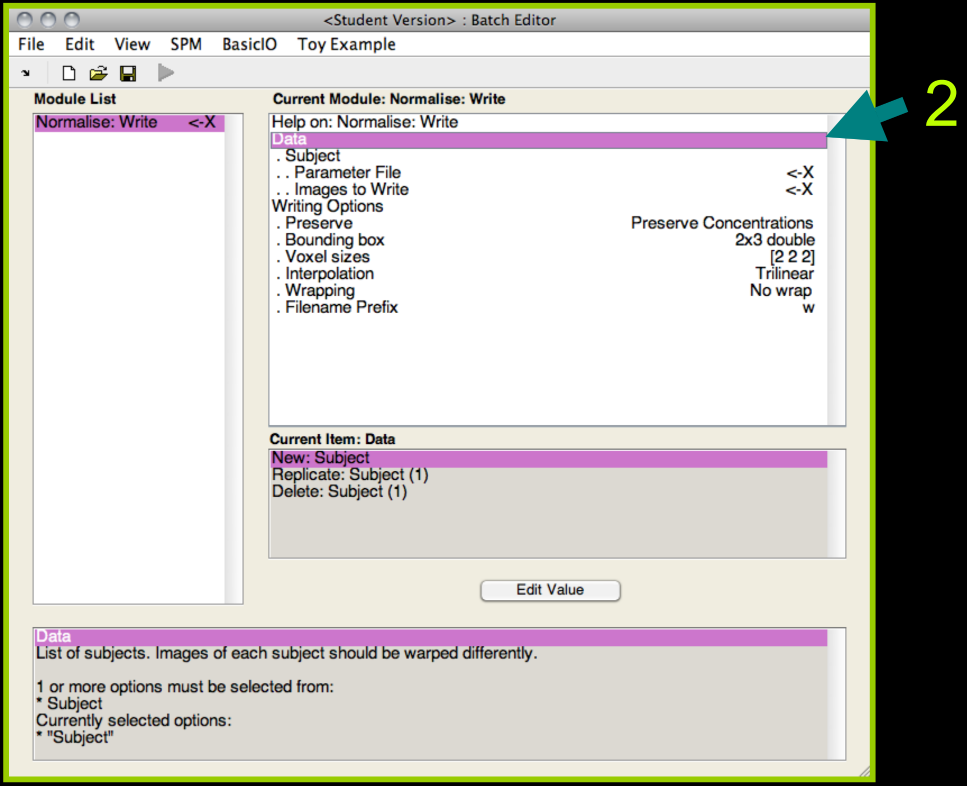
Step 7
Normalise (Optional)

- Select NORMALISE (WRITE) from the “Normalise” drop-down menu
  - Highlight “Data” and select “New Subject”
  - Open “Subject”, highlight “Parameter File”, and select the sM03953_0007_seg_sn.mat file
  - Highlight “Images to Write” and select the msM03953_0005_007.img file
  - Open “Writing Options” and change “Voxel sizes” to [1 1 1]
  - Save the job as norm_struct.mat
  - Press the “Run” button
- New files: warsM03953_0005_*.img

Step 7
Normalise (Optional)



Step 7
Normalise (Optional)



Current Module: Normalise: Write

Help on: Normalise: Write
Data
. Subject
. . Parameter File <-X
. . Images to Write <-X
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [2 2 2]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

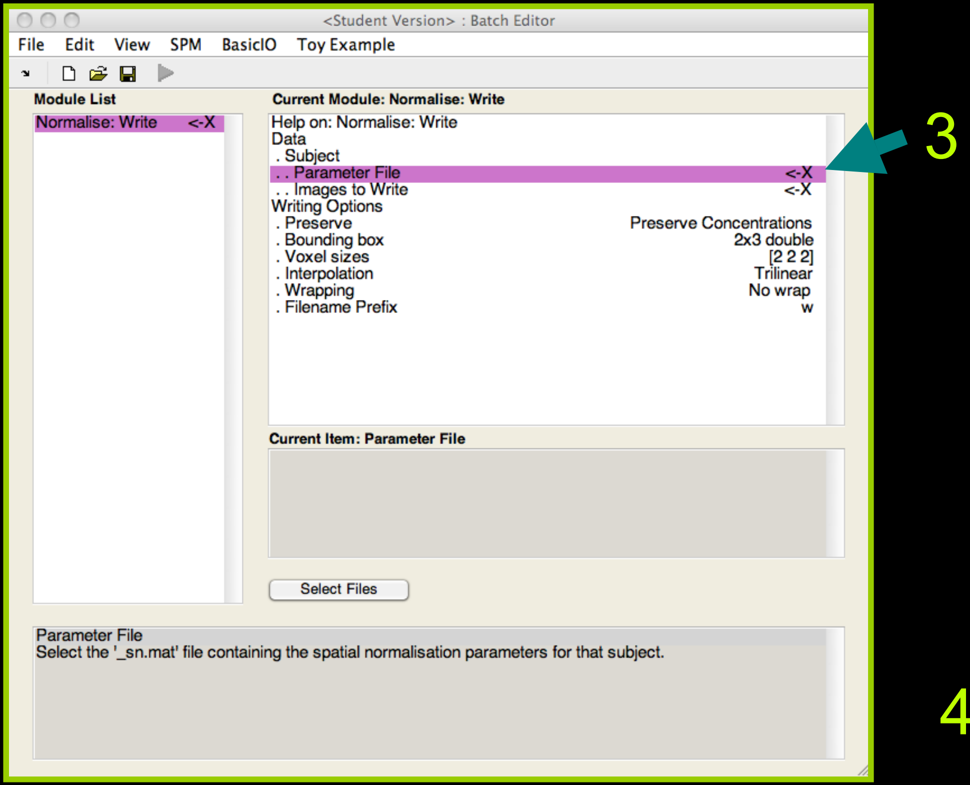
Current Item: Data

New: Subject
Replicate: Subject (1)
Delete: Subject (1)

Data
List of subjects. Images of each subject should be warped differently.

1 or more options must be selected from:
* Subject
Currently selected options:
* "Subject"

Step 7
Normalise (Optional)



Module List

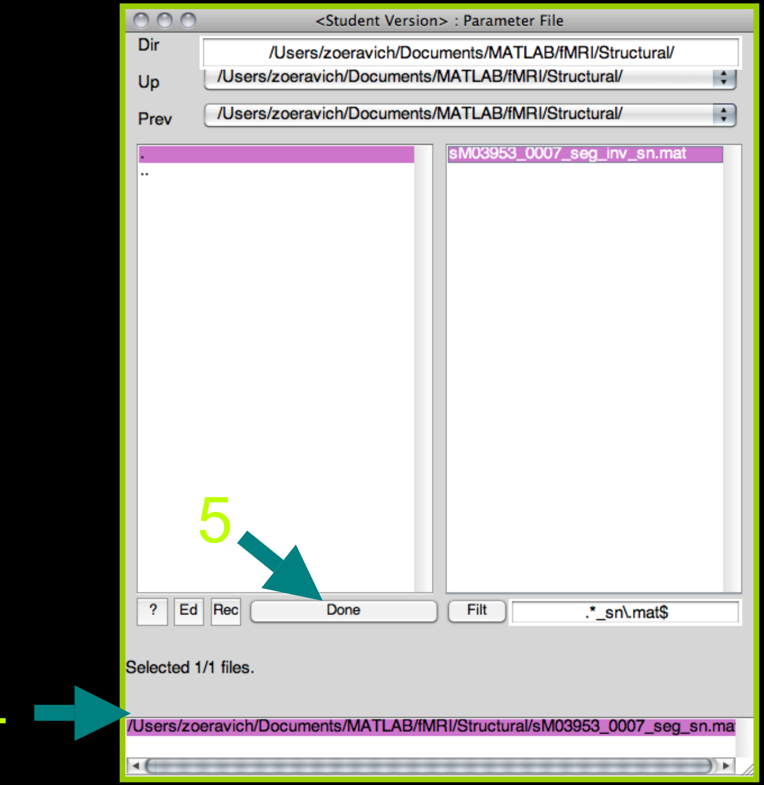
Normalise: Write <-X

Current Module: Normalise: Write

Help on: Normalise: Write
Data
. Subject
. . Parameter File <-X
. . Images to Write <-X
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [2 2 2]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

Current Item: Parameter File

Parameter File
Select the '_sn.mat' file containing the spatial normalisation parameters for that subject.



Dir /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Up /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

.
..

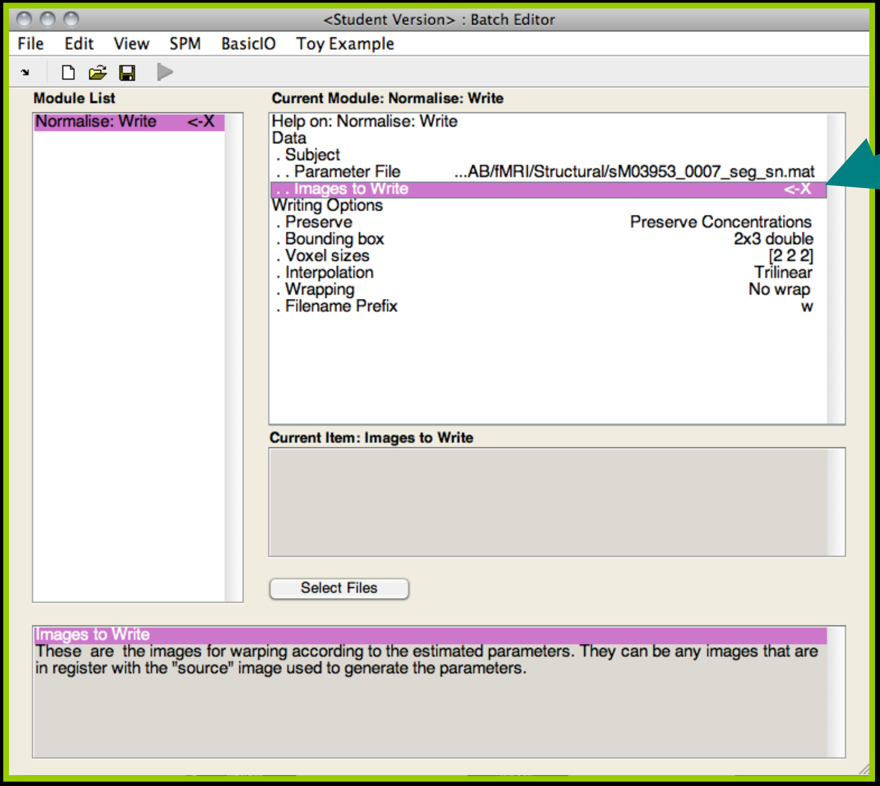
sM03953_0007_seg_inv_sn.mat

Filt .*_sn\.mat$

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/sM03953_0007_seg_sn.ma

Step 7
Normalise (Optional)

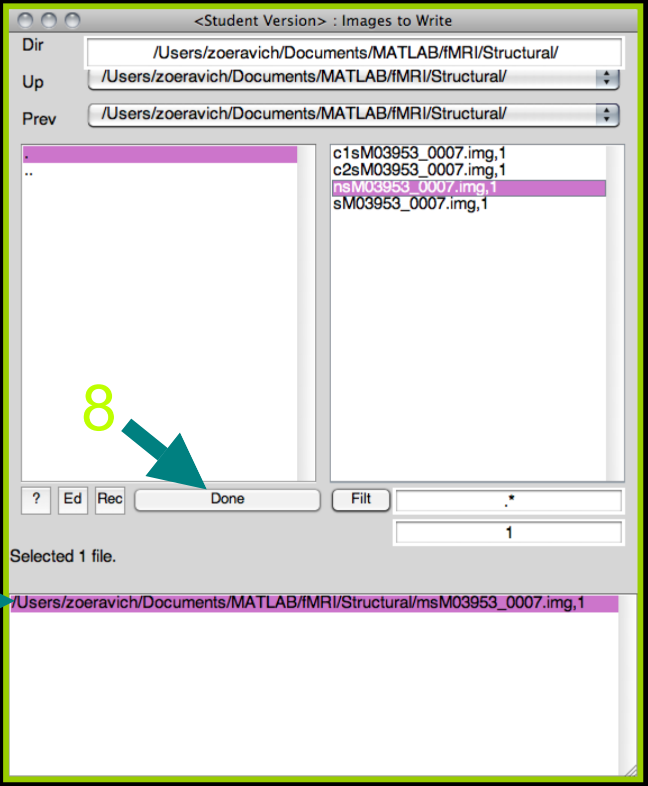


Current Module: Normalise: Write

Help on: Normalise: Write
Data
. Subject
. . Parameter File ...AB/fMRI/Structural/sM03953_0007_seg_sn.mat
. . Images to Write <-X
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [2 2 2]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

Current Item: Images to Write

Images to Write
These are the images for warping according to the estimated parameters. They can be any images that are in register with the "source" image used to generate the parameters.



Dir /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Up /Users/zoeravich/Documents/MATLAB/fMRI/Structural/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/Structural/

.
..

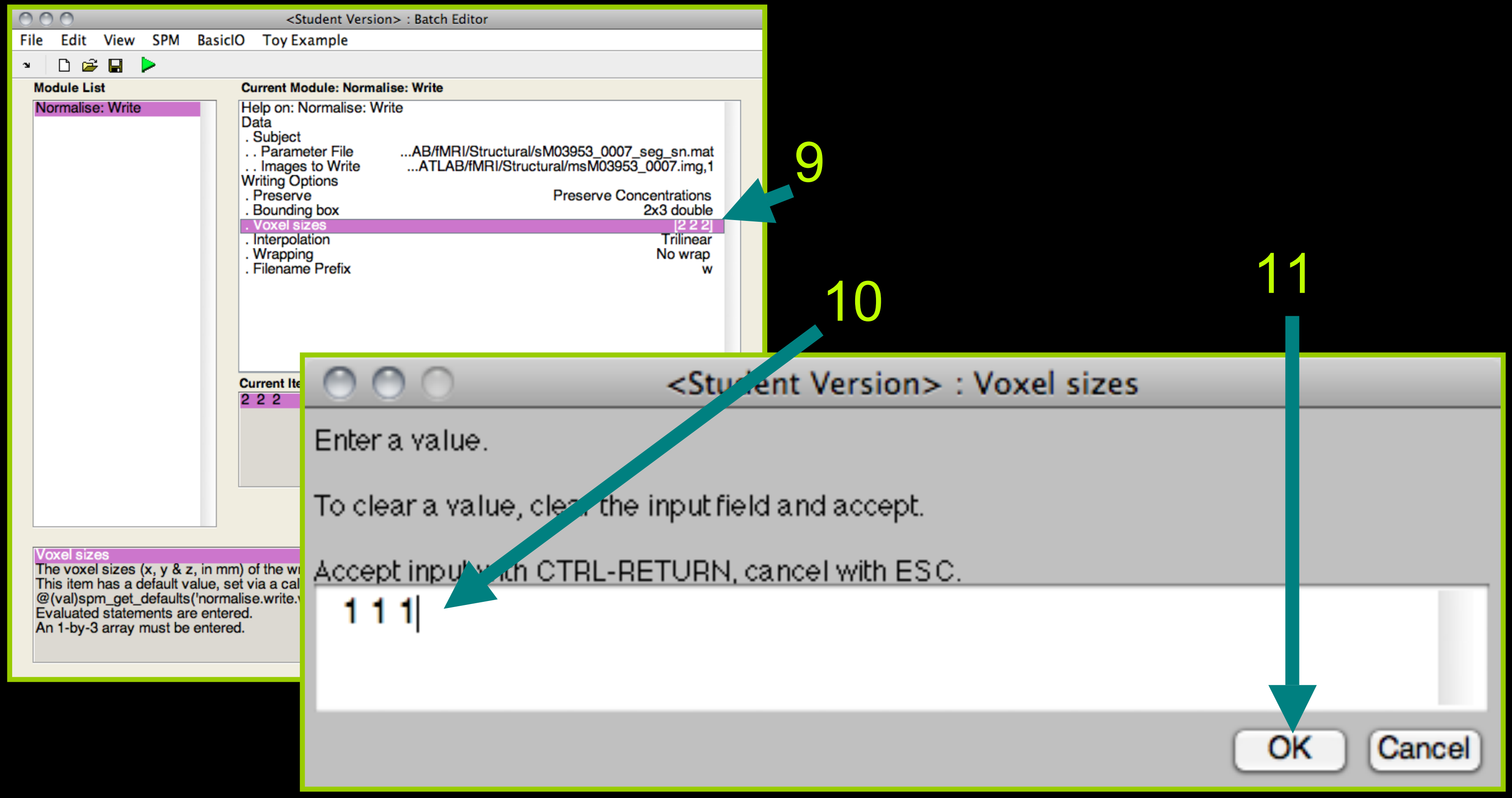
c1sM03953_0007.img,1
c2sM03953_0007.img,1
nsM03953_0007.img,1
sM03953_0007.img,1

Filt .*
1

Selected 1 file.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/msM03953_0007.img,1

Step 7
Normalise (Optional)



Current Module: Normalise: Write

```
Help on: Normalise: Write
Data
 . Subject
 . . Parameter File      ...AB/fMRI/Structural/sM03953_0007_seg_sn.mat
 . . Images to Write     ...ATLAB/fMRI/Structural/msM03953_0007.img,1
Writing Options
 . Preserve                                  Preserve Concentrations
 . Bounding box                                           2x3 double
 . Voxel sizes                                               [2 2 2]
 . Interpolation                                           Trilinear
 . Wrapping                                                  No wrap
 . Filename Prefix                                                 w
```

Current Ite

2 2 2

Voxel sizes

The voxel sizes (x, y & z, in mm) of the wr
This item has a default value, set via a cal
@(val)spm_get_defaults('normalise.write.v
Evaluated statements are entered.
An 1-by-3 array must be entered.

<Stu ent Version> : Voxel sizes

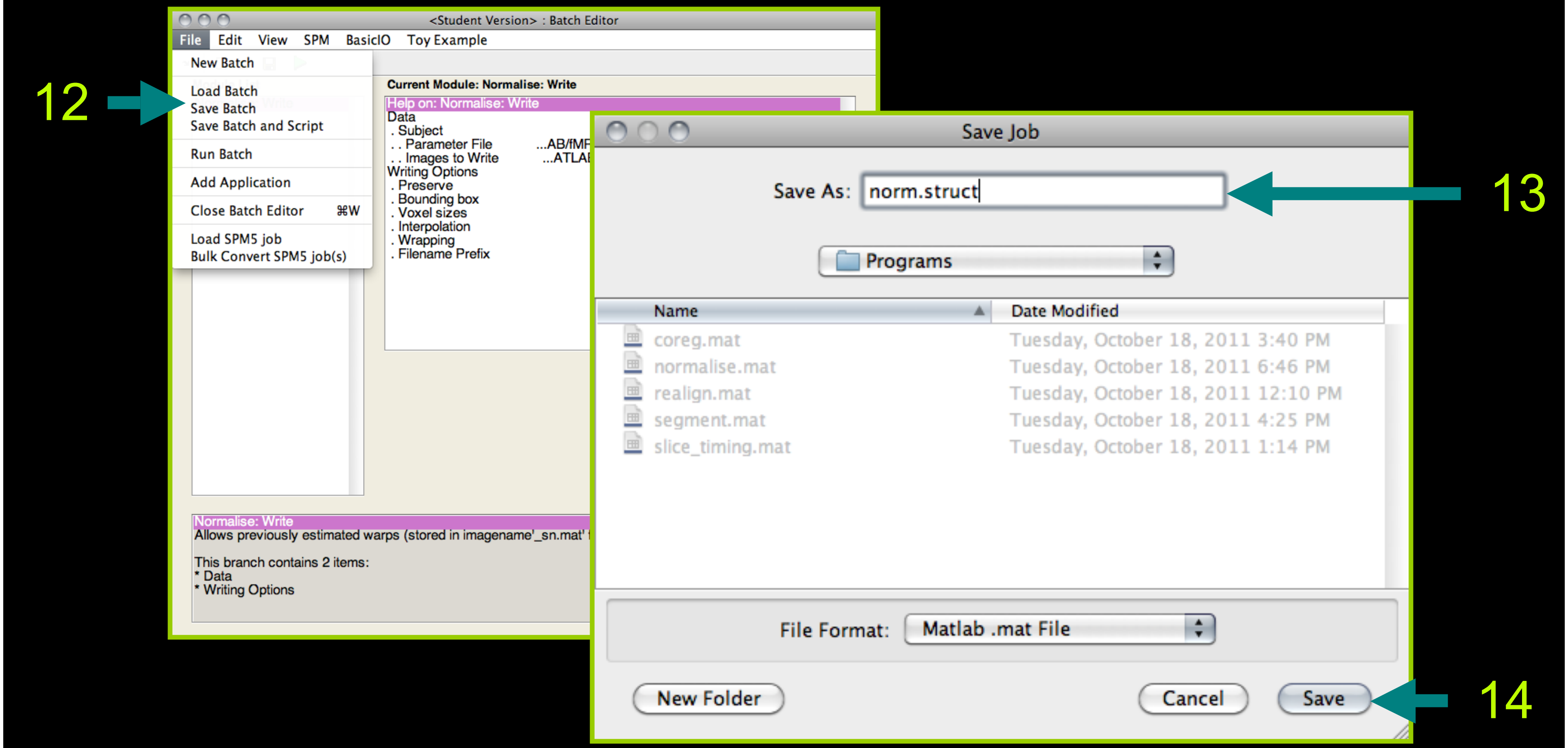
Enter a value.

To clear a value, cle the input field and accept.

Accept inpu th CTRL-RETURN, cancel with ESC.

1 1 1

Step 7
Normalise (Optional)



12

Current Module: Normalise: Write

Help on: Normalise: Write
Data
. Subject
. . Parameter File ...AB/fMF
. . Images to Write ...ATLAI
Writing Options
. Preserve
. Bounding box
. Voxel sizes
. Interpolation
. Wrapping
. Filename Prefix

Normalise: Write
Allows previously estimated warps (stored in imagename'_sn.mat' t

This branch contains 2 items:
* Data
* Writing Options

Save As: norm.struct

13

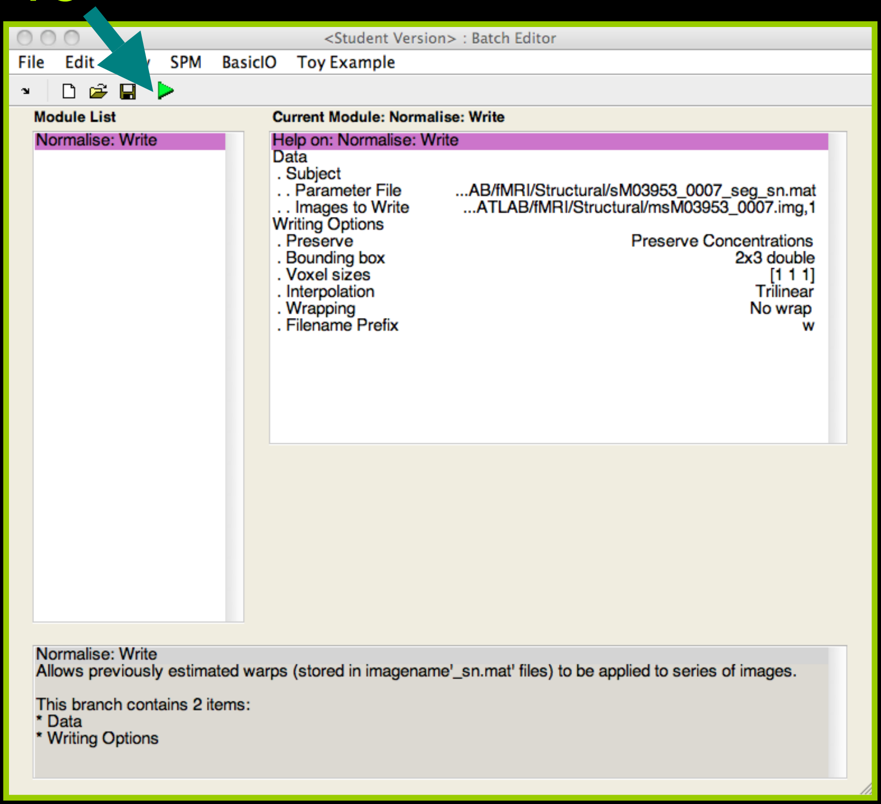
Name	Date Modified
coreg.mat	Tuesday, October 18, 2011 3:40 PM
normalise.mat	Tuesday, October 18, 2011 6:46 PM
realign.mat	Tuesday, October 18, 2011 12:10 PM
segment.mat	Tuesday, October 18, 2011 4:25 PM
slice_timing.mat	Tuesday, October 18, 2011 1:14 PM

File Format: Matlab .mat File

14

Step 7
Normalise (Optional)

15



Normalise: Write

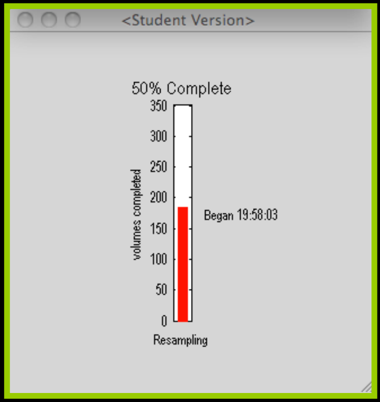
Help on: Normalise: Write

Data
. Subject
. . Parameter File ...AB/fMRI/Structural/sM03953_0007_seg_sn.mat
. . Images to Write ...ATLAB/fMRI/Structural/msM03953_0007.img,1
Writing Options
. Preserve Preserve Concentrations
. Bounding box 2x3 double
. Voxel sizes [1 1 1]
. Interpolation Trilinear
. Wrapping No wrap
. Filename Prefix w

Normalise: Write
Allows previously estimated warps (stored in imagename'_sn.mat' files) to be applied to series of images.

This branch contains 2 items:
* Data
* Writing Options

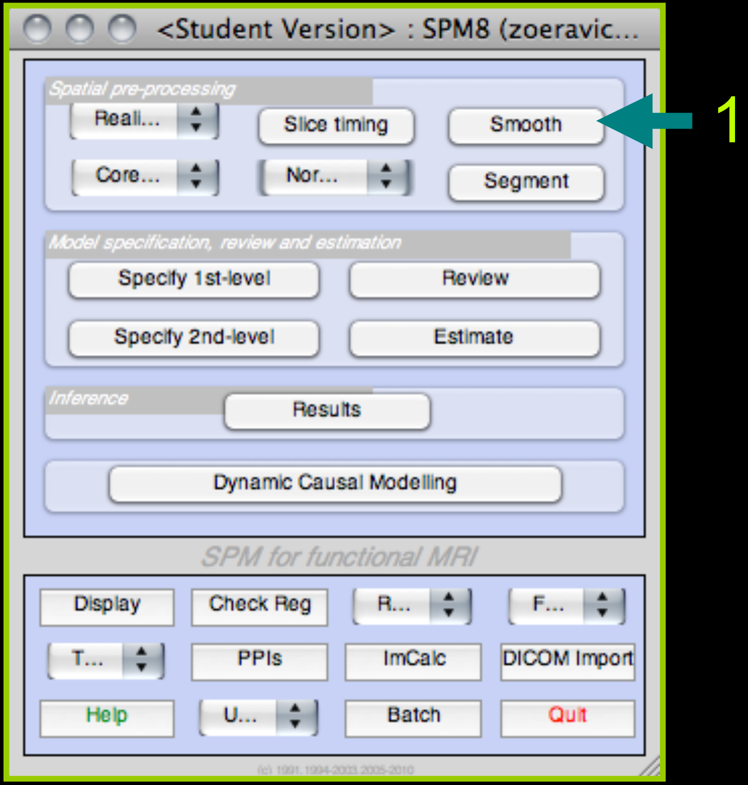
Processing…



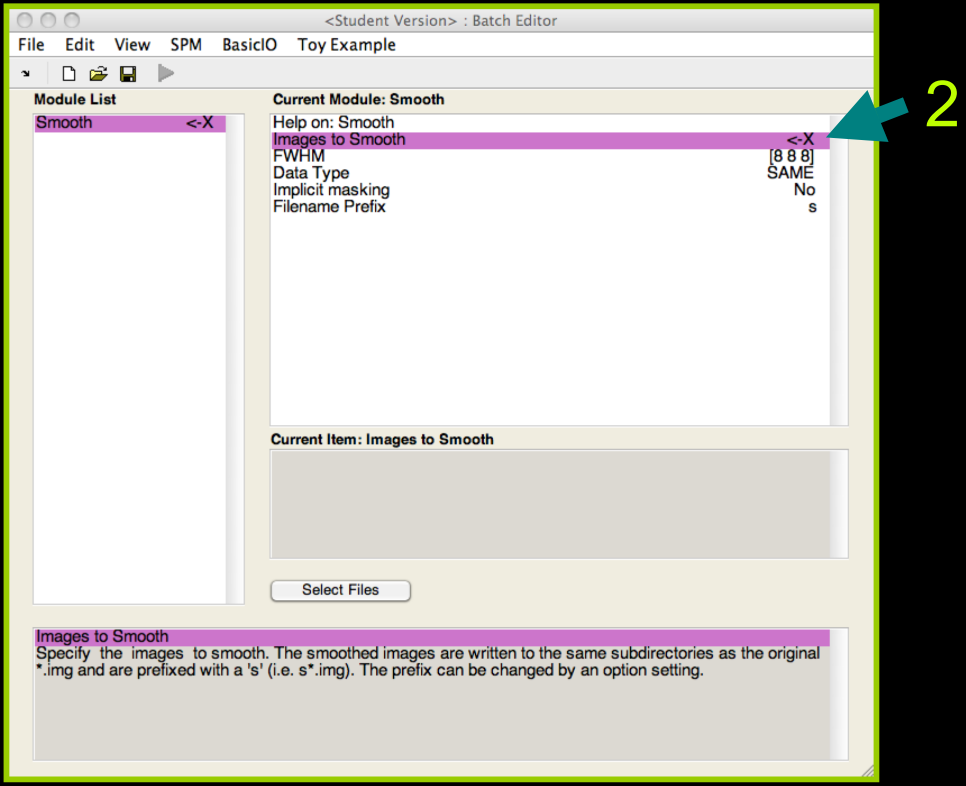
Step 8
Smoothing

- Press the SMOOTH button
  - Highlight “Images to Smooth” and select ^wms.* files
  - Save the job as smooth.mat
  - Press the “Run” button
- New files: swmsM03953_0005_*.img

Step 8
Smoothing



Step 8
Smoothing



Module List

Smooth <-X

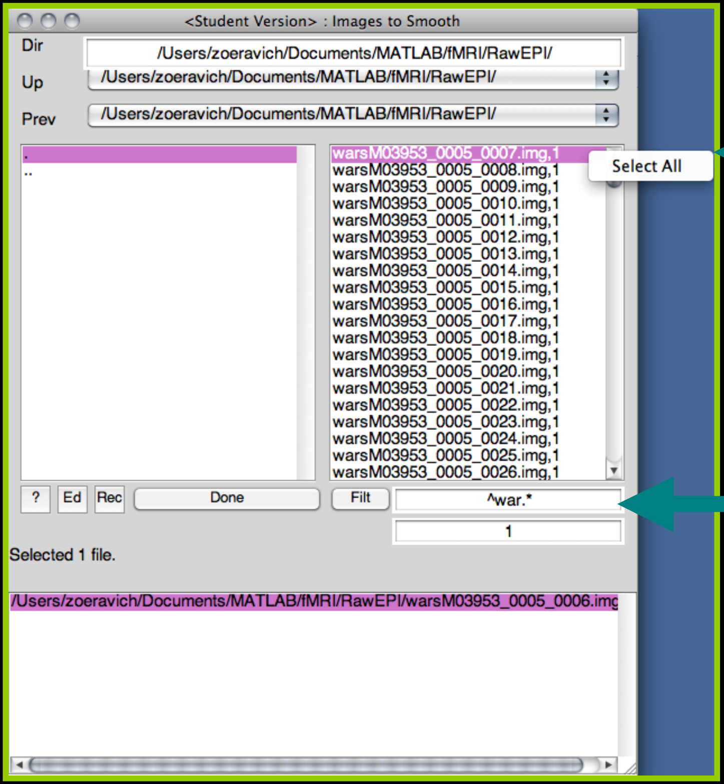
Current Module: Smooth

Help on: Smooth
Images to Smooth <-X
FWHM [8 8 8]
Data Type SAME
Implicit masking No
Filename Prefix s

Current Item: Images to Smooth

Images to Smooth
Specify the images to smooth. The smoothed images are written to the same subdirectories as the original *.img and are prefixed with a 's' (i.e. s*.img). The prefix can be changed by an option setting.

Step 8
Smoothing



Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

```
.
..
```

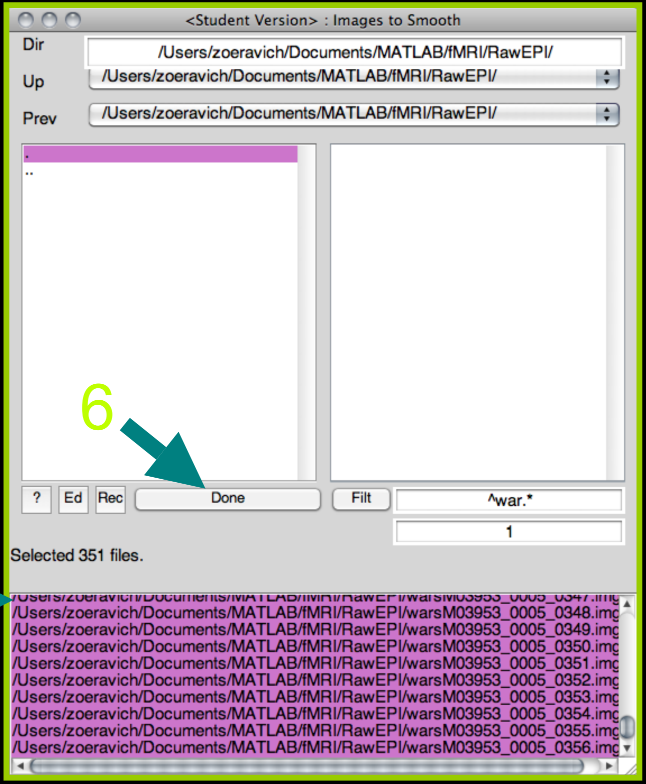
```
warsM03953_0005_0007.img,1
warsM03953_0005_0008.img,1
warsM03953_0005_0009.img,1
warsM03953_0005_0010.img,1
warsM03953_0005_0011.img,1
warsM03953_0005_0012.img,1
warsM03953_0005_0013.img,1
warsM03953_0005_0014.img,1
warsM03953_0005_0015.img,1
warsM03953_0005_0016.img,1
warsM03953_0005_0017.img,1
warsM03953_0005_0018.img,1
warsM03953_0005_0019.img,1
warsM03953_0005_0020.img,1
warsM03953_0005_0021.img,1
warsM03953_0005_0022.img,1
warsM03953_0005_0023.img,1
warsM03953_0005_0024.img,1
warsM03953_0005_0025.img,1
warsM03953_0005_0026.img,1
```

^war.*

1

Selected 1 file.

```
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0006.img
```



Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

```
.
..
```

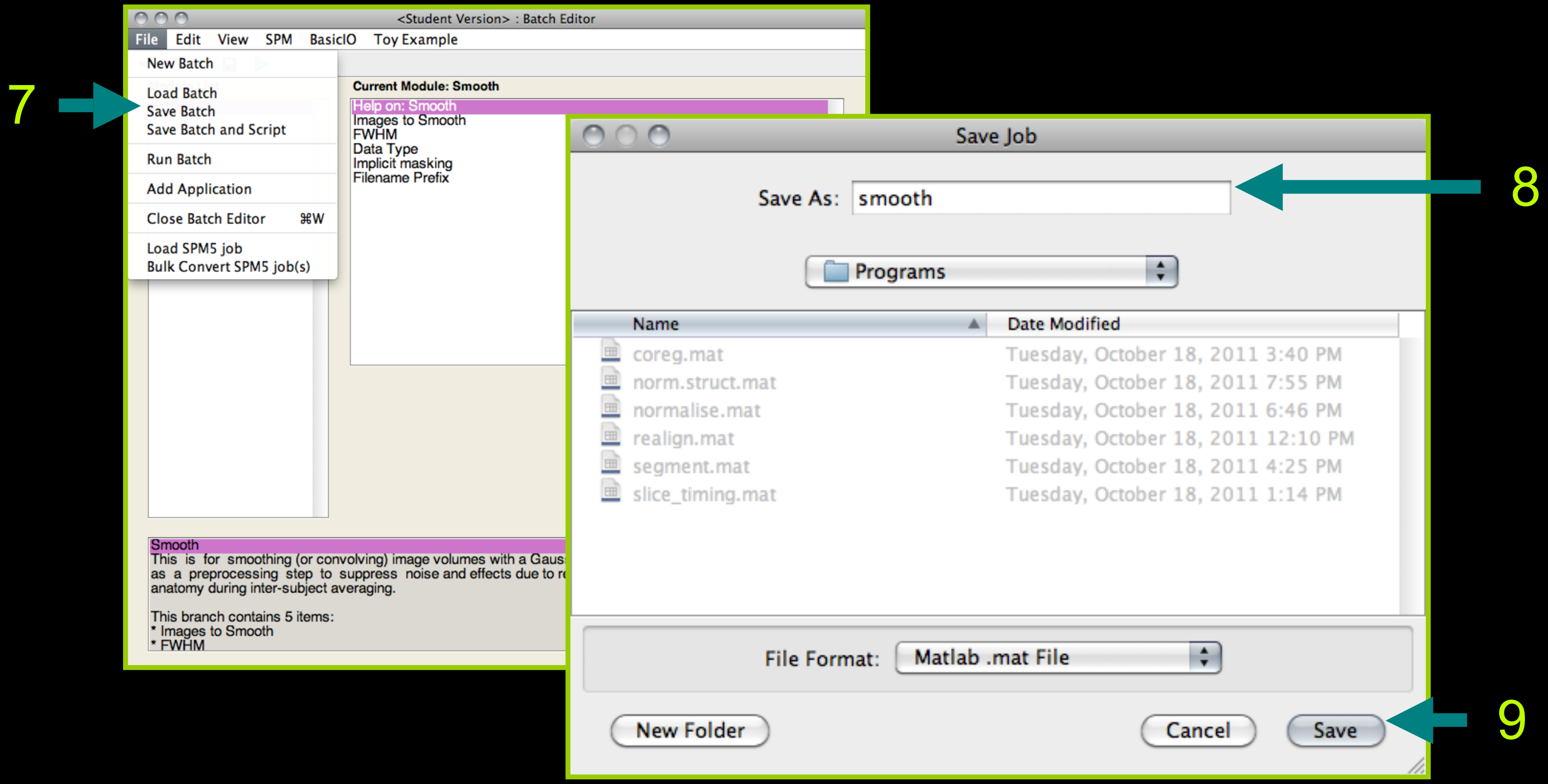
^war.*

1

Selected 351 files.

```
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0347.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0348.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0349.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0350.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0351.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0352.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0353.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0354.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0355.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0356.img
```

Step 8
Smoothing



Current Module: Smooth

Help on: Smooth
Images to Smooth
FWHM
Data Type
Implicit masking
Filename Prefix

Smooth
This is for smoothing (or convolving) image volumes with a Gaus
as a preprocessing step to suppress noise and effects due to r
anatomy during inter-subject averaging.

This branch contains 5 items:
* Images to Smooth
* FWHM

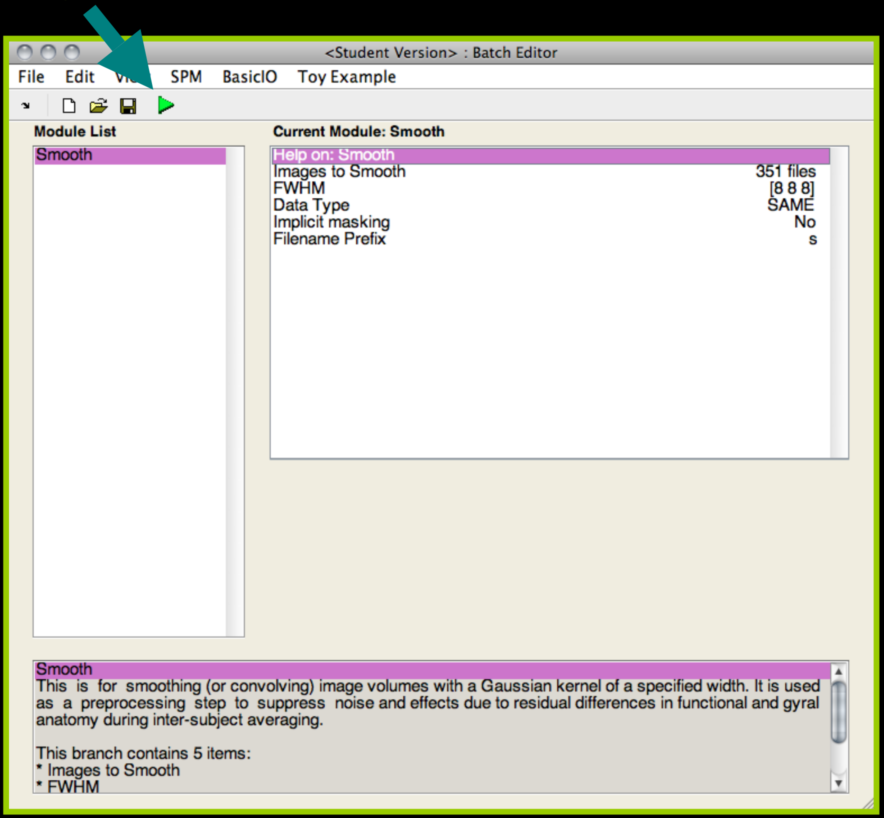
Save As: smooth

Name	Date Modified
coreg.mat	Tuesday, October 18, 2011 3:40 PM
norm.struct.mat	Tuesday, October 18, 2011 7:55 PM
normalise.mat	Tuesday, October 18, 2011 6:46 PM
realign.mat	Tuesday, October 18, 2011 12:10 PM
segment.mat	Tuesday, October 18, 2011 4:25 PM
slice_timing.mat	Tuesday, October 18, 2011 1:14 PM

File Format: Matlab .mat File

Step 8
Smoothing

10



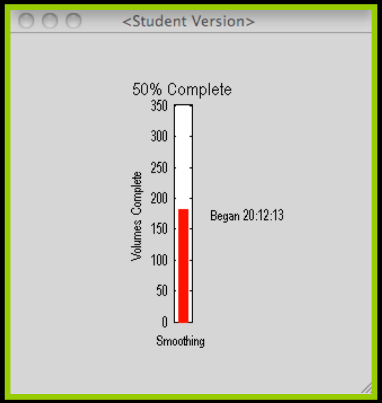
Images to Smooth 351 files
FWHM [8 8 8]
Data Type SAME
Implicit masking No
Filename Prefix s

Smooth

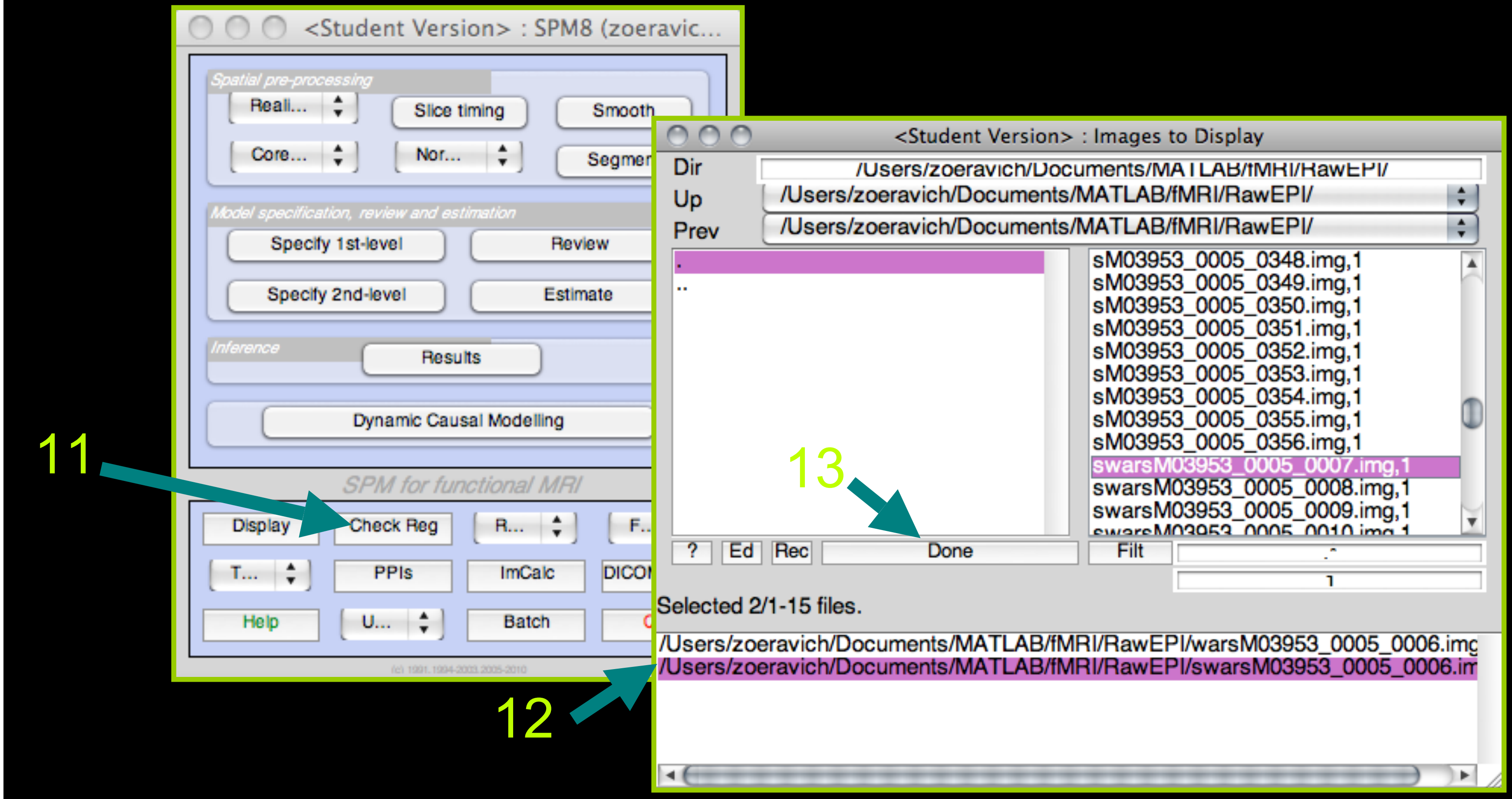
This is for smoothing (or convolving) image volumes with a Gaussian kernel of a specified width. It is used as a preprocessing step to suppress noise and effects due to residual differences in functional and gyral anatomy during inter-subject averaging.

This branch contains 5 items:
* Images to Smooth
* FWHM

Processing…



Step 8
Smoothing



Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

.
..

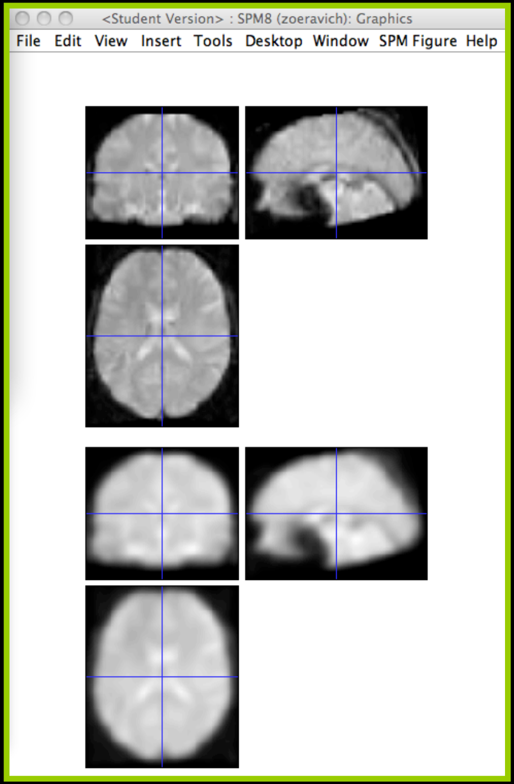
sM03953_0005_0348.img,1
sM03953_0005_0349.img,1
sM03953_0005_0350.img,1
sM03953_0005_0351.img,1
sM03953_0005_0352.img,1
sM03953_0005_0353.img,1
sM03953_0005_0354.img,1
sM03953_0005_0355.img,1
sM03953_0005_0356.img,1
swarsM03953_0005_0007.img,1
swarsM03953_0005_0008.img,1
swarsM03953_0005_0009.img,1
swarsM03953_0005_0010.img,1

.^
1

Selected 2/1-15 files.

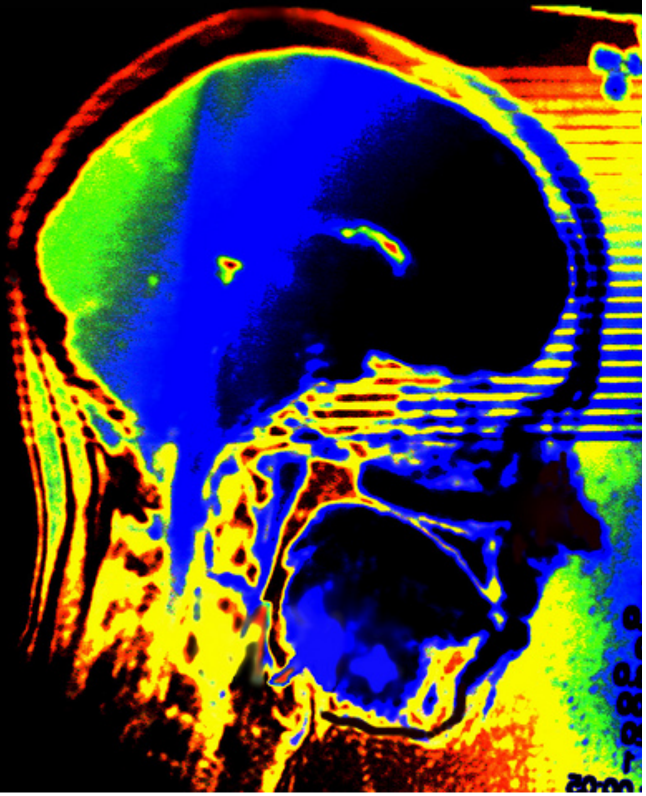
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/warsM03953_0005_0006.img
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0006.im

Step 8
Smoothing



Modelling Overview

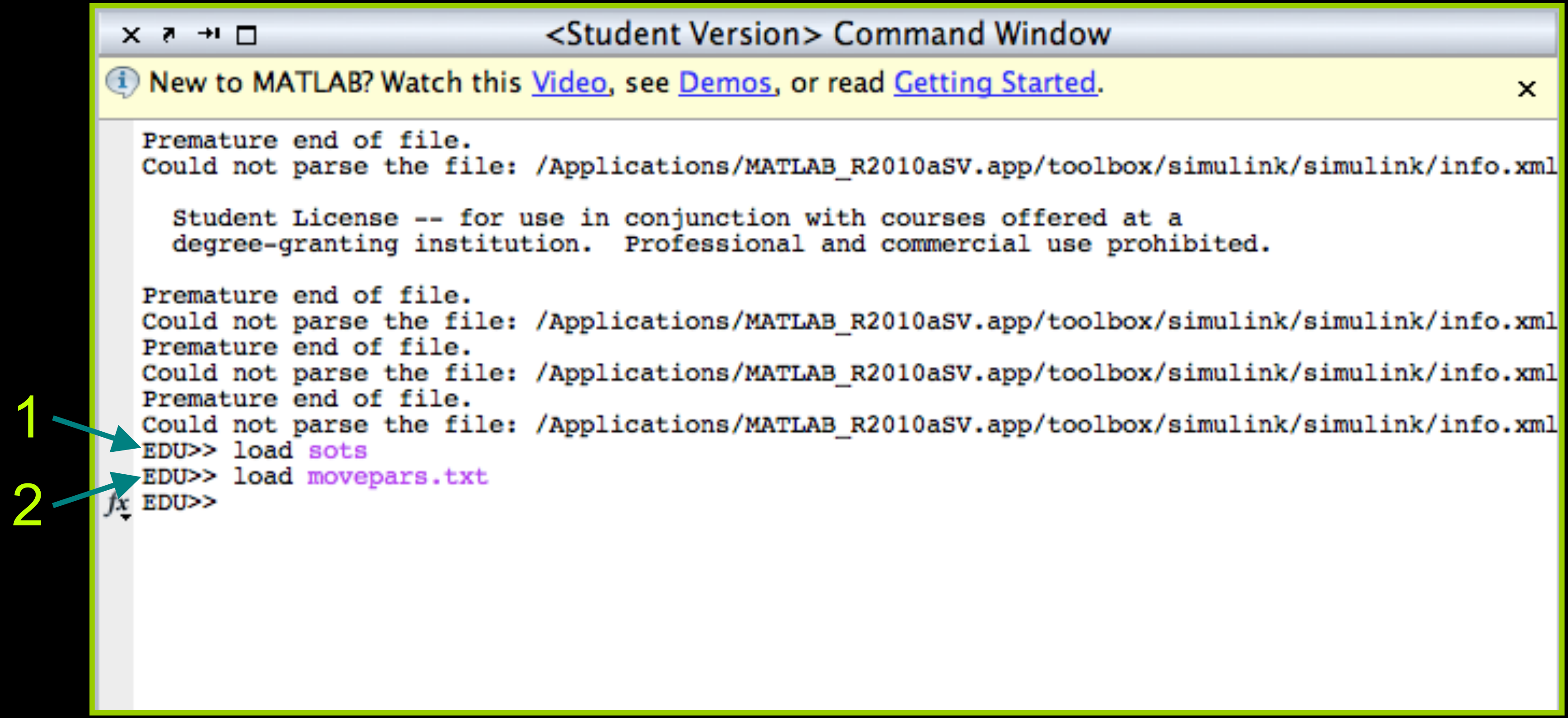
1. Specify First Level
2. Estimate
3. Inference for Categorical Design
4. Statistical Tables
5. F-Contrasts
6. Testing Effects of Movement



Step 9
Specify First-Level (Part 1)

- At the MATLAB command prompt, type “load sots” and then “moveparts.txt”
- Press the SPECIFY 1ST-LEVEL button
  - Highlight “Units for design” in the “Timing parameters” section and select “Scans”
    - “Interscan interval”; Type “2”
    - “Microtime resolution”; Type “24”
    - “Microtime onset”; Type “12”
  - Highlight “Data and Design” and select “New Subject/Session”; then highlight “Scans” and use the ^swar.* filter to choose 351 functional images

Step 9
Specify First-Level (Part 1)



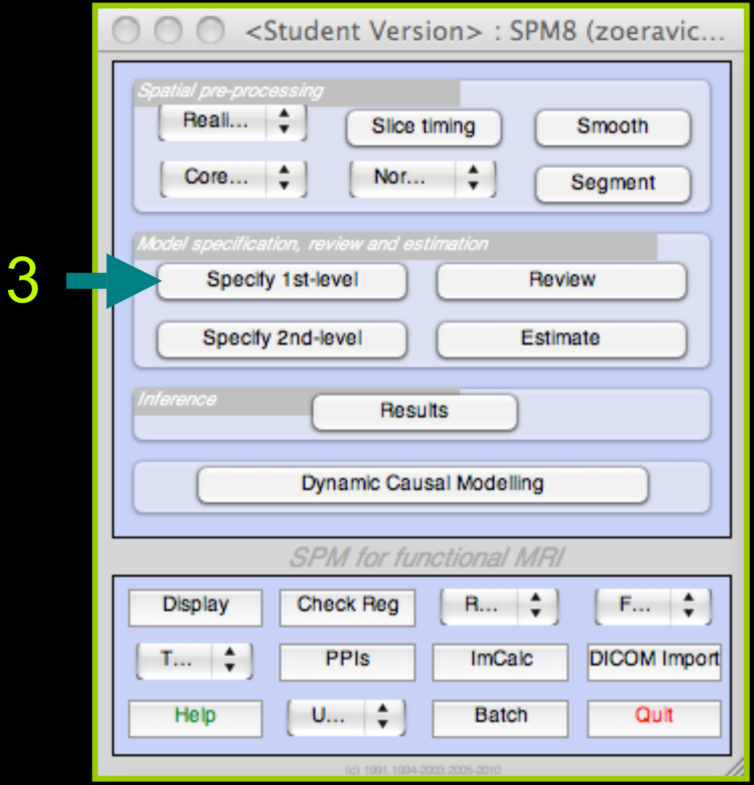
New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
Premature end of file.
Could not parse the file: /Applications/MATLAB_R2010aSV.app/toolbox/simulink/simulink/info.xml

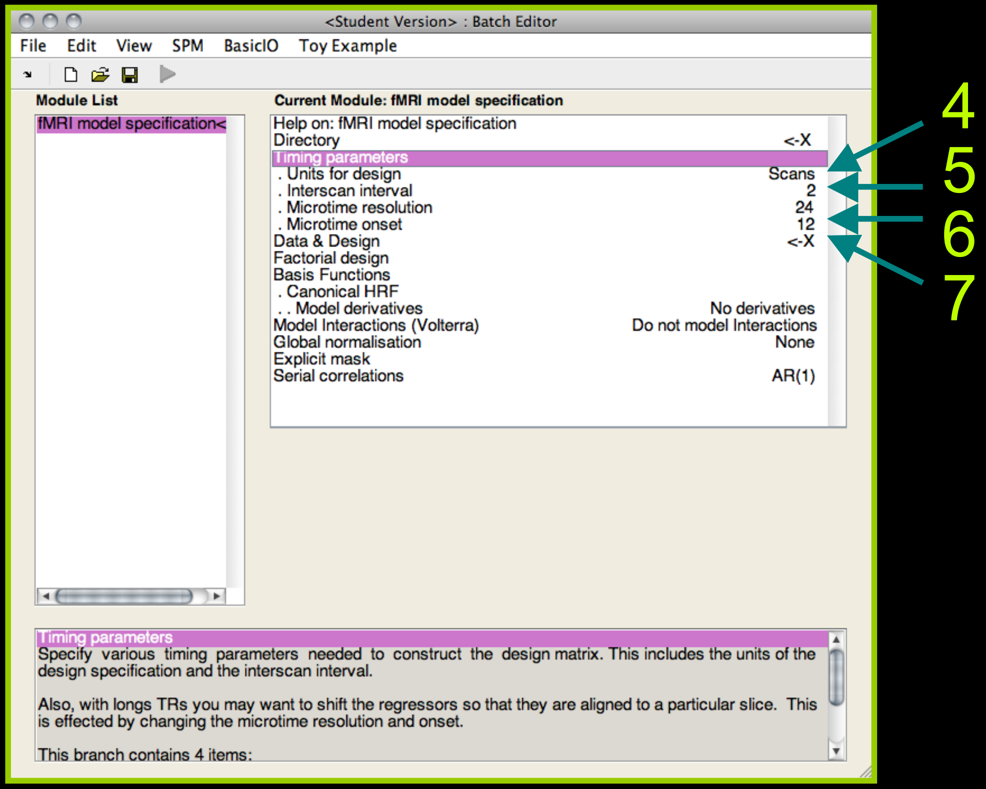
  Student License -- for use in conjunction with courses offered at a
  degree-granting institution.  Professional and commercial use prohibited.

Premature end of file.
Could not parse the file: /Applications/MATLAB_R2010aSV.app/toolbox/simulink/simulink/info.xml
Premature end of file.
Could not parse the file: /Applications/MATLAB_R2010aSV.app/toolbox/simulink/simulink/info.xml
Premature end of file.
Could not parse the file: /Applications/MATLAB_R2010aSV.app/toolbox/simulink/simulink/info.xml
EDU>> load sots
EDU>> load movepars.txt
EDU>>
```

Step 9
Specify First-Level (Part 1)



Step 9
Specify First-Level (Part 1)



Current Module: fMRI model specification

Help on: fMRI model specification	
Directory	<-X
Timing parameters	
. Units for design	Scans
. Interscan interval	2
. Microtime resolution	24
. Microtime onset	12
Data & Design	<-X
Factorial design	
Basis Functions	
. Canonical HRF	
. . Model derivatives	No derivatives
Model Interactions (Volterra)	Do not model Interactions
Global normalisation	None
Explicit mask	
Serial correlations	AR(1)

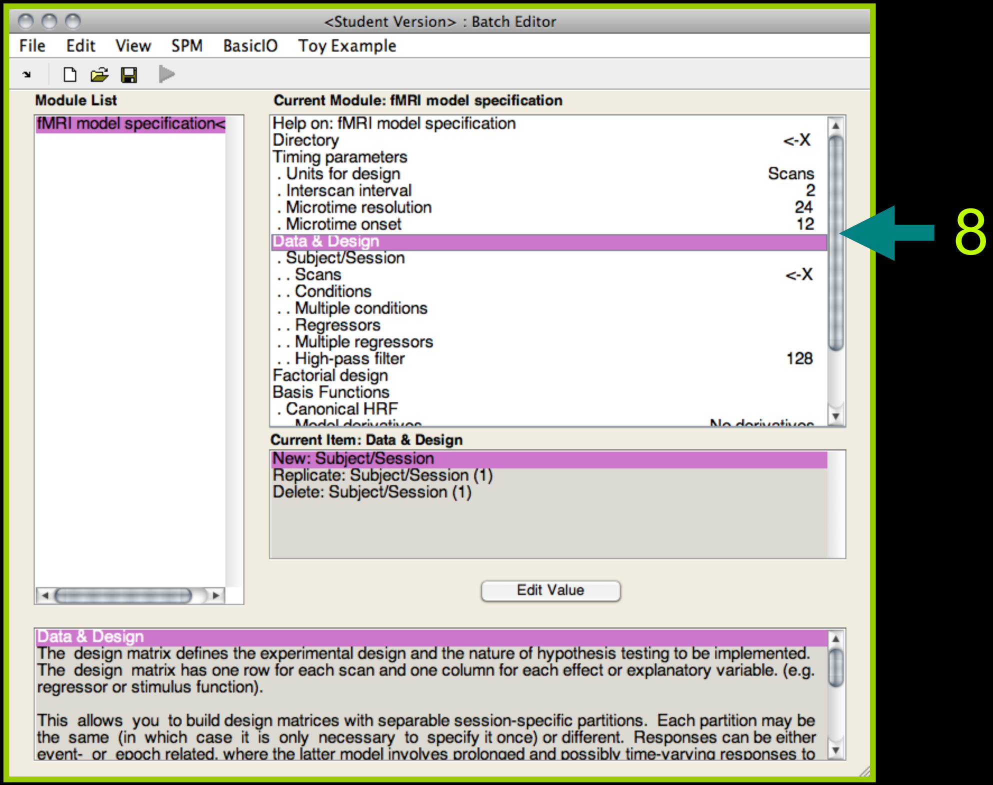
Timing parameters

Specify various timing parameters needed to construct the design matrix. This includes the units of the design specification and the interscan interval.

Also, with longs TRs you may want to shift the regressors so that they are aligned to a particular slice. This is effected by changing the microtime resolution and onset.

This branch contains 4 items:

Step 9
Specify First-Level (Part 1)



fMRI model specification<

Current Module: fMRI model specification

Help on: fMRI model specification
Directory <-X
Timing parameters
. Units for design Scans
. Interscan interval 2
. Microtime resolution 24
. Microtime onset 12
Data & Design
. Subject/Session
. . Scans <-X
. . Conditions
. . Multiple conditions
. . Regressors
. . Multiple regressors
. . High-pass filter 128
Factorial design
Basis Functions
. Canonical HRF

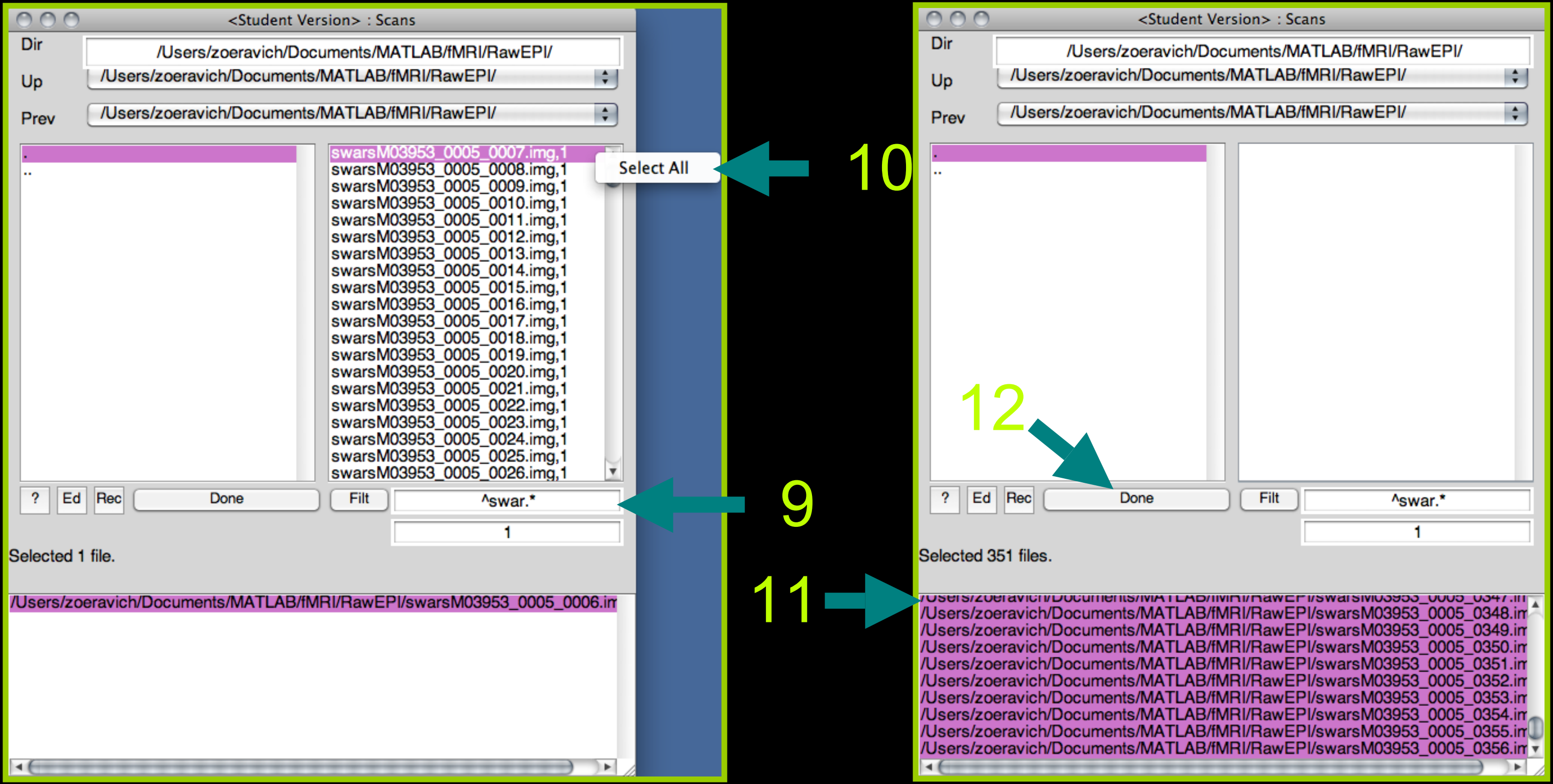
Current Item: Data & Design

New: Subject/Session
Replicate: Subject/Session (1)
Delete: Subject/Session (1)

Data & Design
The design matrix defines the experimental design and the nature of hypothesis testing to be implemented. The design matrix has one row for each scan and one column for each effect or explanatory variable. (e.g. regressor or stimulus function).

This allows you to build design matrices with separable session-specific partitions. Each partition may be the same (in which case it is only necessary to specify it once) or different. Responses can be either event- or epoch related, where the latter model involves prolonged and possibly time-varying responses to

Step 9
Specify First-Level (Part 1)



<Student Version> : Scans

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

```
.
..
```

```
swarsM03953_0005_0007.img,1
swarsM03953_0005_0008.img,1
swarsM03953_0005_0009.img,1
swarsM03953_0005_0010.img,1
swarsM03953_0005_0011.img,1
swarsM03953_0005_0012.img,1
swarsM03953_0005_0013.img,1
swarsM03953_0005_0014.img,1
swarsM03953_0005_0015.img,1
swarsM03953_0005_0016.img,1
swarsM03953_0005_0017.img,1
swarsM03953_0005_0018.img,1
swarsM03953_0005_0019.img,1
swarsM03953_0005_0020.img,1
swarsM03953_0005_0021.img,1
swarsM03953_0005_0022.img,1
swarsM03953_0005_0023.img,1
swarsM03953_0005_0024.img,1
swarsM03953_0005_0025.img,1
swarsM03953_0005_0026.img,1
```

Filt ^swar.*

1

Selected 1 file.

```
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0006.im
```

<Student Version> : Scans

Dir /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Up /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

```
.
..
```

Filt ^swar.*

1

Selected 351 files.

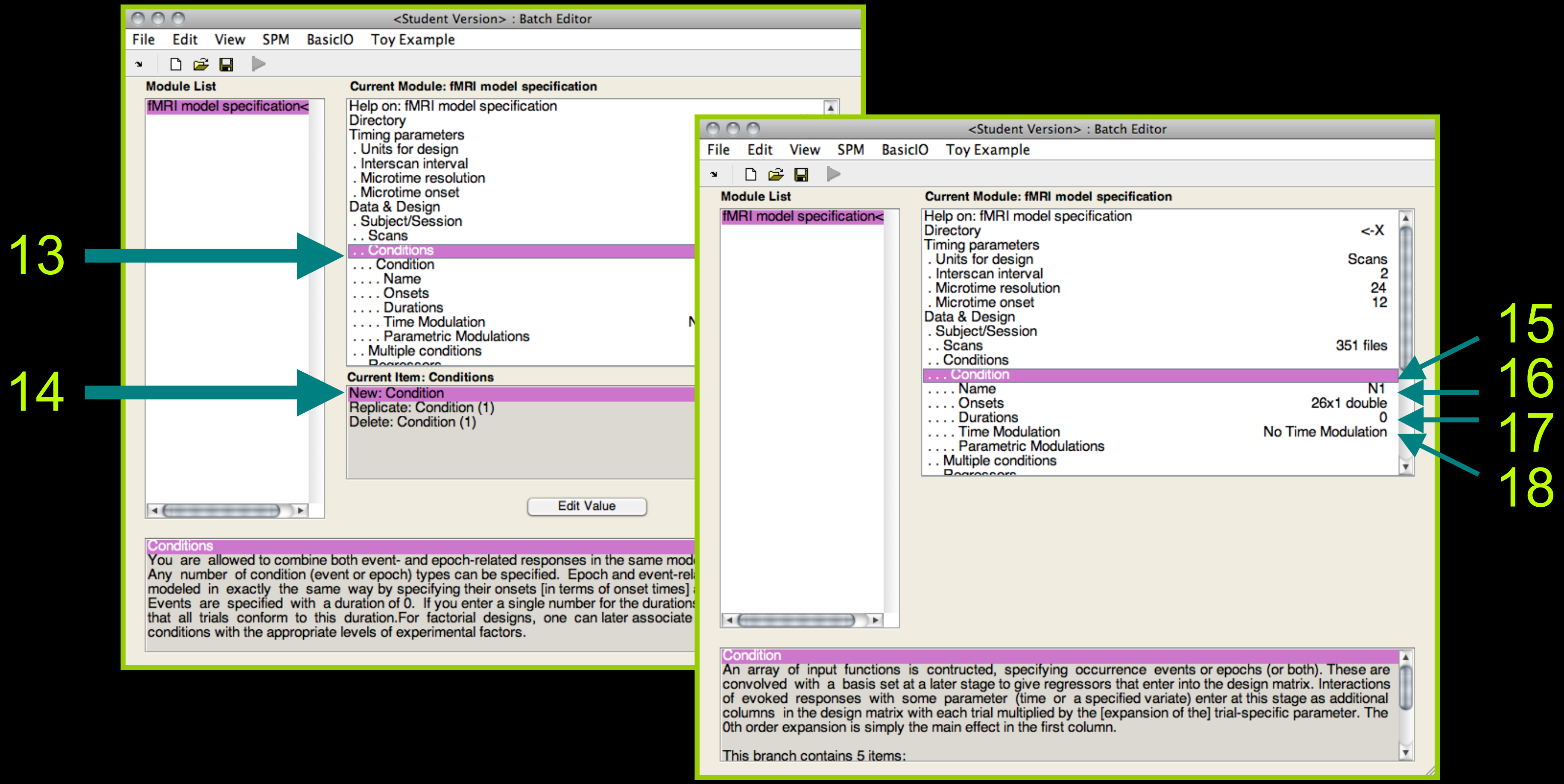
```
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0347.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0348.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0349.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0350.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0351.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0352.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0353.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0354.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0355.im
/Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/swarsM03953_0005_0356.im
```

Step 9

Specify First-Level (Part 2)

- Highlight “Conditions”, select “New condition”, and open the newly created “Condition” option
  - “Name”; Type “N1”
  - “Onsets”; Type “sot{1}”
  - “Durations”; Type “0”
- Highlight “Conditions”, select “Replicate condition”, and then open the newly created “Condition” option
  - “Name”; Type “N2”
  - “Onsets”; Type “sot{2}”

Step 9
Specify First-Level (Part 2)



Current Module: fMRI model specification

fMRI model specification<

Help on: fMRI model specification
Directory
Timing parameters
. Units for design
. Interscan interval
. Microtime resolution
. Microtime onset
Data & Design
. Subject/Session
. . Scans
. . Conditions
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation N
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors

Current Item: Conditions

New: Condition
Replicate: Condition (1)
Delete: Condition (1)

Conditions

You are allowed to combine both event- and epoch-related responses in the same mod
Any number of condition (event or epoch) types can be specified. Epoch and event-rel
modeled in exactly the same way by specifying their onsets [in terms of onset times] a
Events are specified with a duration of 0. If you enter a single number for the durations
that all trials conform to this duration.For factorial designs, one can later associate
conditions with the appropriate levels of experimental factors.

Current Module: fMRI model specification

fMRI model specification<

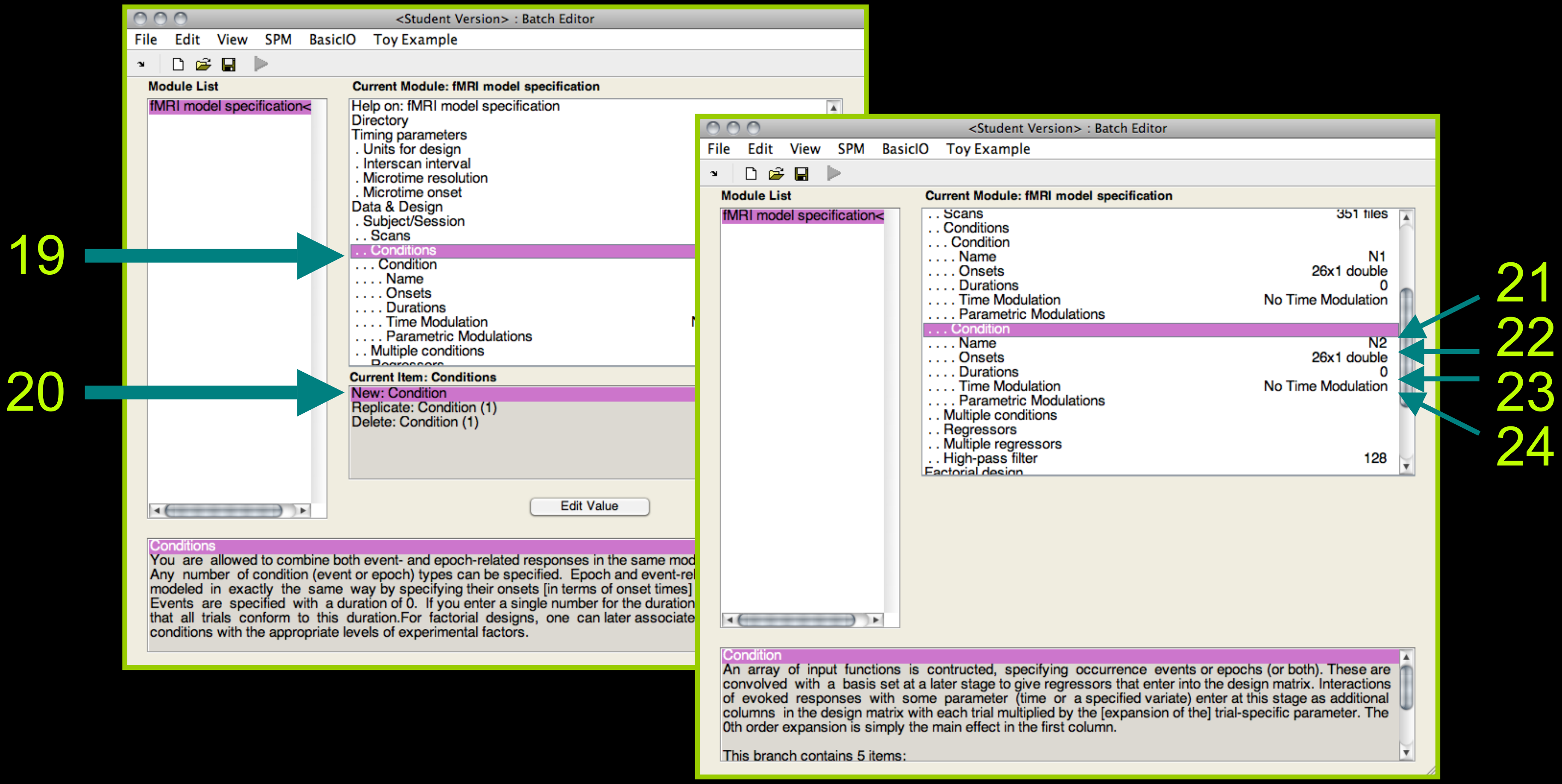
Help on: fMRI model specification
Directory <-X
Timing parameters
. Units for design Scans
. Interscan interval 2
. Microtime resolution 24
. Microtime onset 12
Data & Design
. Subject/Session
. . Scans 351 files
. . Conditions
. . . Condition
. . . . Name N1
. . . . Onsets 26x1 double
. . . . Durations 0
. . . . Time Modulation No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors

Condition

An array of input functions is contructed, specifying occurrence events or epochs (or both). These are convolved with a basis set at a later stage to give regressors that enter into the design matrix. Interactions of evoked responses with some parameter (time or a specified variate) enter at this stage as additional columns in the design matrix with each trial multiplied by the [expansion of the] trial-specific parameter. The 0th order expansion is simply the main effect in the first column.

This branch contains 5 items:

Step 9
Specify First-Level (Part 2)



Current Module: fMRI model specification

Help on: fMRI model specification
Directory
Timing parameters
. Units for design
. Interscan interval
. Microtime resolution
. Microtime onset
Data & Design
. Subject/Session
. . Scans
. . Conditions
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation
. . . . Parametric Modulations
. . Multiple conditions

Current Item: Conditions

New: Condition
Replicate: Condition (1)
Delete: Condition (1)

Conditions

You are allowed to combine both event- and epoch-related responses in the same mod
Any number of condition (event or epoch) types can be specified. Epoch and event-rel
modeled in exactly the same way by specifying their onsets [in terms of onset times]
Events are specified with a duration of 0. If you enter a single number for the duration
that all trials conform to this duration.For factorial designs, one can later associate
conditions with the appropriate levels of experimental factors.

Current Module: fMRI model specification

```
. . Scans                                   351 files
. . Conditions
. . . Condition
. . . . Name                                       N1
. . . . Onsets                           26x1 double
. . . . Durations                                   0
. . . . Time Modulation             No Time Modulation
. . . . Parametric Modulations
. . . Condition
. . . . Name                                       N2
. . . . Onsets                           26x1 double
. . . . Durations                                   0
. . . . Time Modulation             No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors
. . High-pass filter                              128
Factorial design
```

Condition

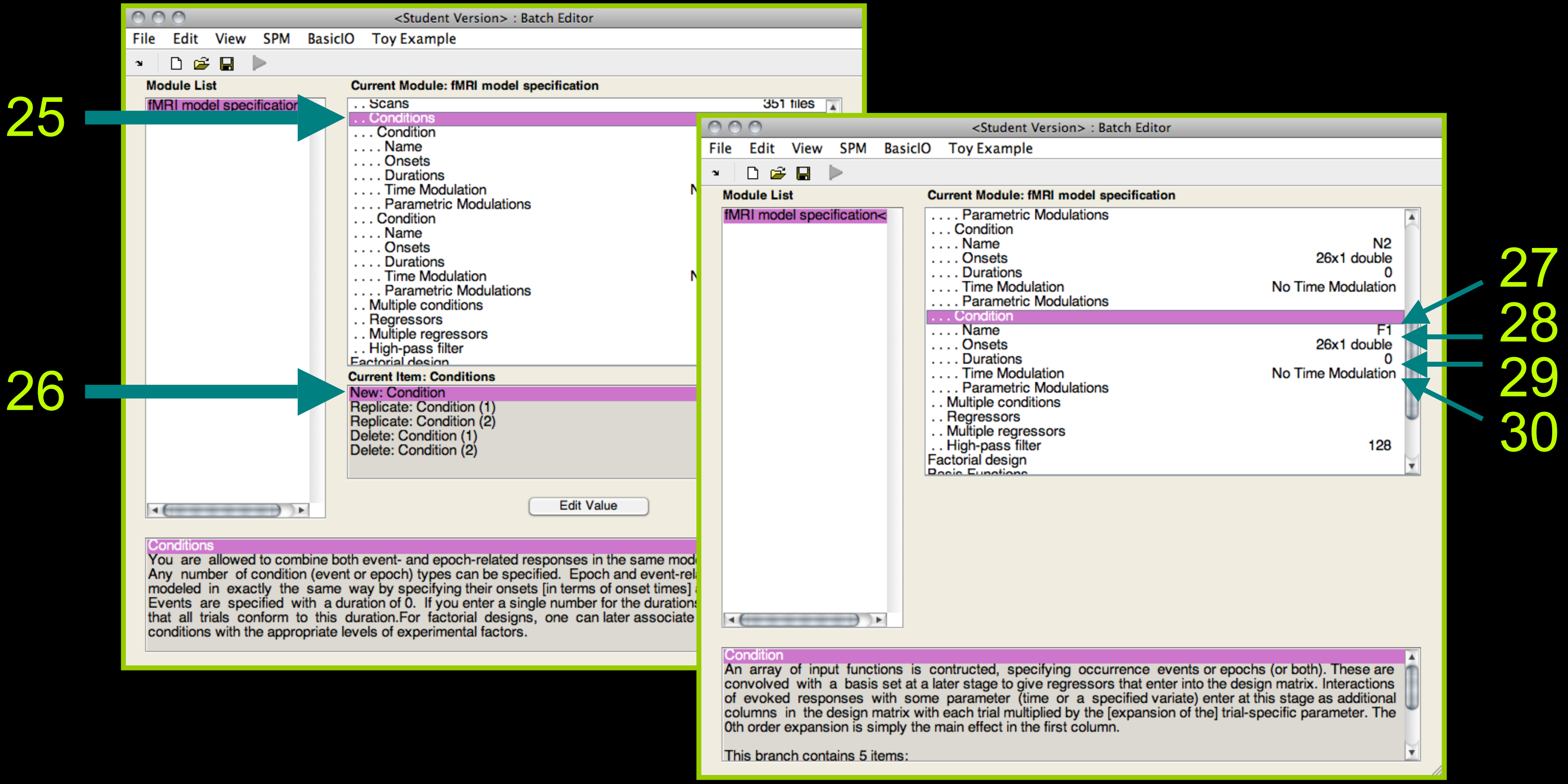
An array of input functions is contructed, specifying occurrence events or epochs (or both). These are convolved with a basis set at a later stage to give regressors that enter into the design matrix. Interactions of evoked responses with some parameter (time or a specified variate) enter at this stage as additional columns in the design matrix with each trial multiplied by the [expansion of the] trial-specific parameter. The 0th order expansion is simply the main effect in the first column.

This branch contains 5 items:

Step 9
Specify First-Level (Part 3)

- Highlight “Conditions”, select “Replicate condition”, and then open the newly created “Condition” option
  - “Name”; Type “F1”
  - “Onsets”; Type “sot{3}”
- Highlight “Conditions”, select “Replicate condition”, and then open the newly created “Condition” option
  - “Name”; Type “F2”
  - “Onsets”; Type “sot{4}”
- Highlight “Multiple Regressions” and select the movepars.txt file

Step 9
Specify First-Level (Part 3)



Current Module: fMRI model specification

fMRI model specification

. . Scans 351 files
. . Conditions
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation N
. . . . Parametric Modulations
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation N
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors
. . High-pass filter
Factorial design

Current Item: Conditions

New: Condition
Replicate: Condition (1)
Replicate: Condition (2)
Delete: Condition (1)
Delete: Condition (2)

Conditions

You are allowed to combine both event- and epoch-related responses in the same mod
Any number of condition (event or epoch) types can be specified. Epoch and event-rel
modeled in exactly the same way by specifying their onsets [in terms of onset times]
Events are specified with a duration of 0. If you enter a single number for the durations
that all trials conform to this duration.For factorial designs, one can later associate
conditions with the appropriate levels of experimental factors.

Current Module: fMRI model specification

fMRI model specification<

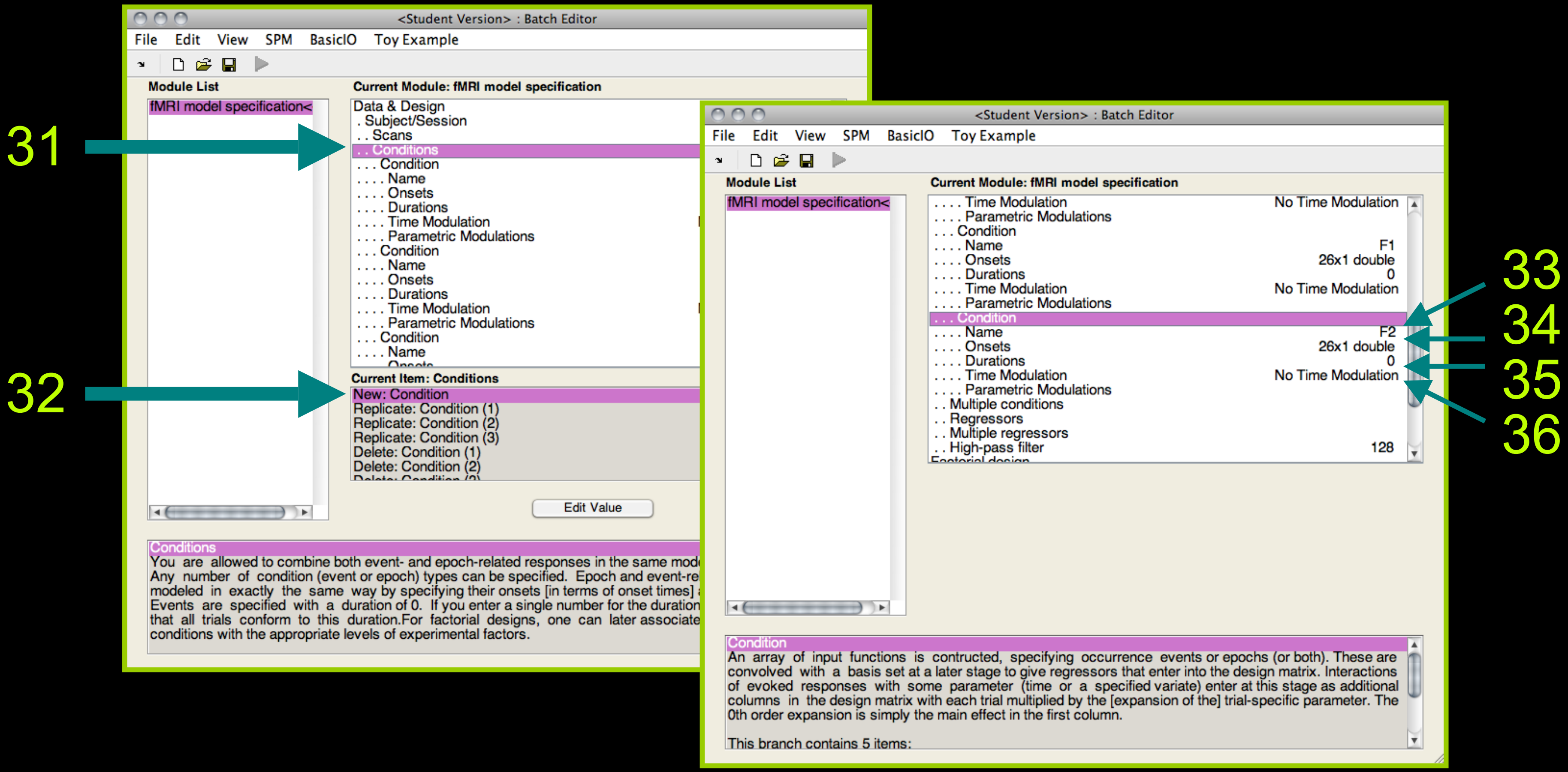
. . . . Parametric Modulations
. . . Condition
. . . . Name N2
. . . . Onsets 26x1 double
. . . . Durations 0
. . . . Time Modulation No Time Modulation
. . . . Parametric Modulations
. . . Condition
. . . . Name F1
. . . . Onsets 26x1 double
. . . . Durations 0
. . . . Time Modulation No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors
. . High-pass filter 128
Factorial design
Basis Functions

Condition

An array of input functions is contructed, specifying occurrence events or epochs (or both). These are convolved with a basis set at a later stage to give regressors that enter into the design matrix. Interactions of evoked responses with some parameter (time or a specified variate) enter at this stage as additional columns in the design matrix with each trial multiplied by the [expansion of the] trial-specific parameter. The 0th order expansion is simply the main effect in the first column.

This branch contains 5 items:

Step 9
Specify First-Level (Part 3)



Current Module: fMRI model specification

```
Data & Design
. Subject/Session
. . Scans
. . Conditions
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation
. . . . Parametric Modulations
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation
. . . . Parametric Modulations
. . . Condition
. . . . Name
```

Current Item: Conditions

```
New: Condition
Replicate: Condition (1)
Replicate: Condition (2)
Replicate: Condition (3)
Delete: Condition (1)
Delete: Condition (2)
```

Conditions

You are allowed to combine both event- and epoch-related responses in the same mode
Any number of condition (event or epoch) types can be specified. Epoch and event-re
modeled in exactly the same way by specifying their onsets [in terms of onset times]
Events are specified with a duration of 0. If you enter a single number for the duration
that all trials conform to this duration.For factorial designs, one can later associate
conditions with the appropriate levels of experimental factors.

Current Module: fMRI model specification

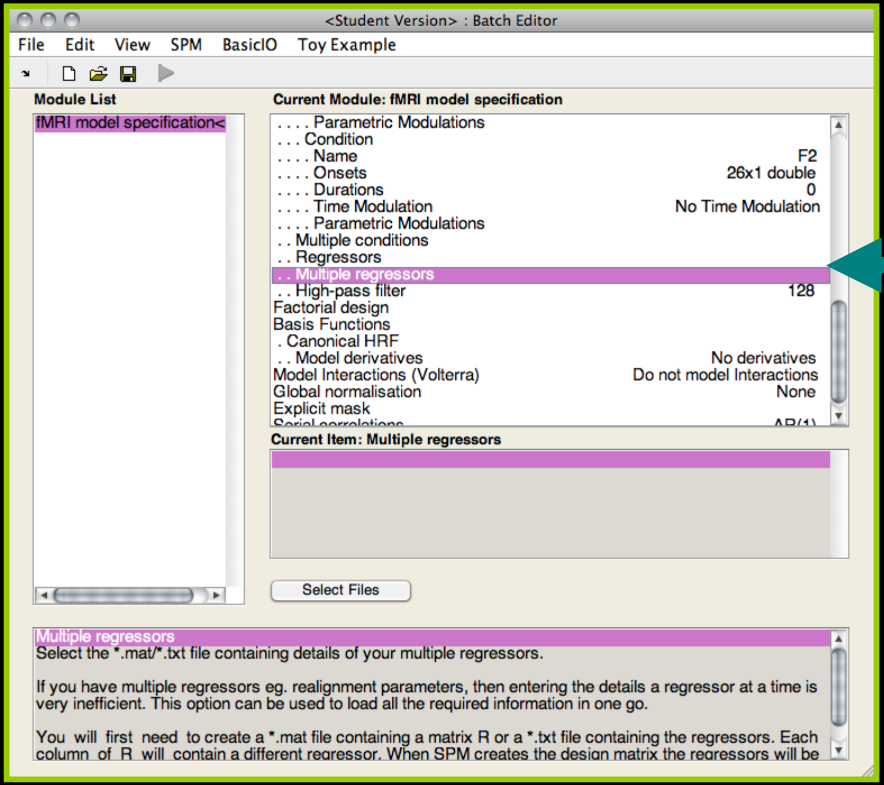
```
. . . . Time Modulation                  No Time Modulation
. . . . Parametric Modulations
. . . Condition
. . . . Name                                             F1
. . . . Onsets                                  26x1 double
. . . . Durations                                         0
. . . . Time Modulation                  No Time Modulation
. . . . Parametric Modulations
. . . Condition
. . . . Name                                             F2
. . . . Onsets                                  26x1 double
. . . . Durations                                         0
. . . . Time Modulation                  No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors
. . High-pass filter                                    128
```

Condition

An array of input functions is contructed, specifying occurrence events or epochs (or both). These are convolved with a basis set at a later stage to give regressors that enter into the design matrix. Interactions of evoked responses with some parameter (time or a specified variate) enter at this stage as additional columns in the design matrix with each trial multiplied by the [expansion of the] trial-specific parameter. The 0th order expansion is simply the main effect in the first column.

This branch contains 5 items:

Step 9
Specify First-Level (Part 3)



fMRI model specification<

Current Module: fMRI model specification

. . . . Parametric Modulations
. . . Condition
. . . . Name F2
. . . . Onsets 26x1 double
. . . . Durations 0
. . . . Time Modulation No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors
. . High-pass filter 128
Factorial design
Basis Functions
. Canonical HRF
. . Model derivatives No derivatives
Model Interactions (Volterra) Do not model Interactions
Global normalisation None
Explicit mask
Serial correlations AR(1)

Current Item: Multiple regressors

Multiple regressors
Select the *.mat/*.txt file containing details of your multiple regressors.

If you have multiple regressors eg. realignment parameters, then entering the details a regressor at a time is very inefficient. This option can be used to load all the required information in one go.

You will first need to create a *.mat file containing a matrix R or a *.txt file containing the regressors. Each column of R will contain a different regressor. When SPM creates the design matrix the regressors will be

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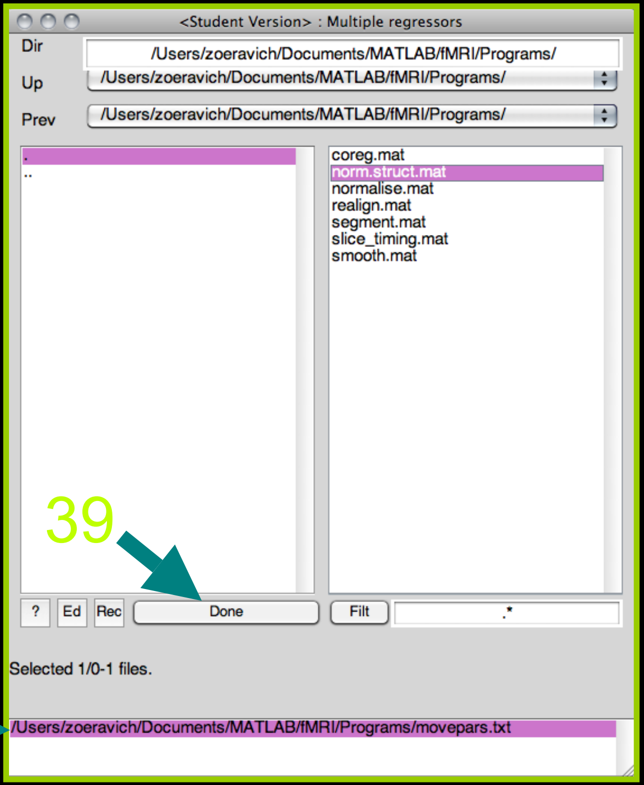

Dir /Users/zoeravich/Documents/MATLAB/fMRI/Programs/
Up /Users/zoeravich/Documents/MATLAB/fMRI/Programs/
Prev /Users/zoeravich/Documents/MATLAB/fMRI/Programs/

.
..

coreg.mat
norm.struct.mat
normalise.mat
realign.mat
segment.mat
slice_timing.mat
smooth.mat

Selected 1/0-1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/Programs/movepars.txt

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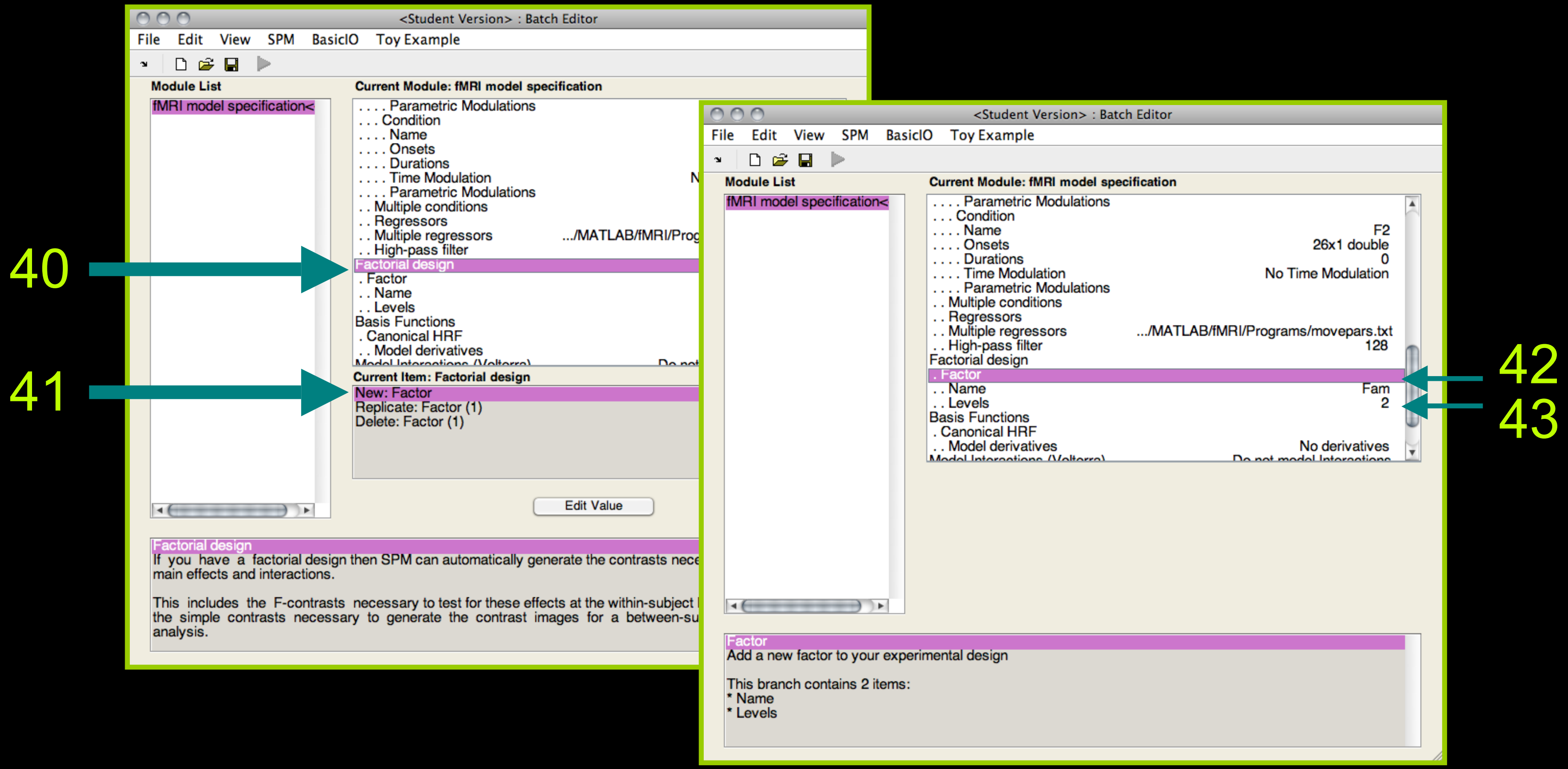
Step 9
Specify First-Level (Part 4)

- Highlight “Factorial Design”, select “New Factor”, and open the newly created “Factor” option
  - “Name”; Type “Fam”
  - “Levels”; Type “2”
- Highlight “Factorial Design”, select “New Factor”, and then open the newly created “Factor” option
  - “Name”; Type “Rep”
  - “Levels”; Type “2”
- Highlight “Basis Functions” and select “Canonical HRF”; choose “Model derivatives” and then “Time and Dispersion derivatives”

Step 9
Specify First-Level (Part 4)



fMRI model specification<

Current Module: fMRI model specification

```
. . . . Parametric Modulations
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation                       N
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors          .../MATLAB/fMRI/Prog
. . High-pass filter
Factorial design
. Factor
. . Name
. . Levels
Basis Functions
. Canonical HRF
. . Model derivatives
```

Current Item: Factorial design

New: Factor
Replicate: Factor (1)
Delete: Factor (1)

Factorial design
If you have a factorial design then SPM can automatically generate the contrasts nece main effects and interactions.

This includes the F-contrasts necessary to test for these effects at the within-subject l the simple contrasts necessary to generate the contrast images for a between-su analysis.

fMRI model specification<

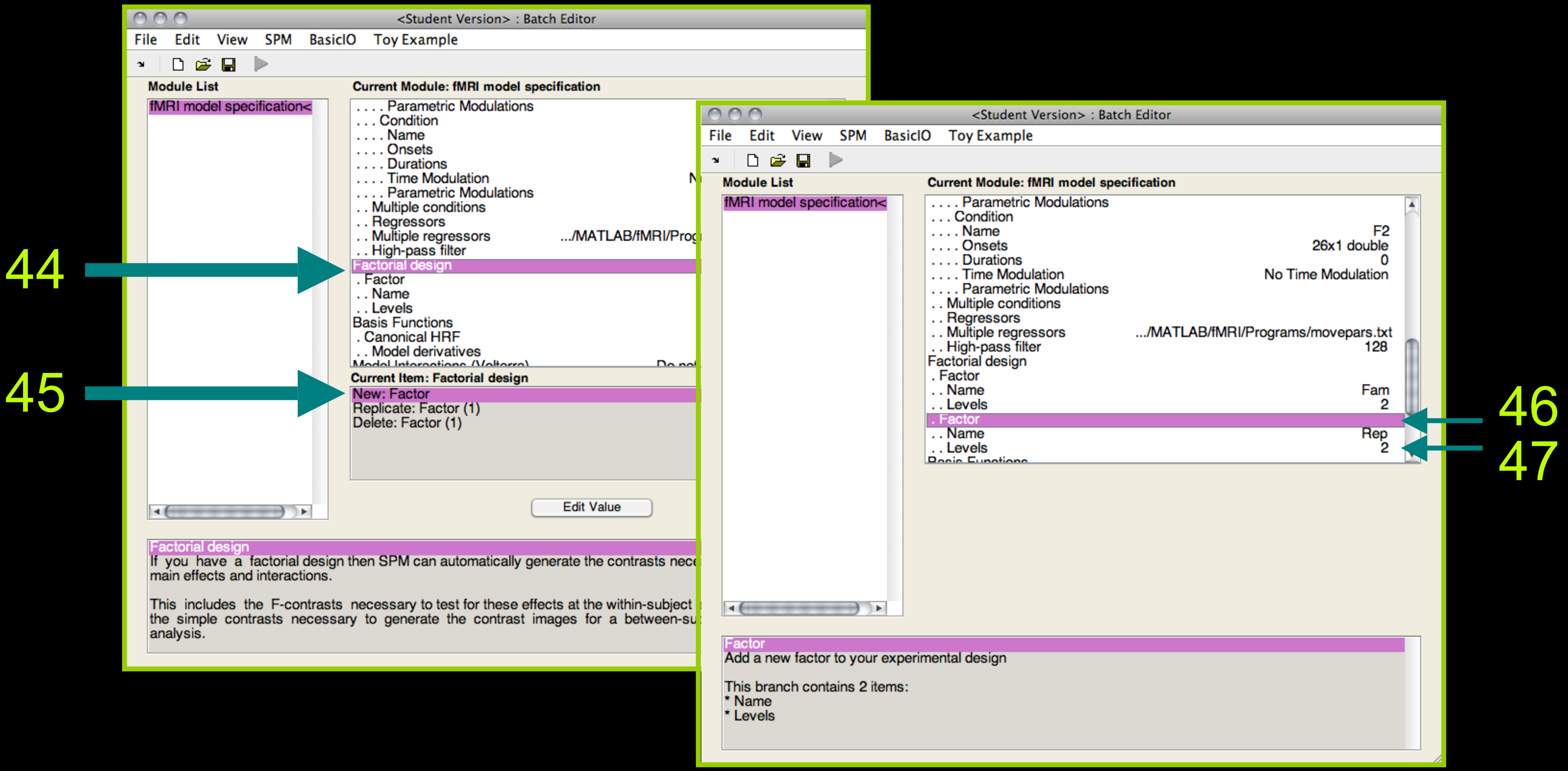
Current Module: fMRI model specification

```
. . . . Parametric Modulations
. . . Condition
. . . . Name                                                    F2
. . . . Onsets                                        26x1 double
. . . . Durations                                                0
. . . . Time Modulation                          No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors      .../MATLAB/fMRI/Programs/movepars.txt
. . High-pass filter                                           128
Factorial design
. Factor
. . Name                                                       Fam
. . Levels                                                       2
Basis Functions
. Canonical HRF
. . Model derivatives                               No derivatives
```

Factor
Add a new factor to your experimental design

This branch contains 2 items:
* Name
* Levels

Step 9
Specify First-Level (Part 4)



Current Module: fMRI model specification

```
. . . . Parametric Modulations
. . . Condition
. . . . Name
. . . . Onsets
. . . . Durations
. . . . Time Modulation                                N
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors          .../MATLAB/fMRI/Prog
. . High-pass filter
Factorial design
. Factor
. . Name
. . Levels
Basis Functions
. Canonical HRF
. . Model derivatives
```

Current Item: Factorial design

```
New: Factor
Replicate: Factor (1)
Delete: Factor (1)
```

Factorial design
If you have a factorial design then SPM can automatically generate the contrasts nece
main effects and interactions.

This includes the F-contrasts necessary to test for these effects at the within-subject
the simple contrasts necessary to generate the contrast images for a between-su
analysis.

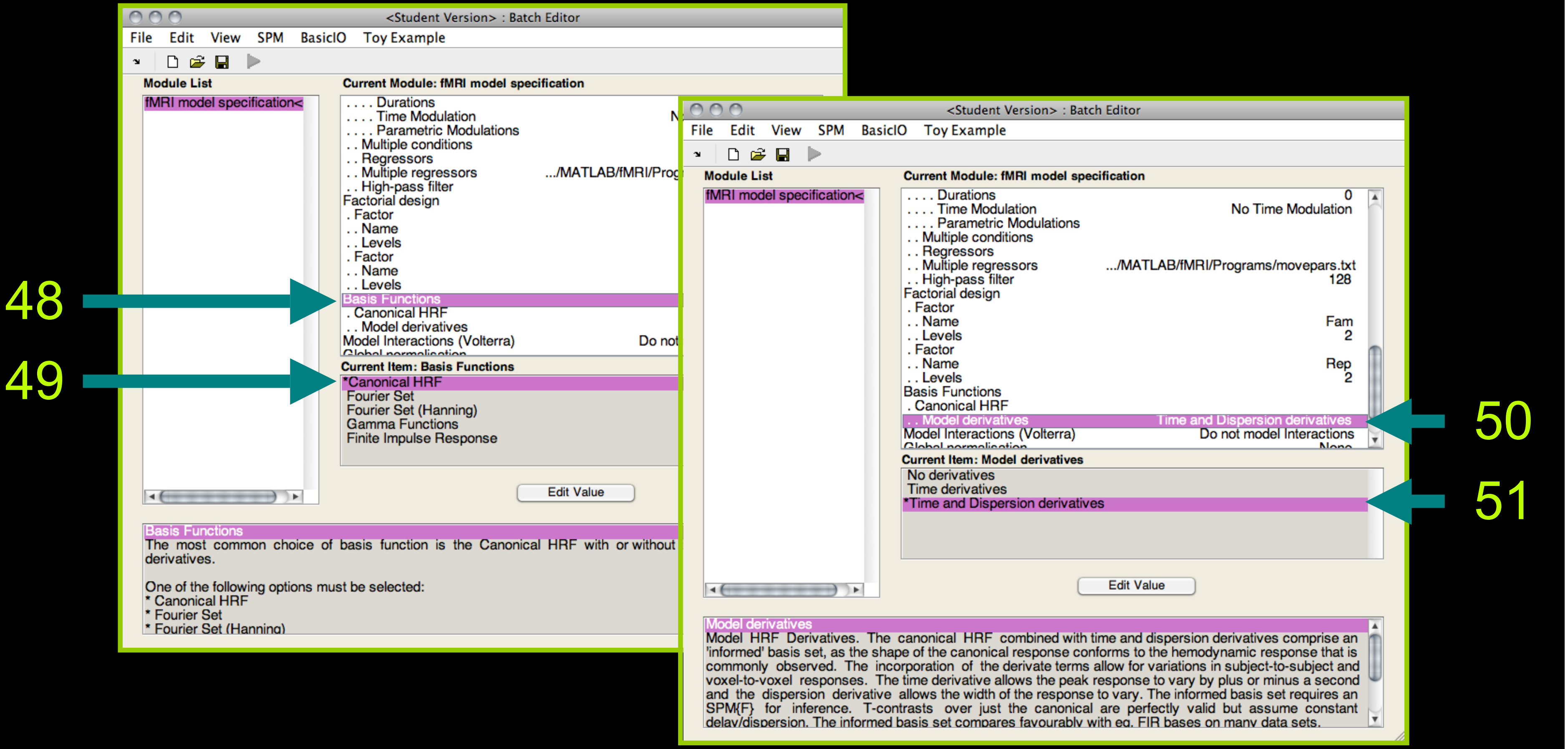
Current Module: fMRI model specification

```
. . . . Parametric Modulations
. . . Condition
. . . . Name                                                          F2
. . . . Onsets                                               26x1 double
. . . . Durations                                                      0
. . . . Time Modulation                              No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors       .../MATLAB/fMRI/Programs/movepars.txt
. . High-pass filter                                                 128
Factorial design
. Factor
. . Name                                                             Fam
. . Levels                                                             2
. Factor
. . Name                                                             Rep
. . Levels                                                             2
```

Factor
Add a new factor to your experimental design

This branch contains 2 items:
* Name
* Levels

Step 9
Specify First-Level (Part 4)



Current Module: fMRI model specification

```
. . . . Durations
. . . . Time Modulation                              N
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors           .../MATLAB/fMRI/Prog
. . High-pass filter
Factorial design
. Factor
. . Name
. . Levels
. Factor
. . Name
. . Levels
Basis Functions
. Canonical HRF
. . Model derivatives
Model Interactions (Volterra)                   Do not
```

Current Item: Basis Functions

```
*Canonical HRF
 Fourier Set
 Fourier Set (Hanning)
 Gamma Functions
 Finite Impulse Response
```

Basis Functions

The most common choice of basis function is the Canonical HRF with or without derivatives.

One of the following options must be selected:
* Canonical HRF
* Fourier Set
* Fourier Set (Hanning)

Current Module: fMRI model specification

```
. . . . Durations                                                  0
. . . . Time Modulation                           No Time Modulation
. . . . Parametric Modulations
. . Multiple conditions
. . Regressors
. . Multiple regressors      .../MATLAB/fMRI/Programs/movepars.txt
. . High-pass filter                                             128
Factorial design
. Factor
. . Name                                                         Fam
. . Levels                                                         2
. Factor
. . Name                                                         Rep
. . Levels                                                         2
Basis Functions
. Canonical HRF
. . Model derivatives               Time and Dispersion derivatives
Model Interactions (Volterra)         Do not model Interactions
```

Current Item: Model derivatives

```
 No derivatives
 Time derivatives
*Time and Dispersion derivatives
```

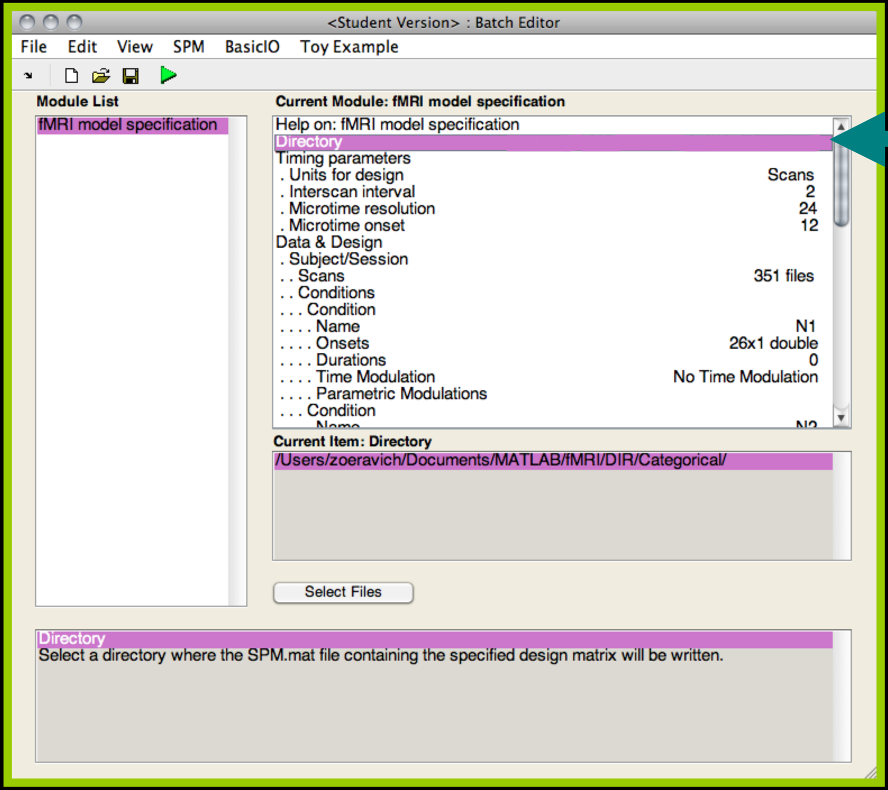
Model derivatives

Model HRF Derivatives. The canonical HRF combined with time and dispersion derivatives comprise an 'informed' basis set, as the shape of the canonical response conforms to the hemodynamic response that is commonly observed. The incorporation of the derivate terms allow for variations in subject-to-subject and voxel-to-voxel responses. The time derivative allows the peak response to vary by plus or minus a second and the dispersion derivative allows the width of the response to vary. The informed basis set requires an SPM{F} for inference. T-contrasts over just the canonical are perfectly valid but assume constant delay/dispersion. The informed basis set compares favourably with eg. FIR bases on many data sets.

Step 9
Specify First-Level (Part 5)

  - Highlight “Directory” and select the DIR/categorical directory
  - Save the job as categorical_spec.mat
  - Press the “Run” button
- Press the REVIEW button (it is advisable to check the model specification)
  - Under the “Design” tab, select the first item “Design Matrix”
  - “Explore” → “Session 1” → “N1”

Step 9
Specify First-Level (Part 5)



Current Module: fMRI model specification

Help on: fMRI model specification
Directory
Timing parameters
. Units for design — Scans
. Interscan interval — 2
. Microtime resolution — 24
. Microtime onset — 12
Data & Design
. Subject/Session
. . Scans — 351 files
. . Conditions
. . . Condition
. . . . Name — N1
. . . . Onsets — 26x1 double
. . . . Durations — 0
. . . . Time Modulation — No Time Modulation
. . . . Parametric Modulations
. . . Condition

Current Item: Directory

/Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Directory
Select a directory where the SPM.mat file containing the specified design matrix will be written.

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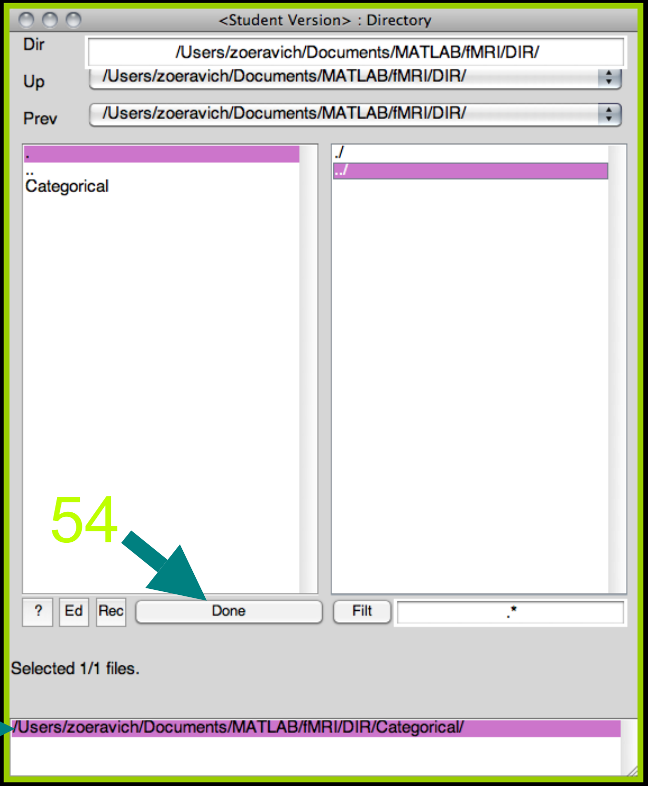

Dir: /Users/zoeravich/Documents/MATLAB/fMRI/DIR/
Up: /Users/zoeravich/Documents/MATLAB/fMRI/DIR/
Prev: /Users/zoeravich/Documents/MATLAB/fMRI/DIR/

.
..
Categorical

./
../

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

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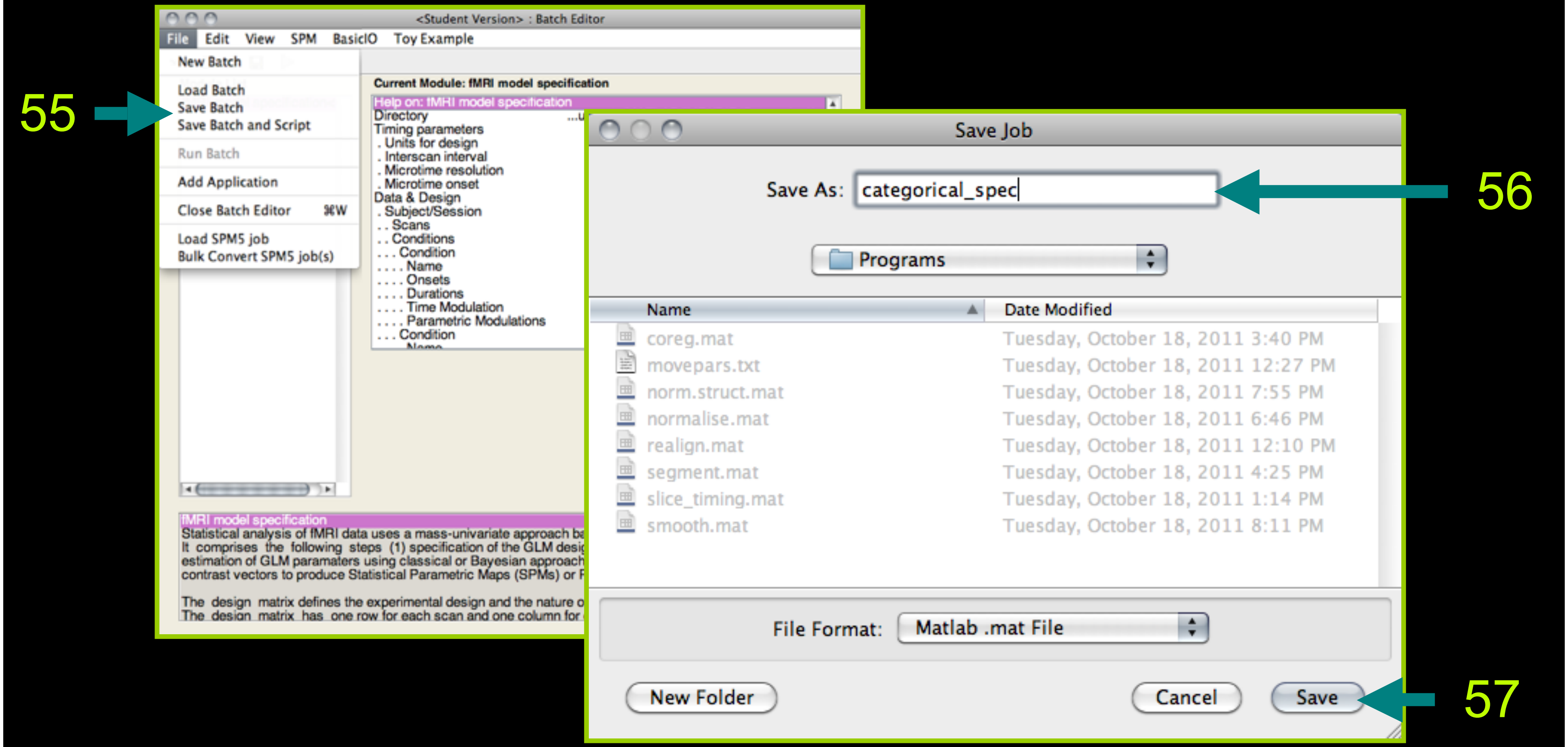
Step 9
Specify First-Level (Part 5)



Statistical analysis of fMRI data uses a mass-univariate approach ba
It comprises the following steps (1) specification of the GLM desi
estimation of GLM paramaters using classical or Bayesian approach
contrast vectors to produce Statistical Parametric Maps (SPMs) or F

The design matrix defines the experimental design and the nature o
The design matrix has one row for each scan and one column for

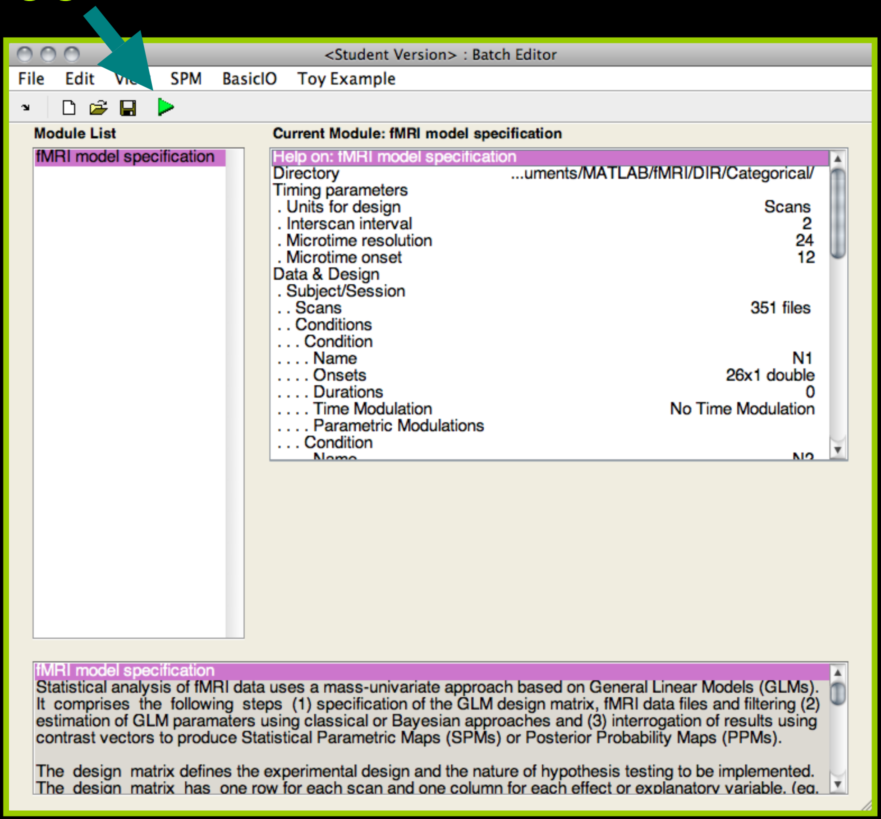
Save As: categorical_spec

Programs

File Format: Matlab .mat File

Step 9

Specify First-Level (Part 5)



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Current Module: fMRI model specification

Help on: fMRI model specification

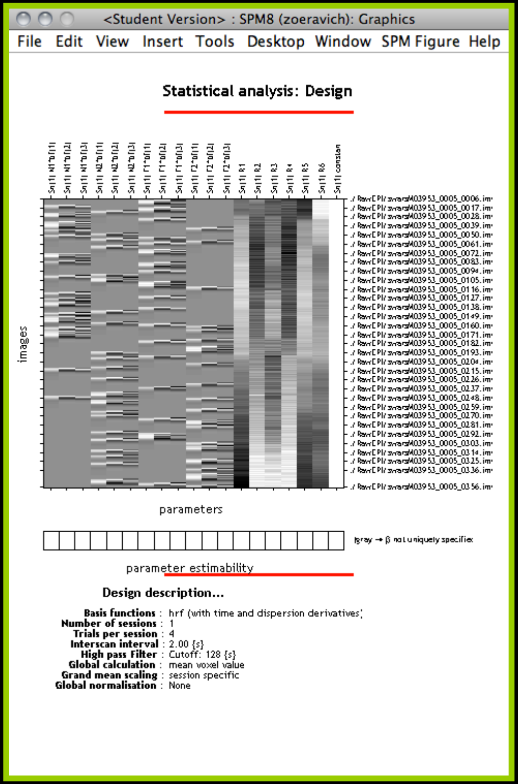
Directory	...uments/MATLAB/fMRI/DIR/Categorical/
Timing parameters	
. Units for design	Scans
. Interscan interval	2
. Microtime resolution	24
. Microtime onset	12
Data & Design	
. Subject/Session	
. . Scans	351 files
. . Conditions	
. . . Condition	
. . . . Name	N1
. . . . Onsets	26x1 double
. . . . Durations	0
. . . . Time Modulation	No Time Modulation
. . . . Parametric Modulations	
. . . Condition	

fMRI model specification

Statistical analysis of fMRI data uses a mass-univariate approach based on General Linear Models (GLMs). It comprises the following steps (1) specification of the GLM design matrix, fMRI data files and filtering (2) estimation of GLM paramaters using classical or Bayesian approaches and (3) interrogation of results using contrast vectors to produce Statistical Parametric Maps (SPMs) or Posterior Probability Maps (PPMs).

The design matrix defines the experimental design and the nature of hypothesis testing to be implemented. The design matrix has one row for each scan and one column for each effect or explanatory variable. (eg.

Step 9
Specify First-Level (Part 5)

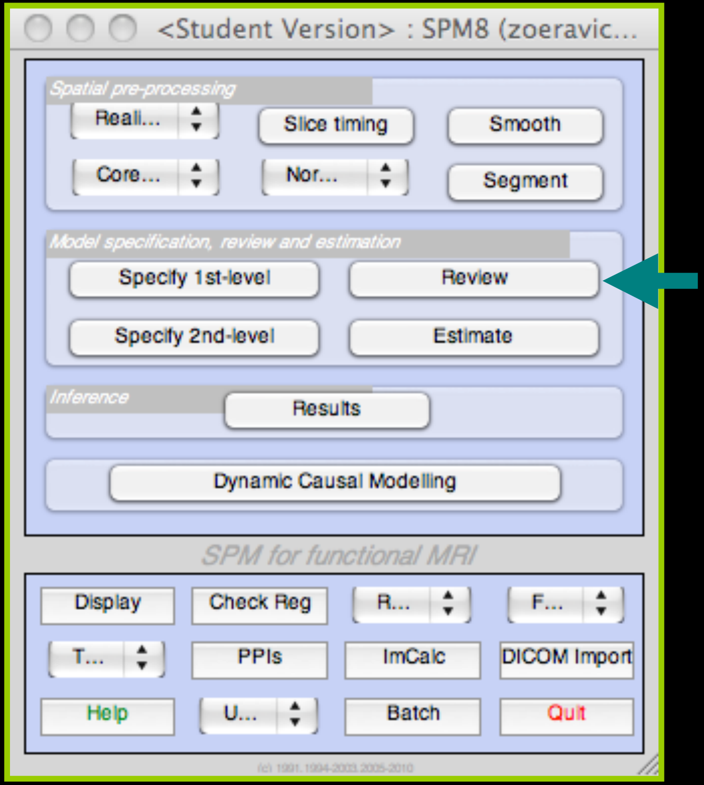


Statistical analysis: Design

Design description...

Basis functions : hrf (with time and dispersion derivatives)
Number of sessions : 1
Trials per session : 4
Interscan interval : 2.00 {s}
High pass Filter : Cutoff: 128 {s}
Global calculation : mean voxel value
Grand mean scaling : session specific
Global normalisation : None

Step 9
Specify First-Level (Part 5)



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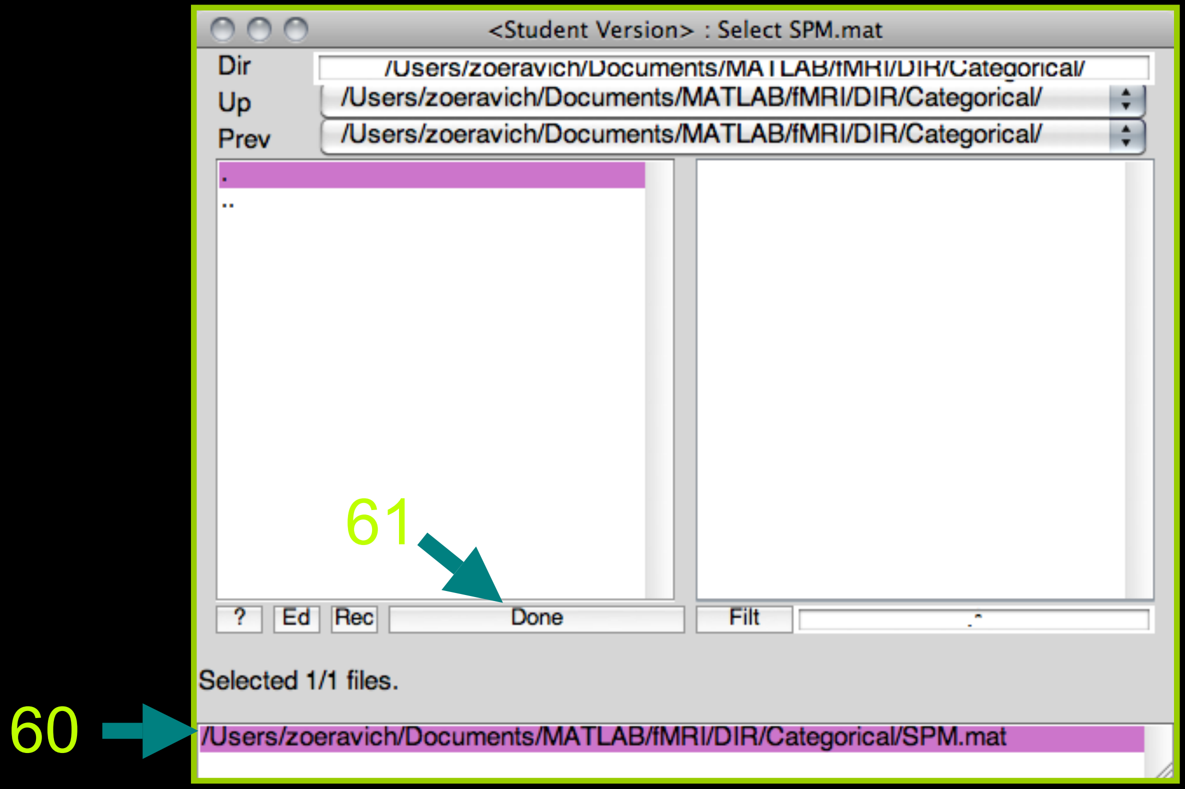
Step 9
Specify First-Level (Part 5)



<Student Version> : Select SPM.mat

Dir /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

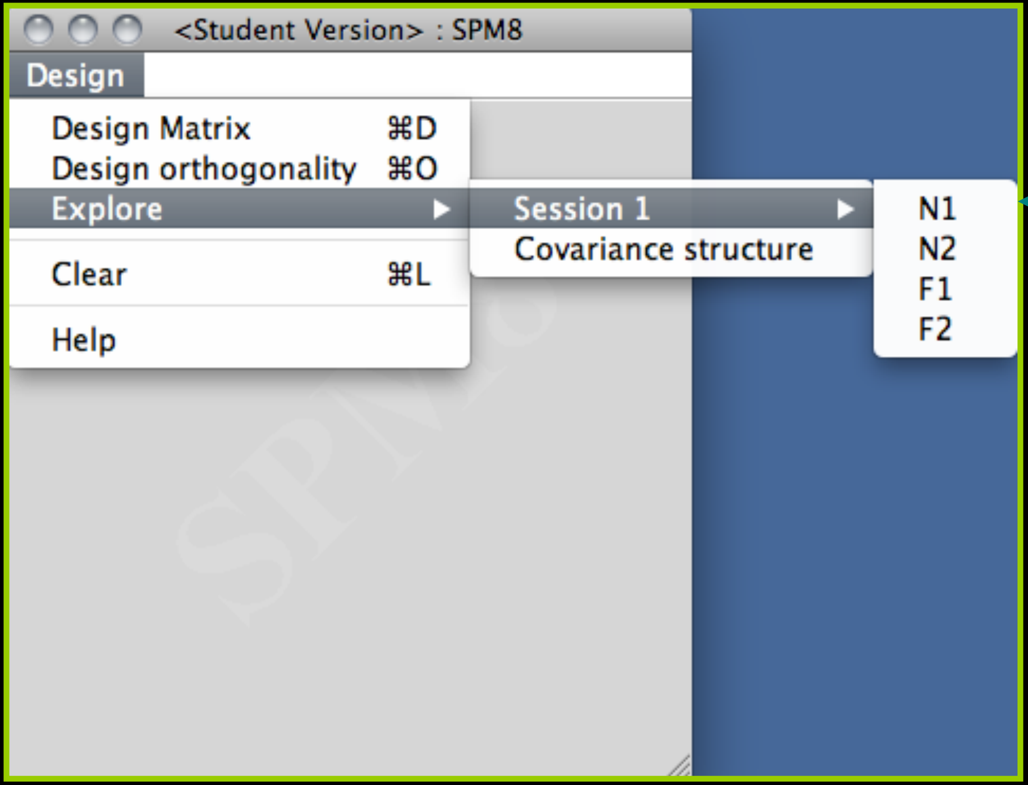
Up /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/SPM.mat

Step 9
Specify First-Level (Part 5)



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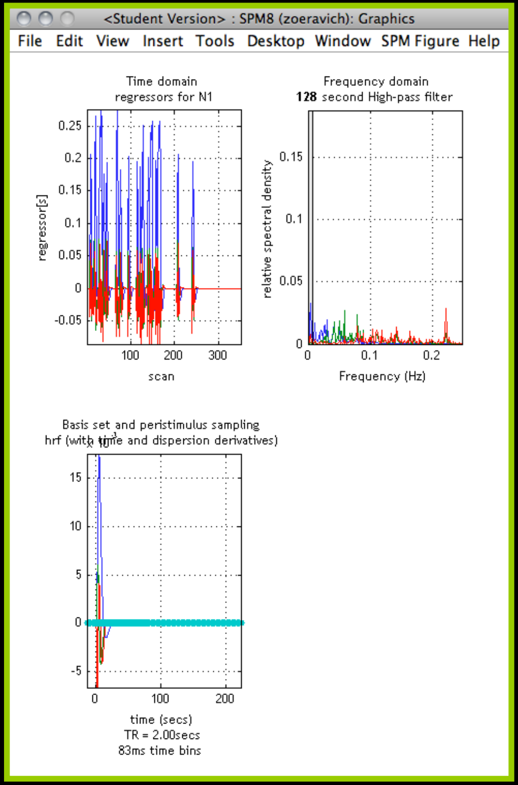
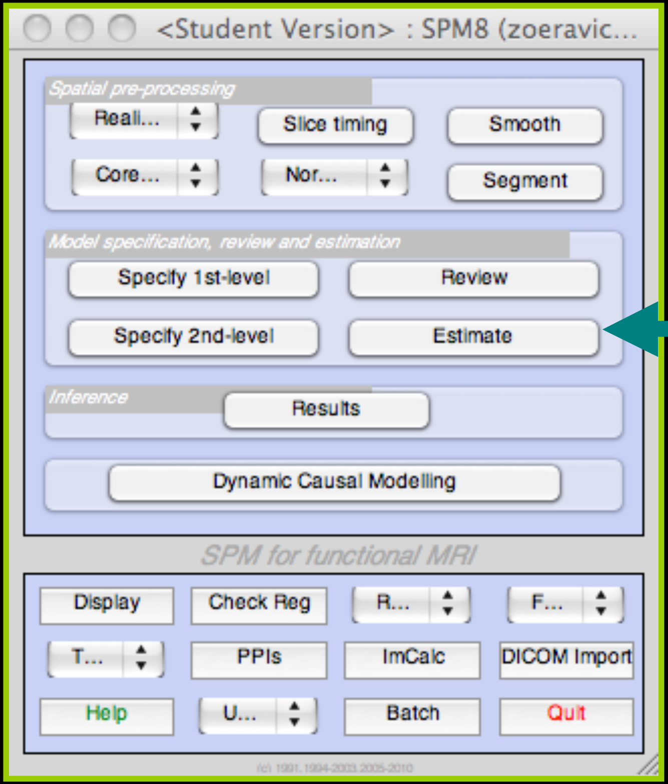
Step 9
Specify First-Level (Part 5)



Step 10
Estimate

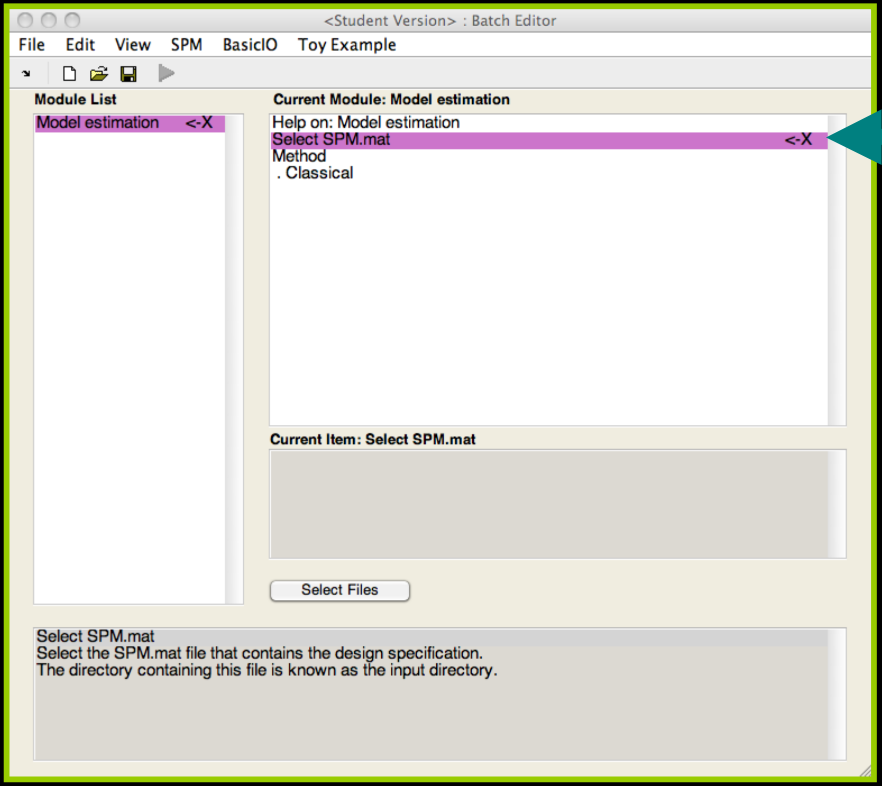
- Press the ESTIMATE button
  - Highlight “Select SPM.mat” and select the SPM.mat file saved in the DIR/categorical directory
  - Save the job as categorical_est.job
  - Press the “Run” button

Step 10
Estimate

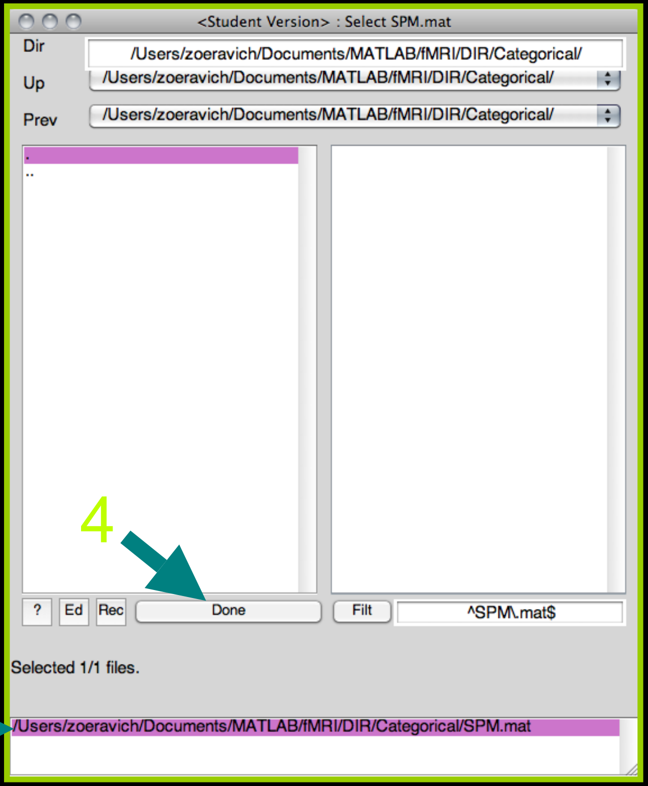


1

Step 10
Estimate



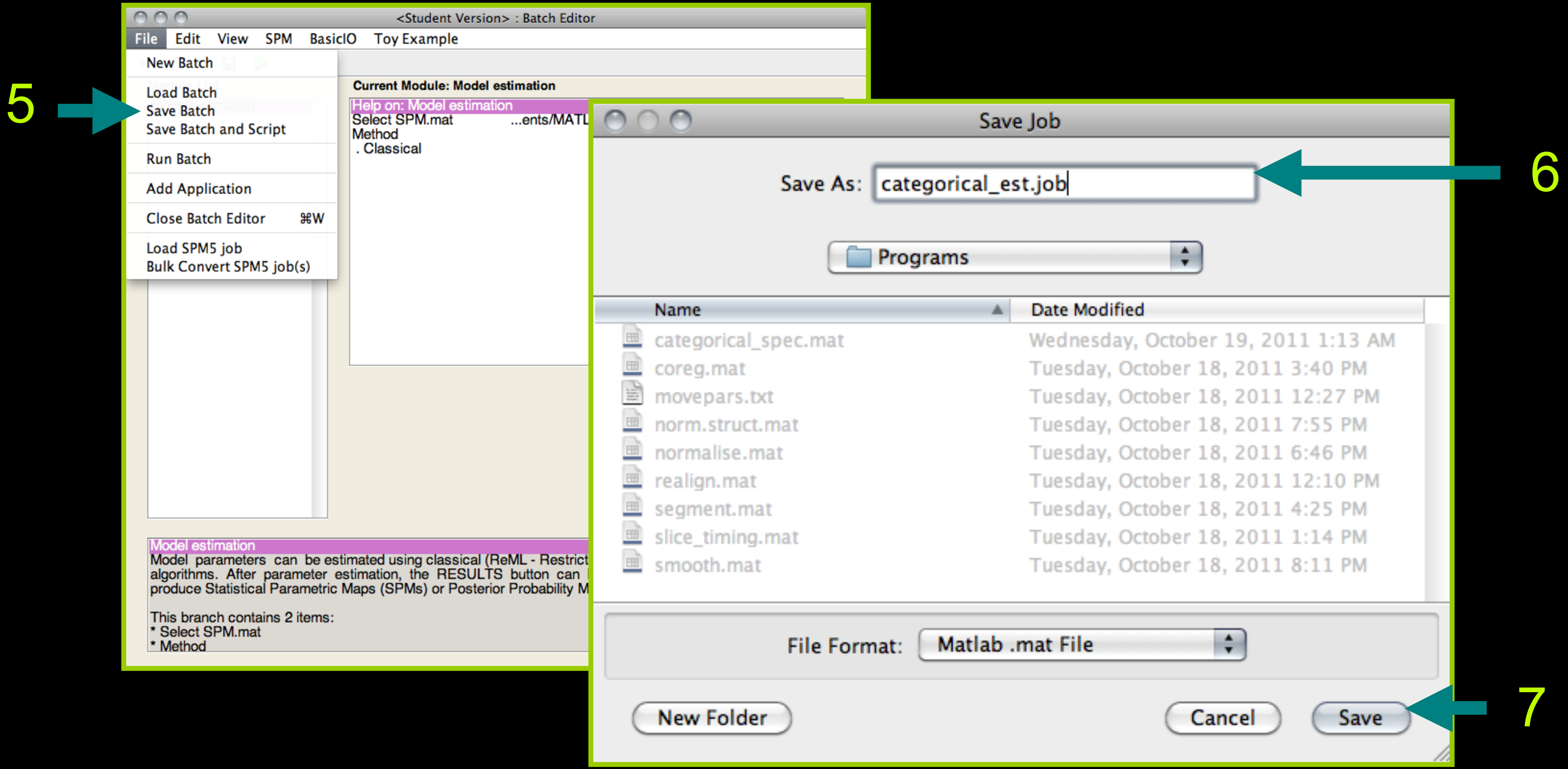
Select SPM.mat
Select the SPM.mat file that contains the design specification.
The directory containing this file is known as the input directory.



Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/SPM.mat

Step 10
Estimate



Current Module: Model estimation

Help on: Model estimation

Select SPM.mat ...ents/MATL

Method

. Classical

Save As: categorical_est.job

Name	Date Modified
categorical_spec.mat	Wednesday, October 19, 2011 1:13 AM
coreg.mat	Tuesday, October 18, 2011 3:40 PM
movepars.txt	Tuesday, October 18, 2011 12:27 PM
norm.struct.mat	Tuesday, October 18, 2011 7:55 PM
normalise.mat	Tuesday, October 18, 2011 6:46 PM
realign.mat	Tuesday, October 18, 2011 12:10 PM
segment.mat	Tuesday, October 18, 2011 4:25 PM
slice_timing.mat	Tuesday, October 18, 2011 1:14 PM
smooth.mat	Tuesday, October 18, 2011 8:11 PM

File Format: Matlab .mat File

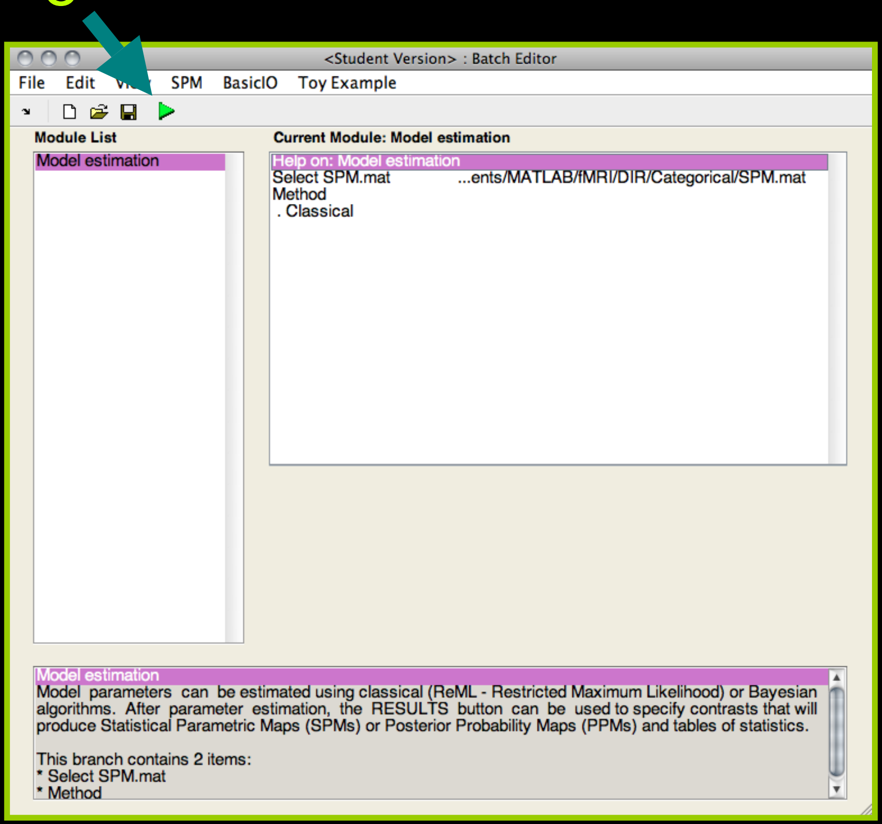
Model estimation

Model parameters can be estimated using classical (ReML - Restrict algorithms. After parameter estimation, the RESULTS button can produce Statistical Parametric Maps (SPMs) or Posterior Probability M

This branch contains 2 items:
* Select SPM.mat
* Method

Step 10
Estimate

8

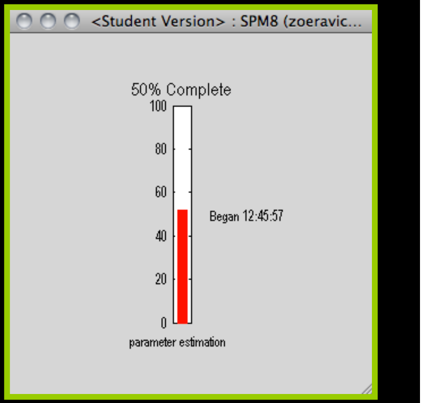


Select SPM.mat ...ents/MATLAB/fMRI/DIR/Categorical/SPM.mat
Method
. Classical

Model estimation
Model parameters can be estimated using classical (ReML - Restricted Maximum Likelihood) or Bayesian algorithms. After parameter estimation, the RESULTS button can be used to specify contrasts that will produce Statistical Parametric Maps (SPMs) or Posterior Probability Maps (PPMs) and tables of statistics.

This branch contains 2 items:
* Select SPM.mat
* Method

Processing…

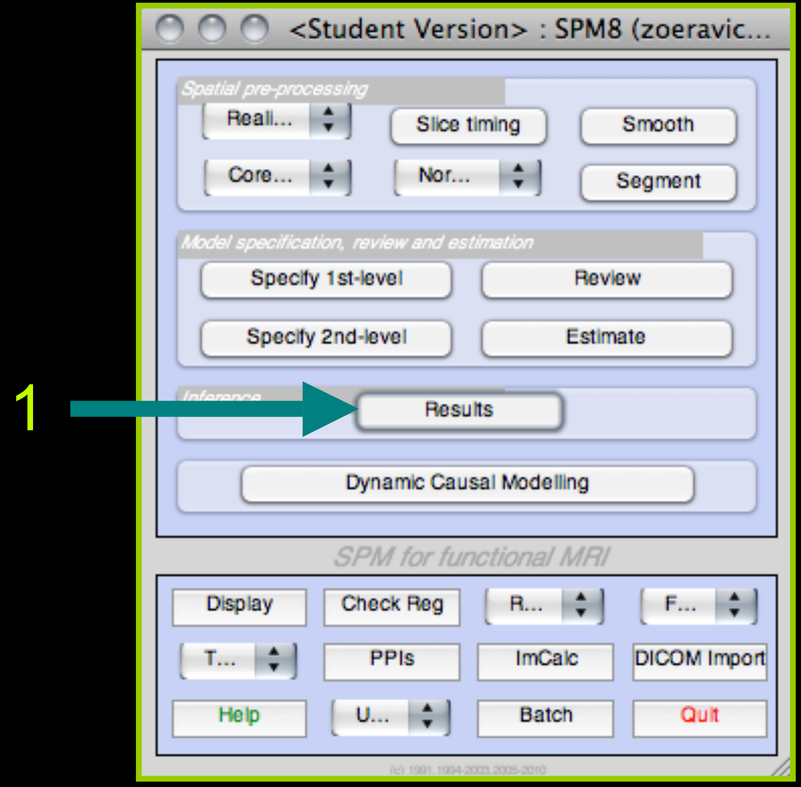


Step 11
Inference for Categorical Design

- Press the RESULTS button
  - Select the SPM.mat file saved in the DIR/categorical directory, choose contrast number 5, and then press “Done”
    - “Mask with other contrast?”; Click “No”
    - “Title for comparison?”; Type “Canonical HRF: Faces > Baseline”
    - “p value adjustment to control”; Click “FWE”
    - “Corrected p value (family-wise error)”; Accept the default value, “0.05”
    - “Extent threshold {voxels}”; Accept the default value, “0”

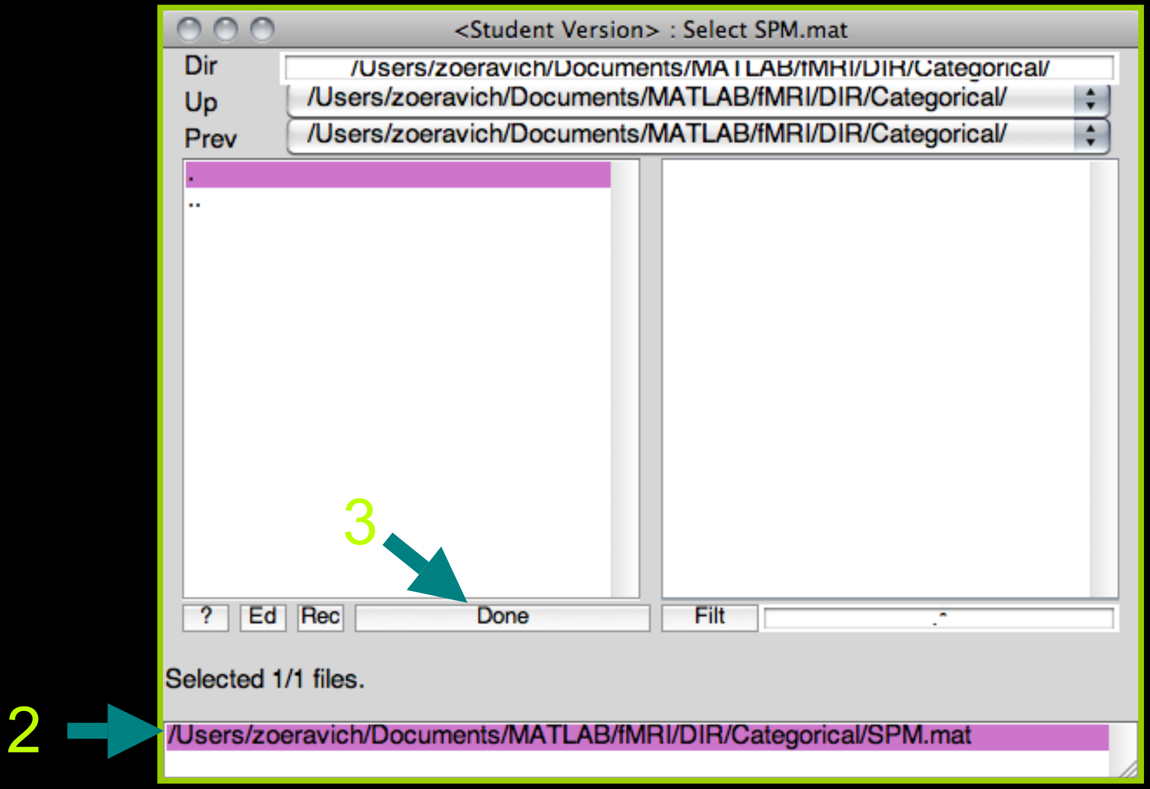
Step 11

Inference for Categorical Design



Step 11

Inference for Categorical Design



<Student Version> : Select SPM.mat

Dir /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Up /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

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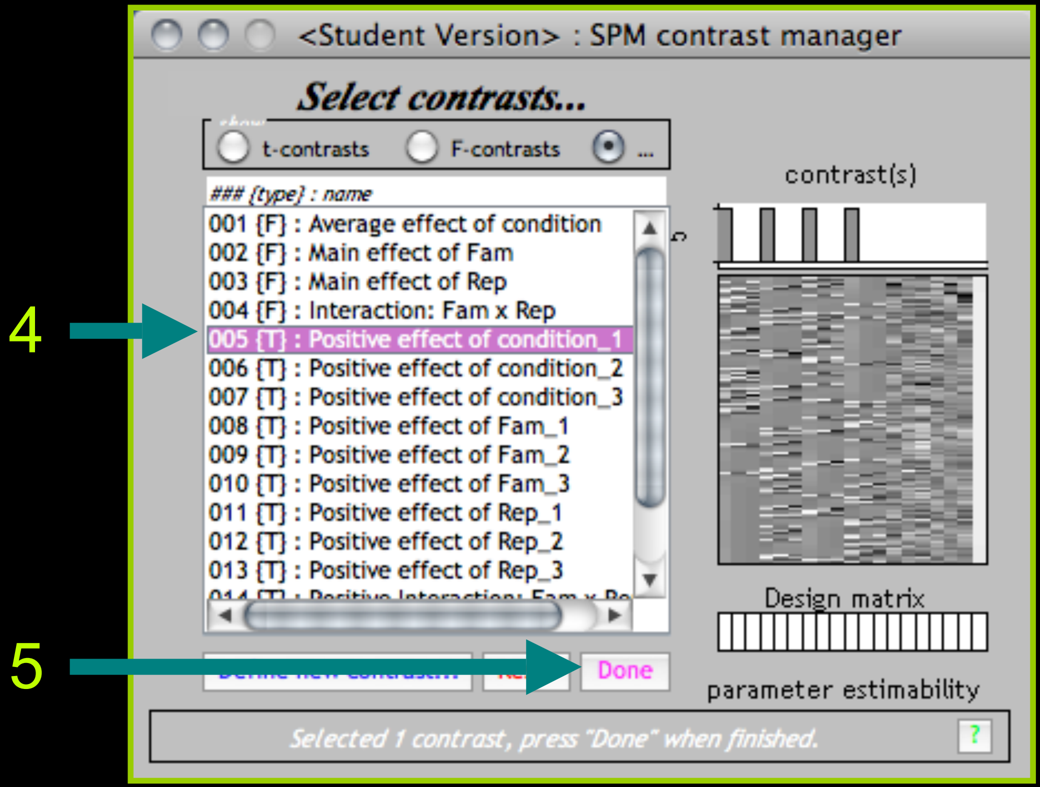
..

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/SPM.mat

Step 11
Inference for Categorical Design



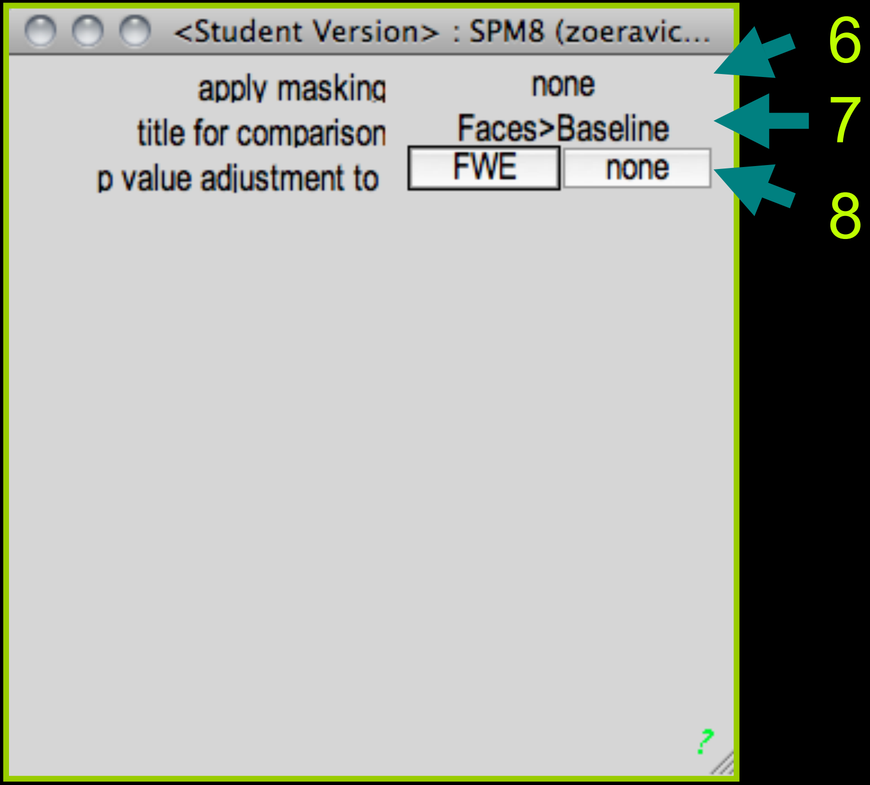
{type} : name

001 {F} : Average effect of condition
002 {F} : Main effect of Fam
003 {F} : Main effect of Rep
004 {F} : Interaction: Fam x Rep
005 {T} : Positive effect of condition_1
006 {T} : Positive effect of condition_2
007 {T} : Positive effect of condition_3
008 {T} : Positive effect of Fam_1
009 {T} : Positive effect of Fam_2
010 {T} : Positive effect of Fam_3
011 {T} : Positive effect of Rep_1
012 {T} : Positive effect of Rep_2
013 {T} : Positive effect of Rep_3
014 {T} : Positive Interaction: Fam x Re

Selected 1 contrast, press "Done" when finished.

Step 11

Inference for Categorical Design

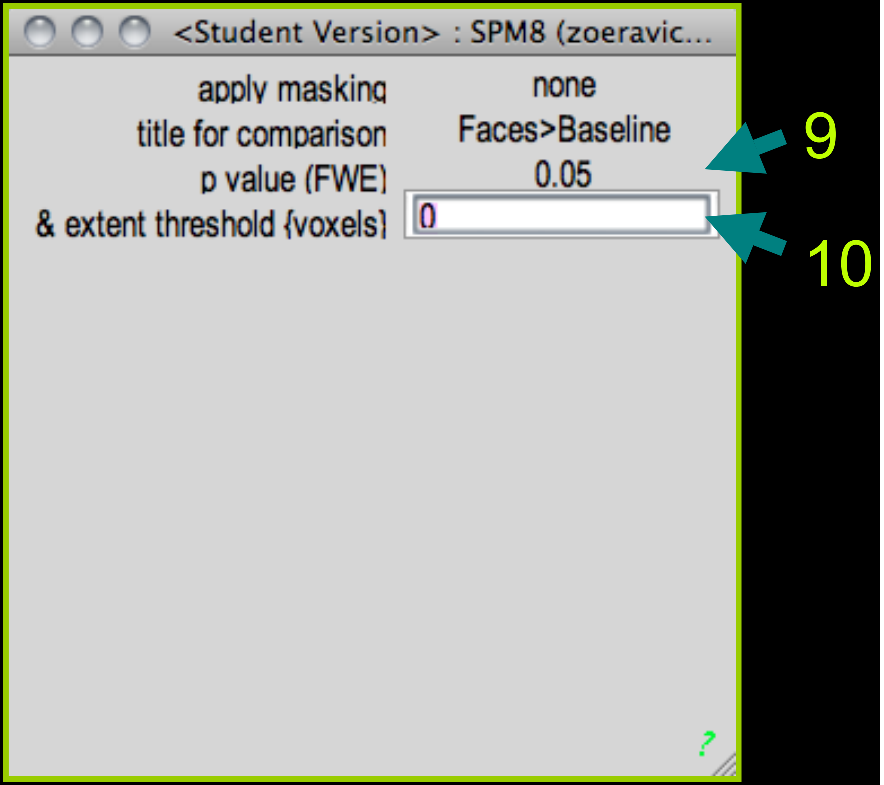


<Student Version> : SPM8 (zoeravic...

apply masking: none

title for comparison: Faces>Baseline

p value adjustment to: FWE | none



<Student Version> : SPM8 (zoeravic...

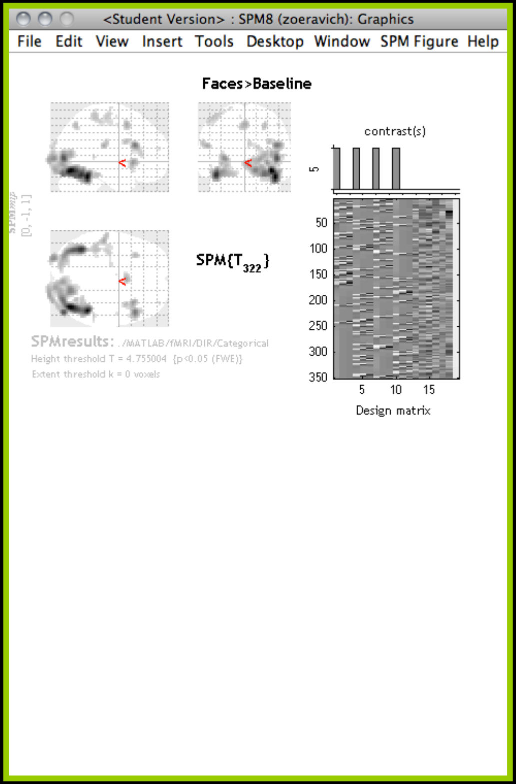
apply masking: none

title for comparison: Faces>Baseline

p value (FWE): 0.05

& extent threshold {voxels}: 0

Step 11
Inference for Categorical Design



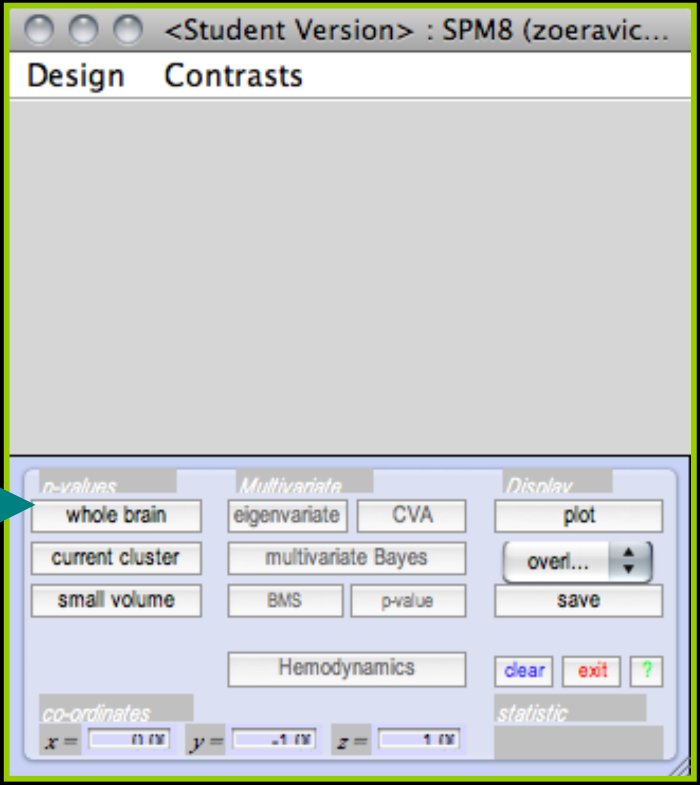
SPMresults: ./MATLAB/fMRI/DIR/Categorical
Height threshold T = 4.755004 {p<0.05 (FWE)}
Extent threshold k = 0 voxels

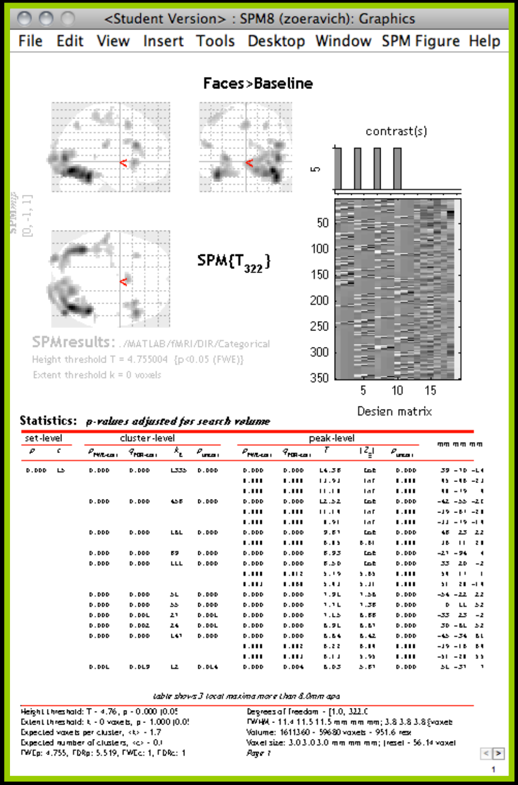
Step 12
Statistical Tables

- Press the WHOLE BRAIN button in the p-values section of the interactive window
  - **x, y, z (mm)** (coordinates in MNI space for each maximum)
  - **Peak-level** (chance of finding a peak with this or a greater height)
  - **Cluster-level** (chance of finding a cluster with this many or a greater number of voxels)
  - **Set-level** (chance of finding this or a greater number of clusters in the search volume)
- Right-click on the MIP and select “goto global maxima” (e.g., [39 -70 -14])

Step 12
Statistical Tables

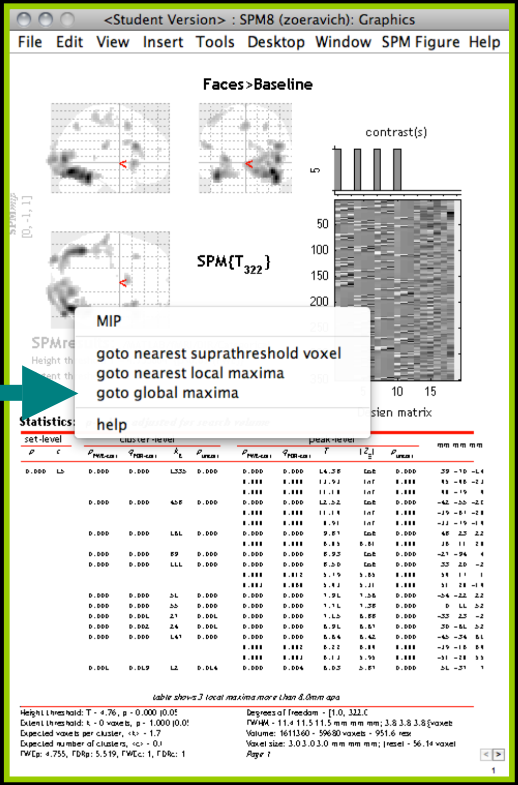
1

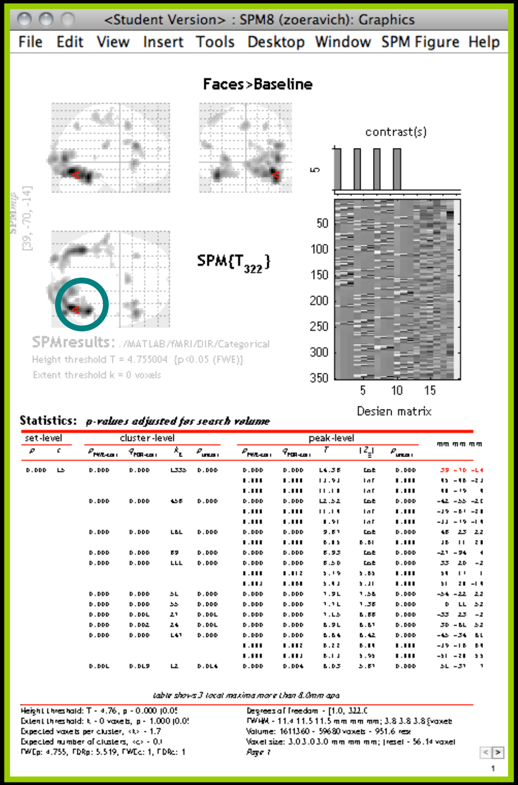




Step 12
Statistical Tables

2

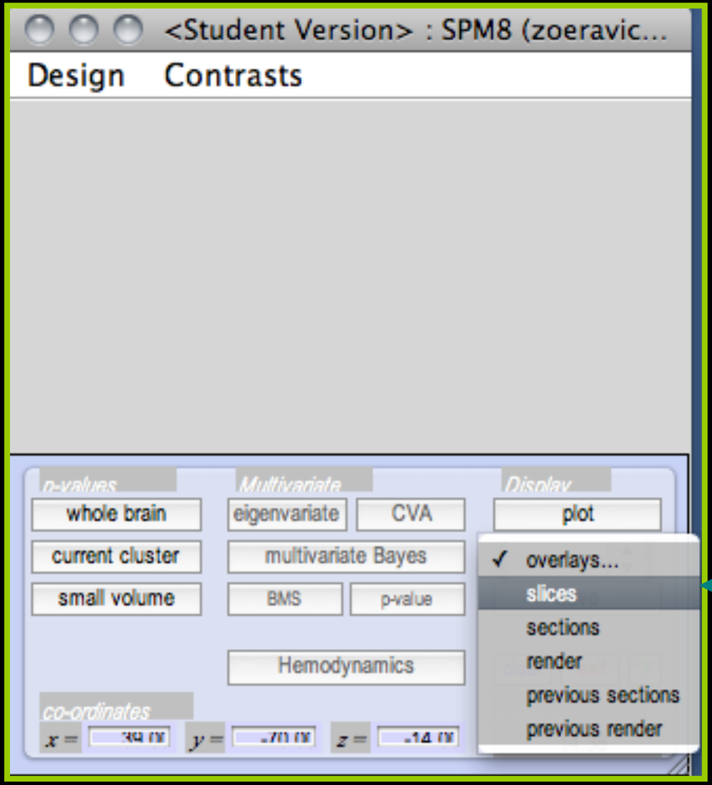




Step 12
Statistical Tables (Optional)

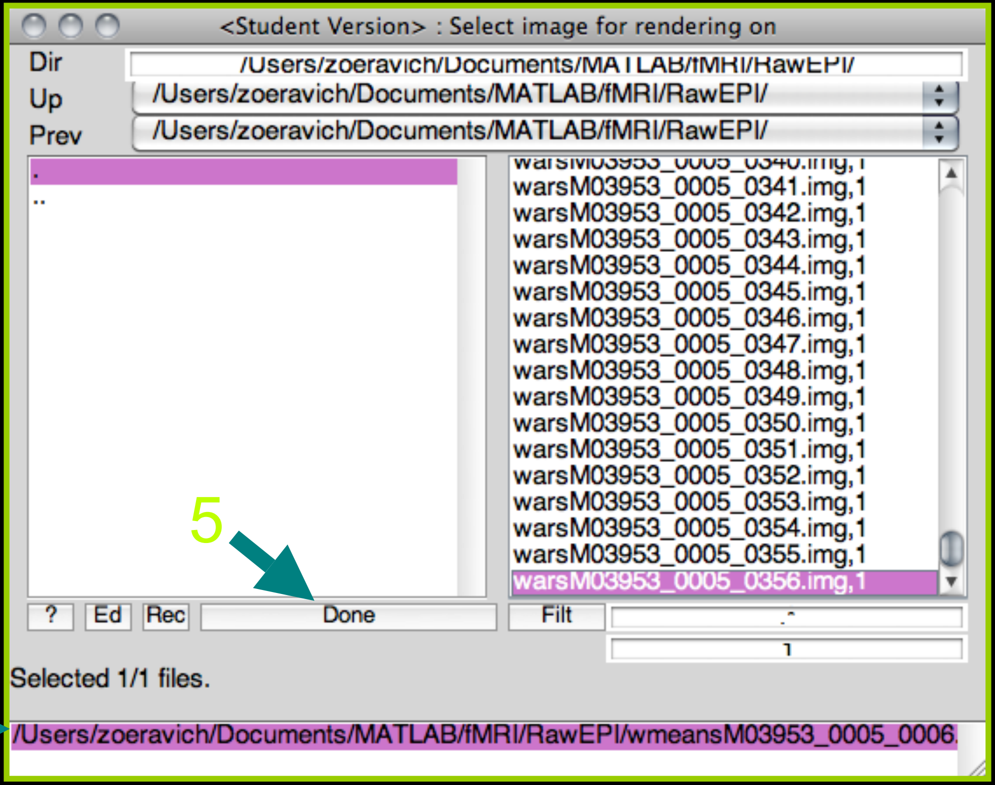
- Select SLICES from the “Overlays” drop-down menu
  - Select the wmeansM03953_0005_0006.img file and then press “Done”
- Click the PLOT button
  - “Plot”; Click “Contrast of estimates and 90% C.I.”
  - “Which contrast?…”; Click “Average effect of condition”

Step 12
Statistical Tables (Optional)



3

Step 12
Statistical Tables (Optional)



Dir: /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Up: /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

Prev: /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/

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.
..
```

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warsM03953_0005_0340.img,1
warsM03953_0005_0341.img,1
warsM03953_0005_0342.img,1
warsM03953_0005_0343.img,1
warsM03953_0005_0344.img,1
warsM03953_0005_0345.img,1
warsM03953_0005_0346.img,1
warsM03953_0005_0347.img,1
warsM03953_0005_0348.img,1
warsM03953_0005_0349.img,1
warsM03953_0005_0350.img,1
warsM03953_0005_0351.img,1
warsM03953_0005_0352.img,1
warsM03953_0005_0353.img,1
warsM03953_0005_0354.img,1
warsM03953_0005_0355.img,1
warsM03953_0005_0356.img,1
```

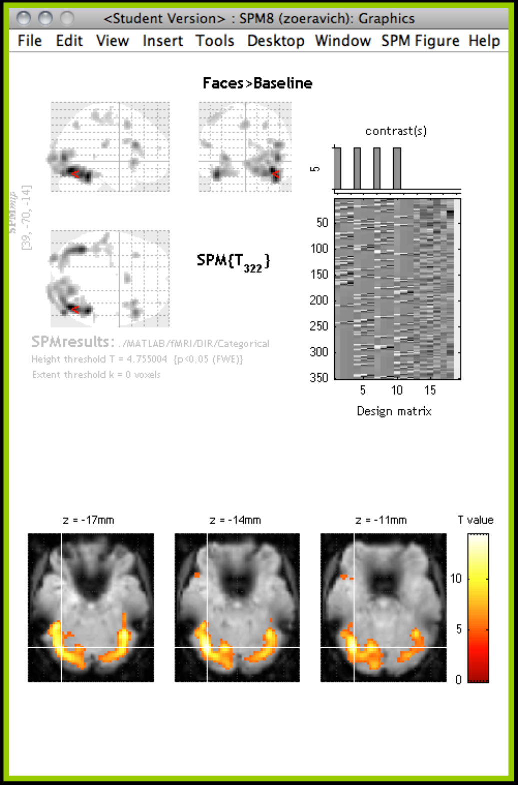
Filt: .^

1

5 → Done

Selected 1/1 files.

4 → /Users/zoeravich/Documents/MATLAB/fMRI/RawEPI/wmeansM03953_0005_0006.

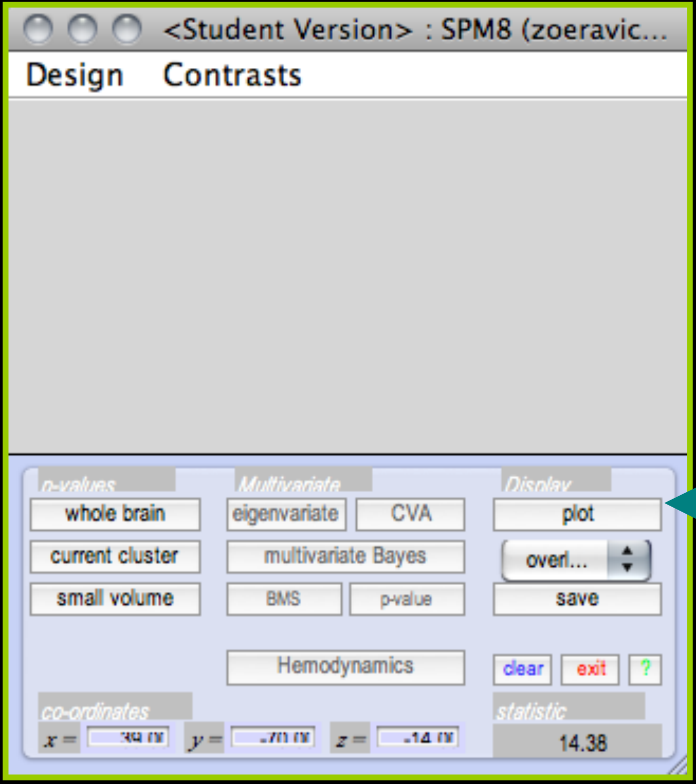


SPMresults: ./MATLAB/fMRI/DIR/Categorical

Height threshold T = 4.755004 {p<0.05 (FWE)}

Extent threshold k = 0 voxels

Step 12
Statistical Tables (Optional)



x = 39.0

y = -70.0

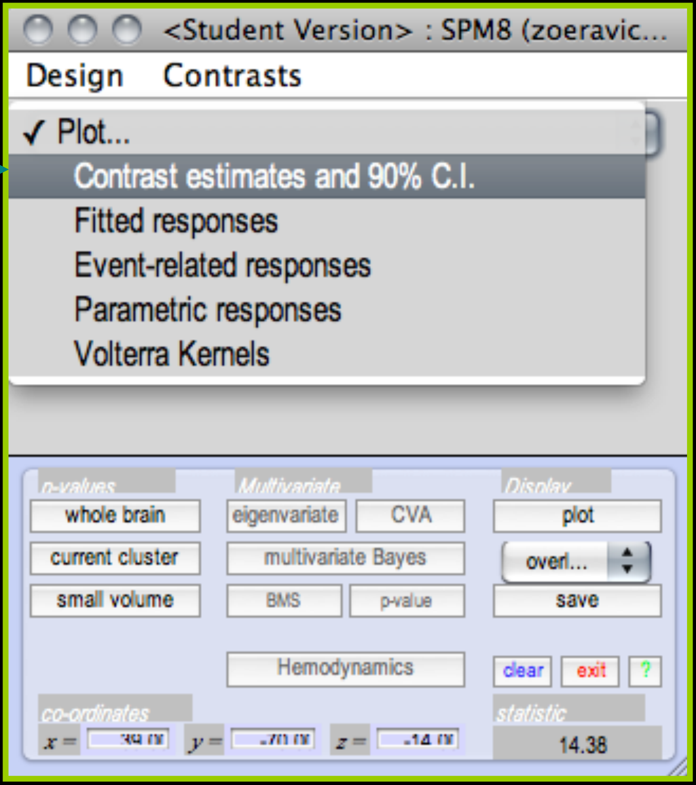
z = -14.0

statistic 14.38

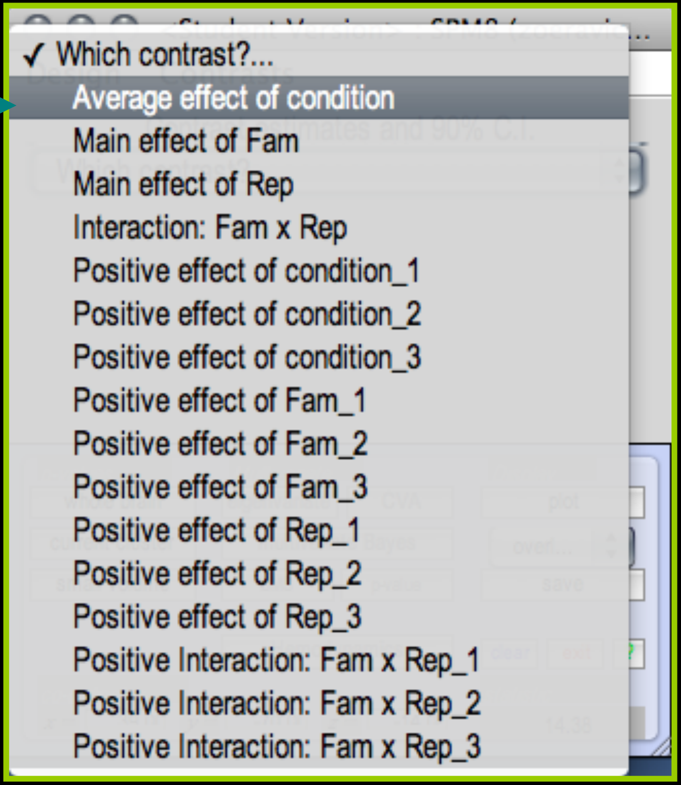
6

Step 12
Statistical Tables (Optional)

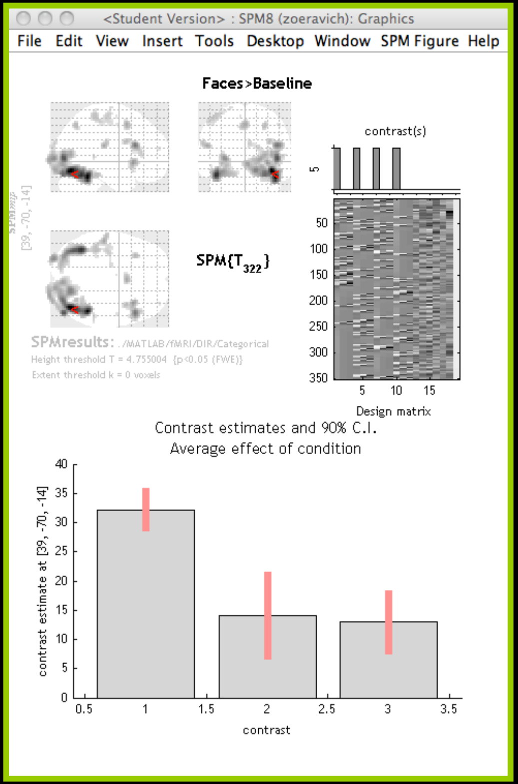
7



8



Step 12
Statistical Tables (Optional)

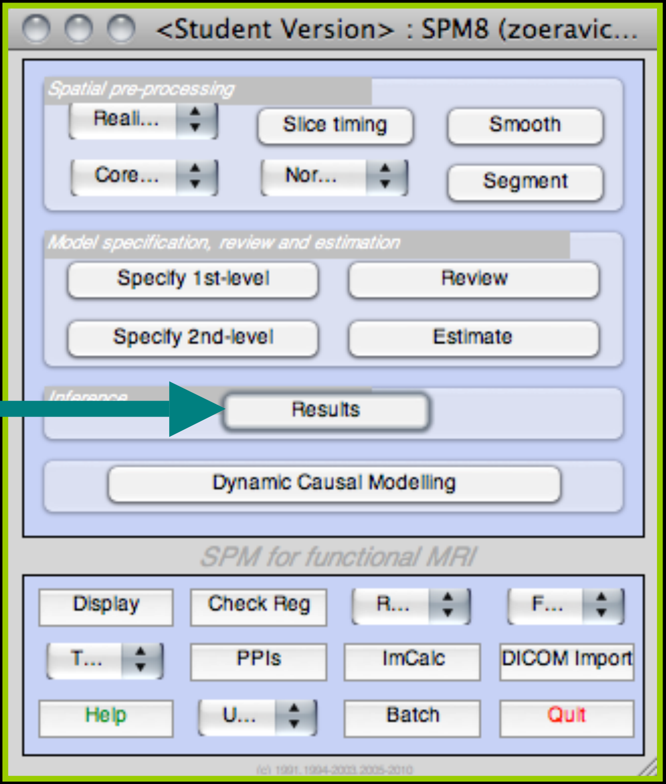


SPMresults: ./MATLAB/fMRI/DIR/Categorical
Height threshold T = 4.755004 {p<0.05 (FWE)}
Extent threshold k = 0 voxels

Step 13
F-Contrasts

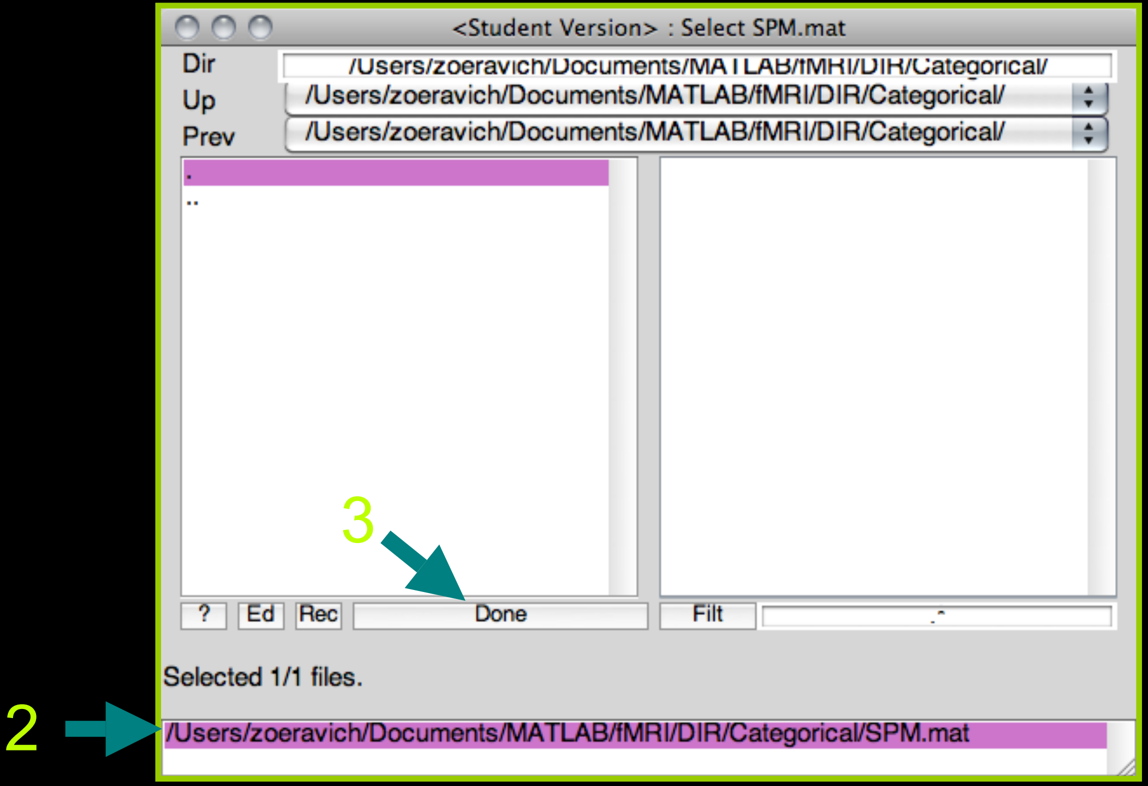
- Press the RESULTS button
  - Select the SPM.mat file saved in the DIR/categorical directory
  - Select the “F-contrast” toggle, choose contrast number 3, and then press “Done”
    - “Mask with other contrast?”; Click “Yes” and select contrast 5
    - “Uncorrected mask p-value?”; Enter “0.001”
    - “Nature of mask?”; Click “Inclusive”
    - “Title for comparison?”; Click “Main effect of Rep…”
    - “p value adjustment to control”; Click “None”
    - “Threshold (F or p value)”; Accept the default value, “0.001”
    - “Extent threshold {voxels}”; Accept the default value, “0”

Step 13
F-Contrasts



1

Step 13
F-Contrasts



Dir: /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

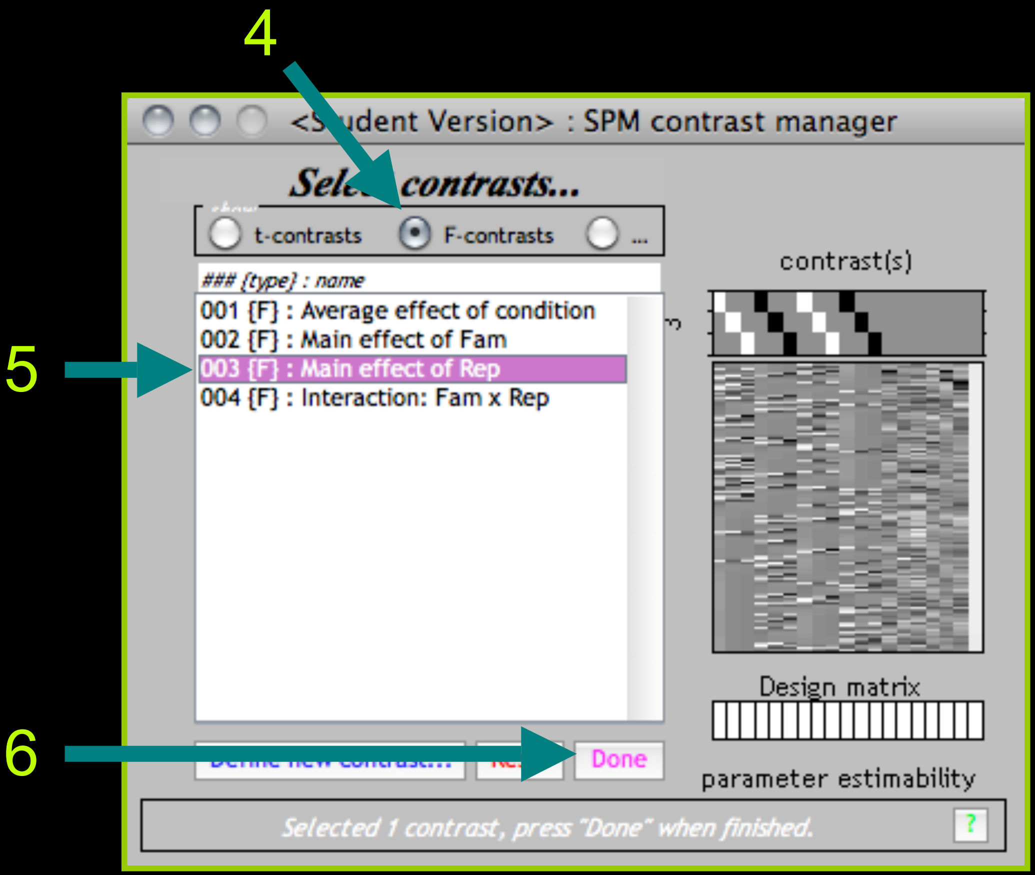
Up: /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Prev: /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/SPM.mat

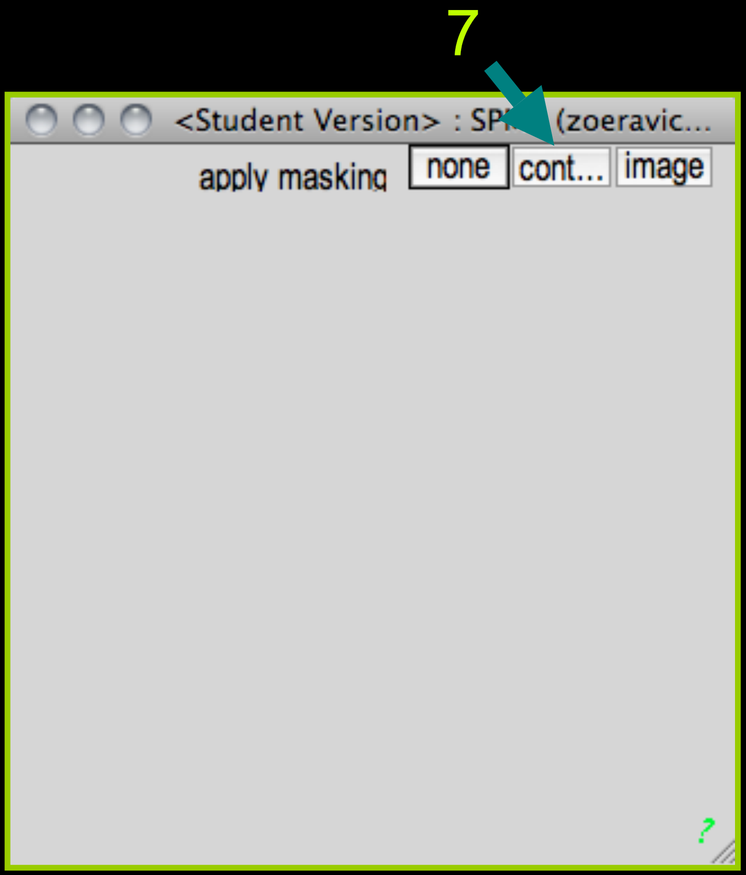
Step 13
F-Contrasts



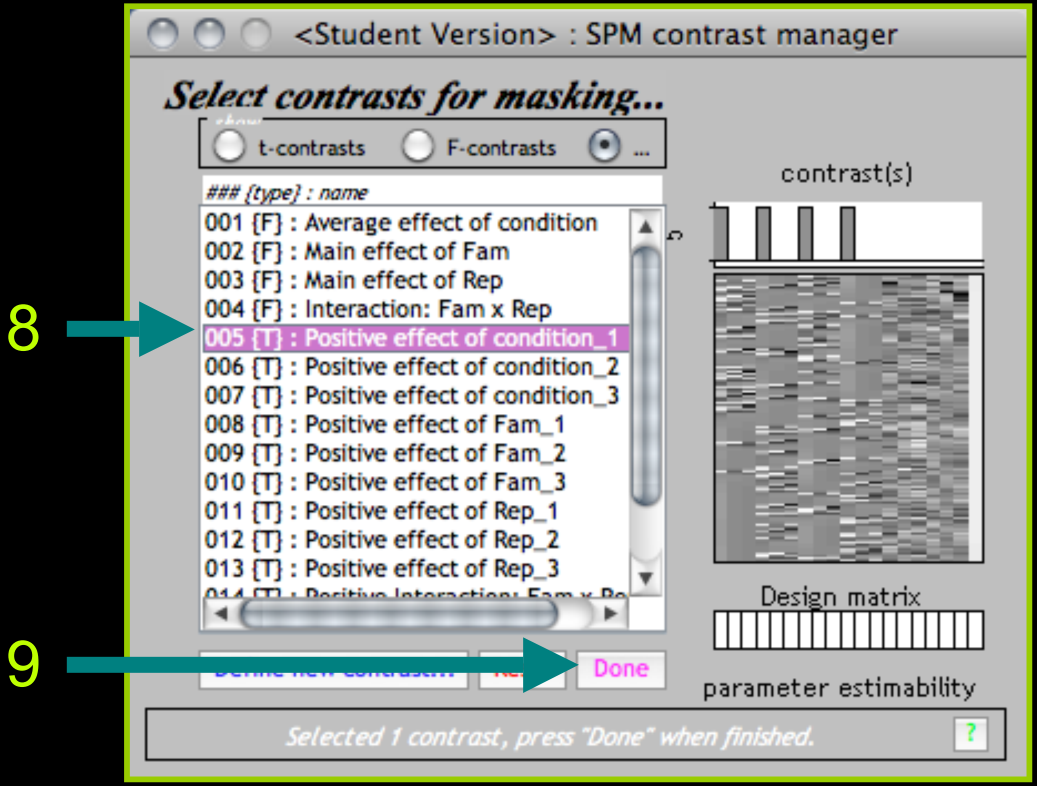
{type} : name
001 {F} : Average effect of condition
002 {F} : Main effect of Fam
003 {F} : Main effect of Rep
004 {F} : Interaction: Fam x Rep

Selected 1 contrast, press "Done" when finished.

Step 13
F-Contrasts



Step 13
F-Contrasts



<Student Version> : SPM contrast manager

Select contrasts for masking...

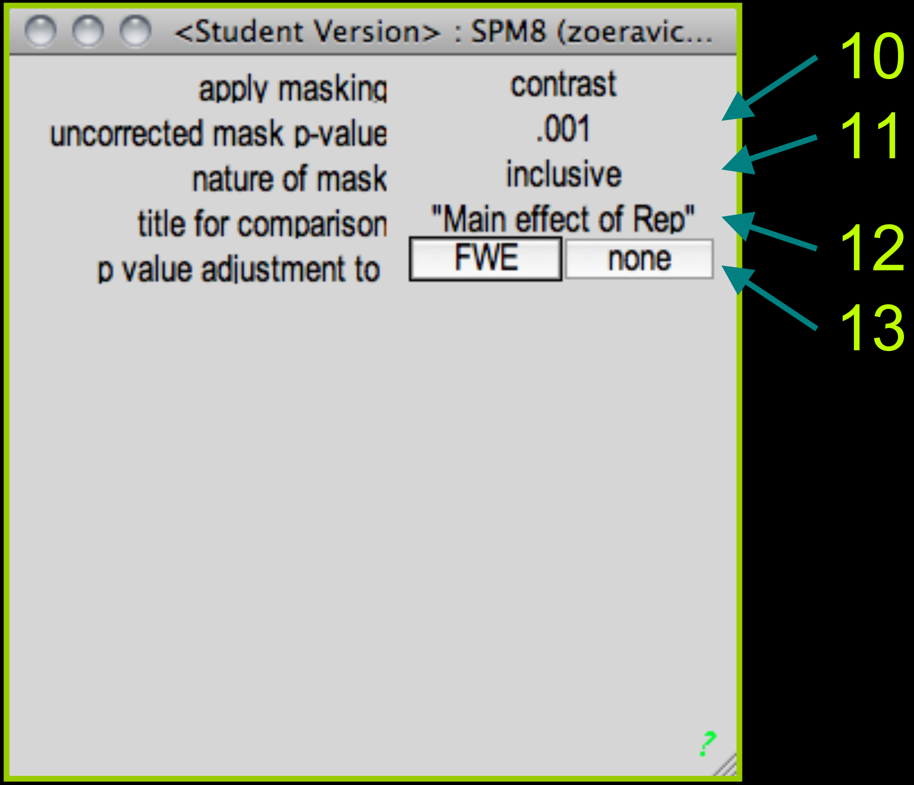
○ t-contrasts ○ F-contrasts ● ...

{type} : name

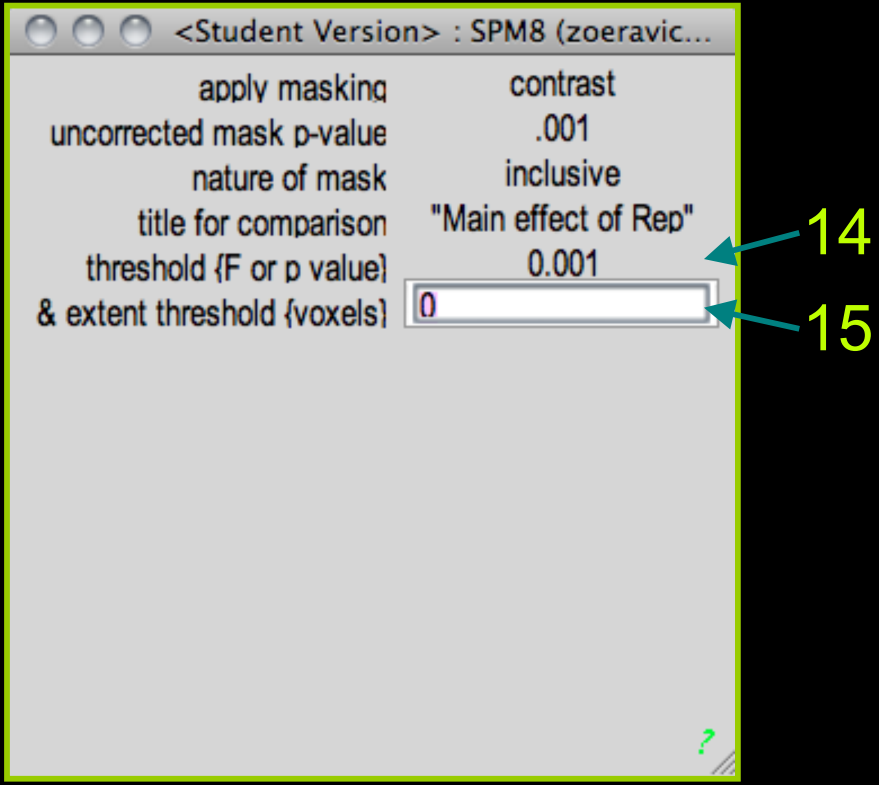
001 {F} : Average effect of condition
002 {F} : Main effect of Fam
003 {F} : Main effect of Rep
004 {F} : Interaction: Fam x Rep
005 {T} : Positive effect of condition_1
006 {T} : Positive effect of condition_2
007 {T} : Positive effect of condition_3
008 {T} : Positive effect of Fam_1
009 {T} : Positive effect of Fam_2
010 {T} : Positive effect of Fam_3
011 {T} : Positive effect of Rep_1
012 {T} : Positive effect of Rep_2
013 {T} : Positive effect of Rep_3

Selected 1 contrast, press "Done" when finished.

Step 13
F-Contrasts

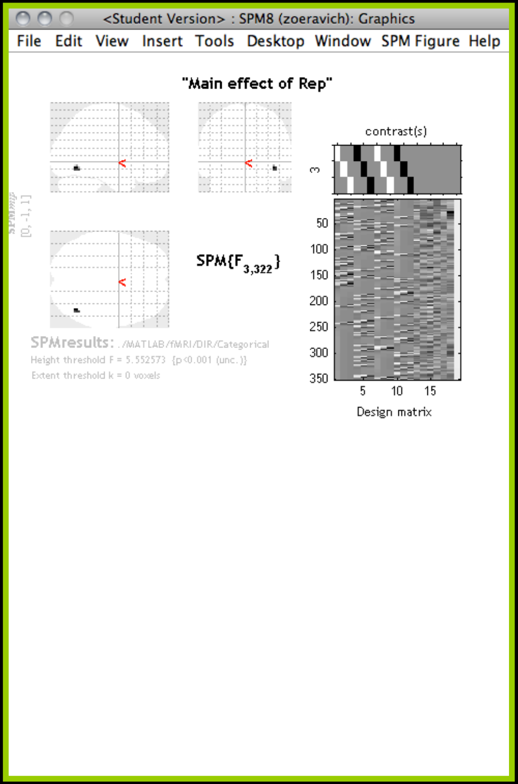


apply masking: contrast
uncorrected mask p-value: .001
nature of mask: inclusive
title for comparison: "Main effect of Rep"
p value adjustment to: FWE none



apply masking: contrast
uncorrected mask p-value: .001
nature of mask: inclusive
title for comparison: "Main effect of Rep"
threshold {F or p value}: 0.001
& extent threshold {voxels}: 0

Step 13
F-Contrasts



SPMresults: ./MATLAB/fMRI/DIR/Categorical

Height threshold F = 5.552573 {p<0.001 (unc.)}

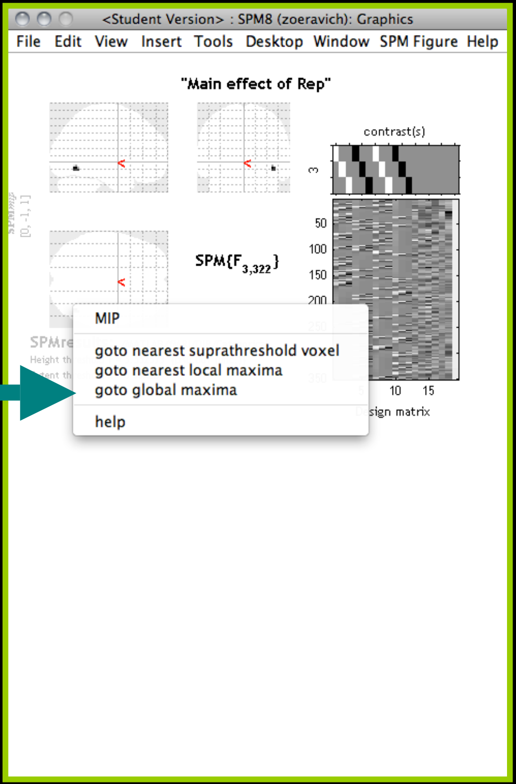
Extent threshold k = 0 voxels

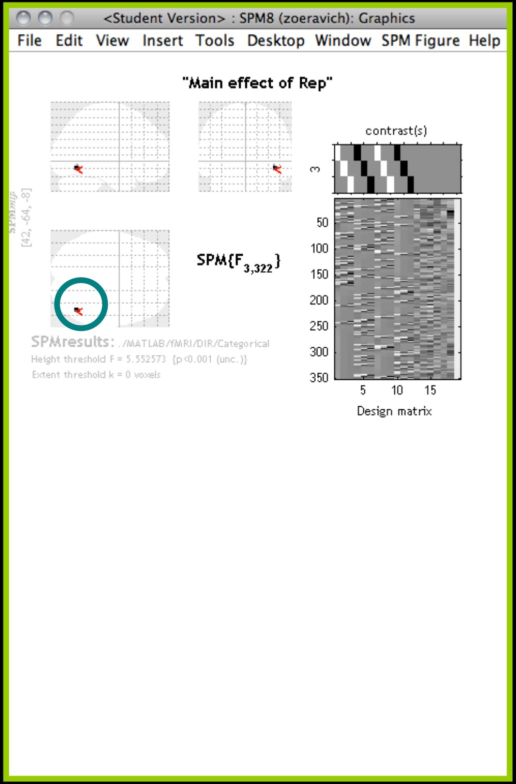
Step 13
F-Contrasts (Optional)

- Right-click on the MIP and select “goto global maxima” (e.g., [42 -64 -8])
- Click the PLOT button
  - “Plot”; Click “Event-related responses”
  - “Which effect…”; Click “F1”
  - “Plot in terms of…”; Click “Fitted response and PSTH”

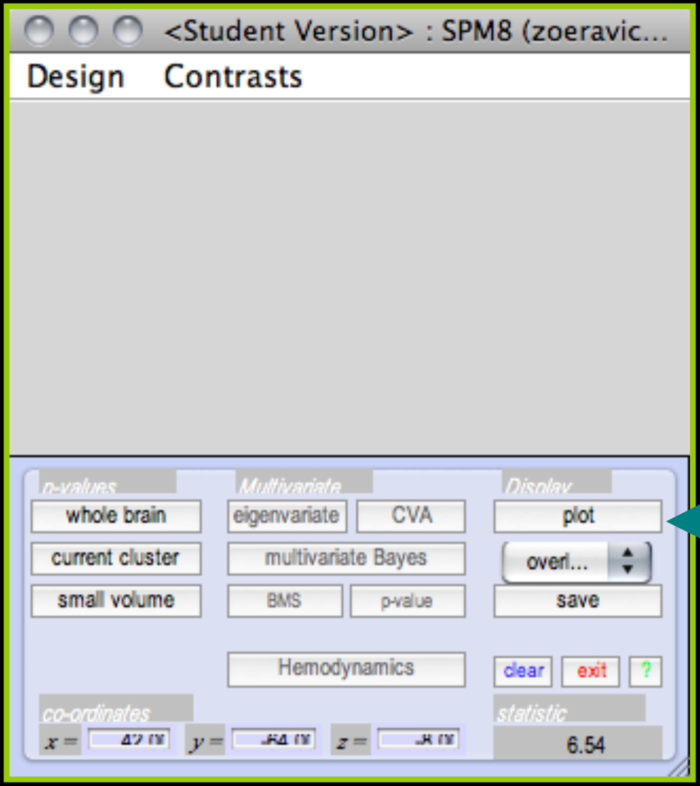
Step 13
F-Contrasts (Optional)

16



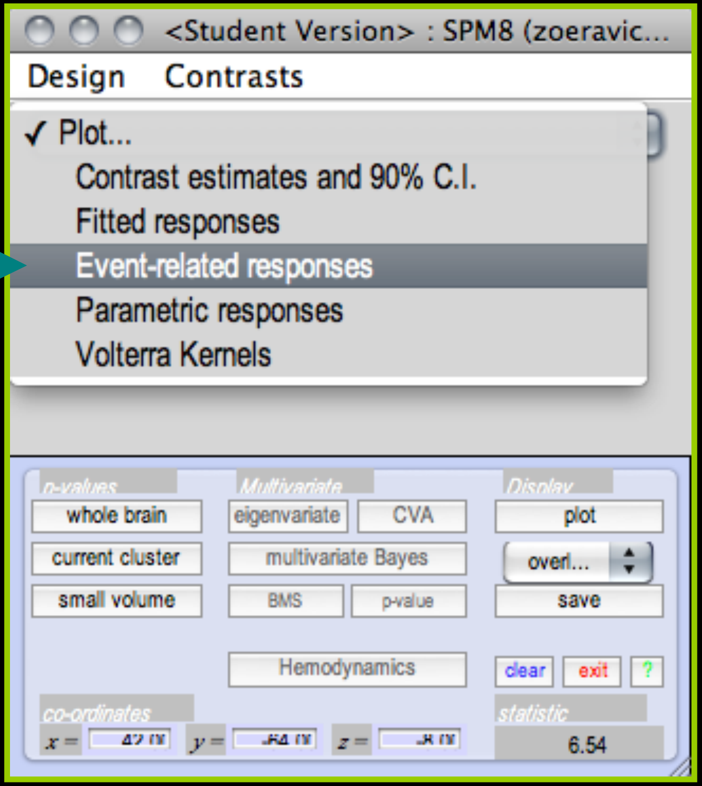


Step 13
F-Contrasts (Optional)



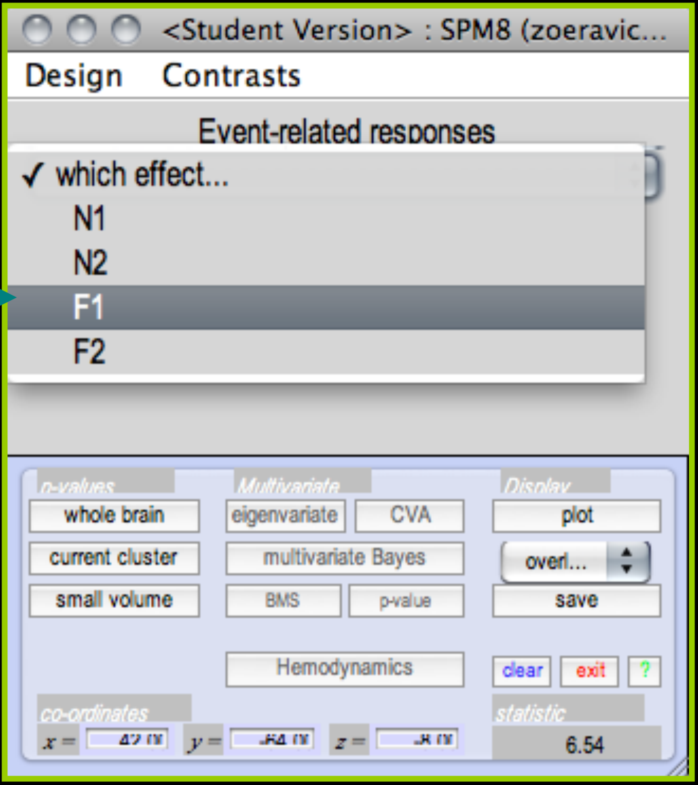
17

18

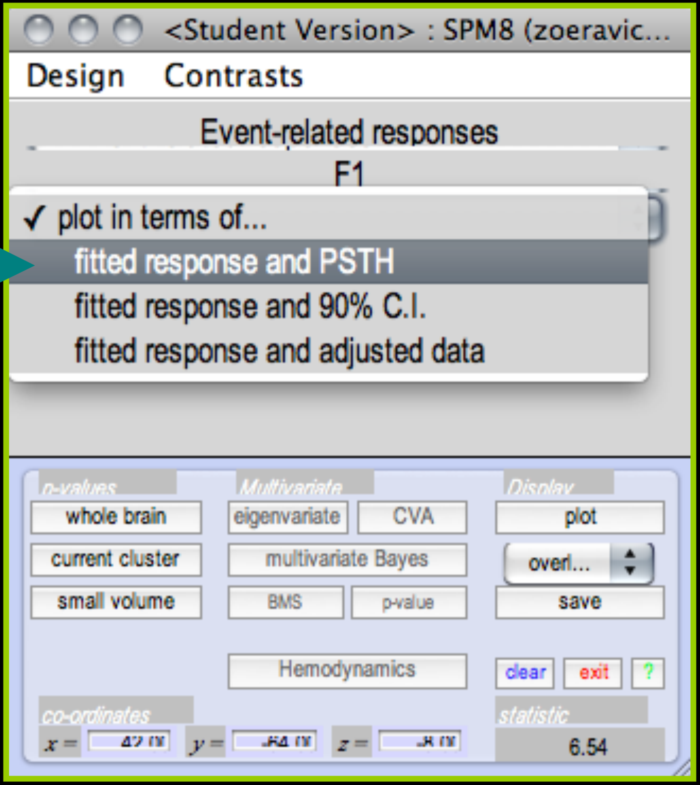


Step 13
F-Contrasts (Optional)

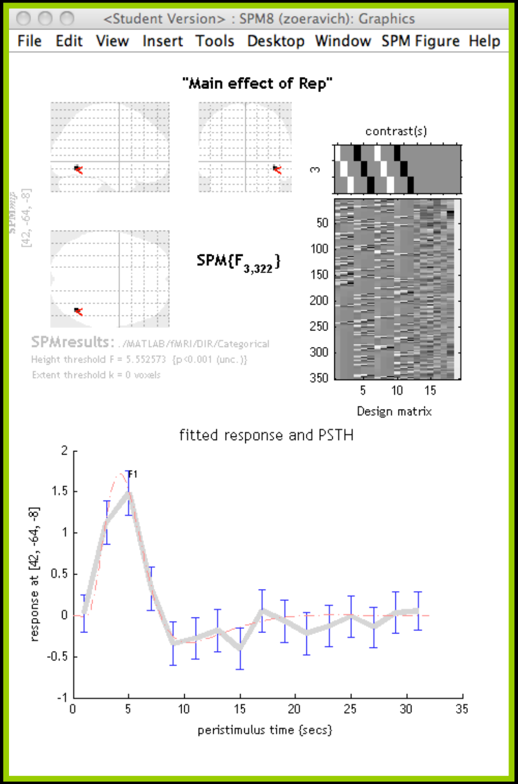
19



20



Step 13
F-Contrasts (Optional)



"Main effect of Rep"

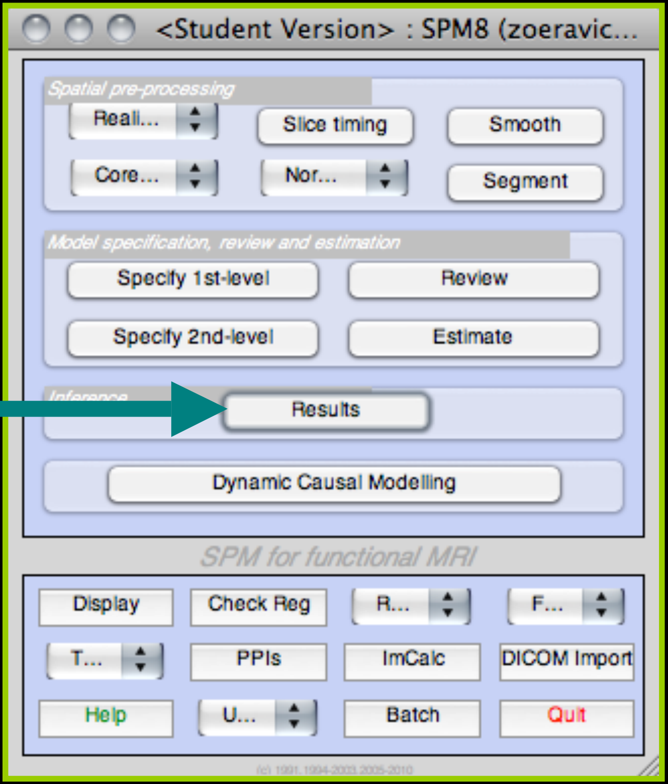
$SPM\{F_{3,322}\}$

```
SPMresults: ./MATLAB/fMRI/DIR/Categorical
Height threshold F = 5.552573  {p<0.001 (unc.)}
Extent threshold k = 0 voxels
```

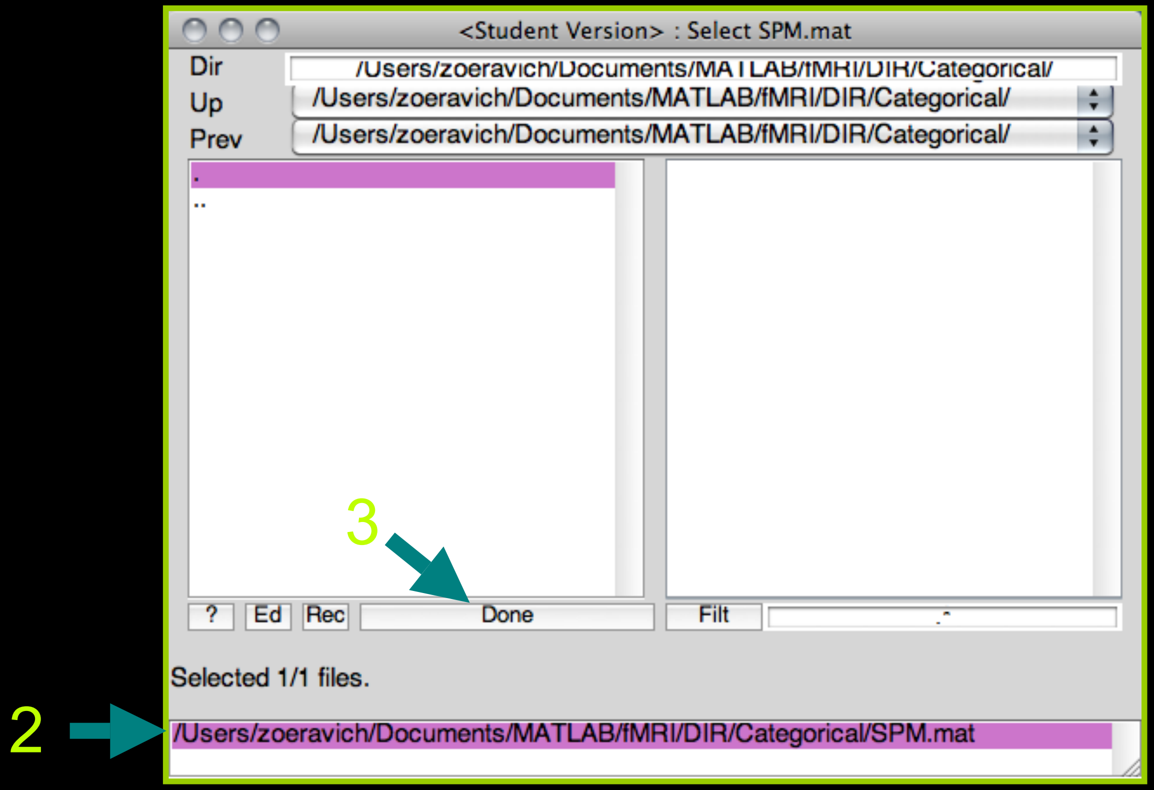
Step 14
Testing Effects of Movement

- Press the RESULTS button
  - Select the SPM.mat file saved in the DIR/categorical directory
  - Specify “F-contrast” in the Contrast Manager and “Movement-related effects” in the “Contrasts weight matrix” window
  - Submit and select the contrast
    - “Mask with other contrast?”; Click “No”
    - “Title for comparison?”; Accept the default
    - “Corrected height threshold”; Select “FWE”
    - “Corrected p value”; Accept the default value, “0.05”

Step 14
Testing Effects of Movement



Step 14
Testing Effects of Movement



<Student Version> : Select SPM.mat

Dir /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

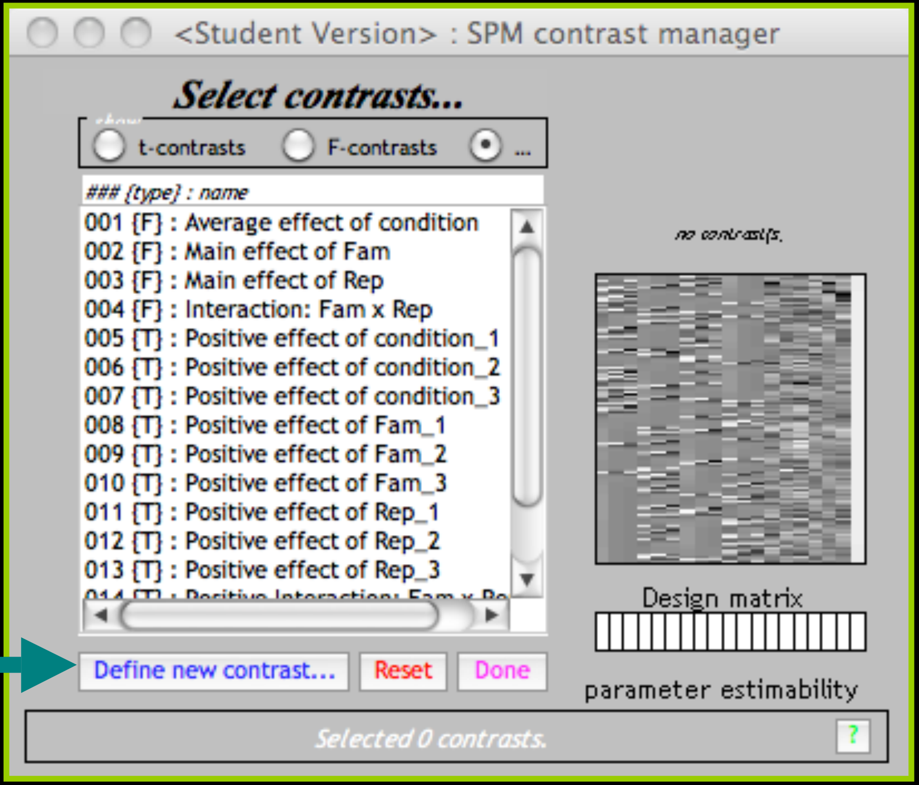
Up /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Prev /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/

Selected 1/1 files.

2 /Users/zoeravich/Documents/MATLAB/fMRI/DIR/Categorical/SPM.mat

Step 14
Testing Effects of Movement



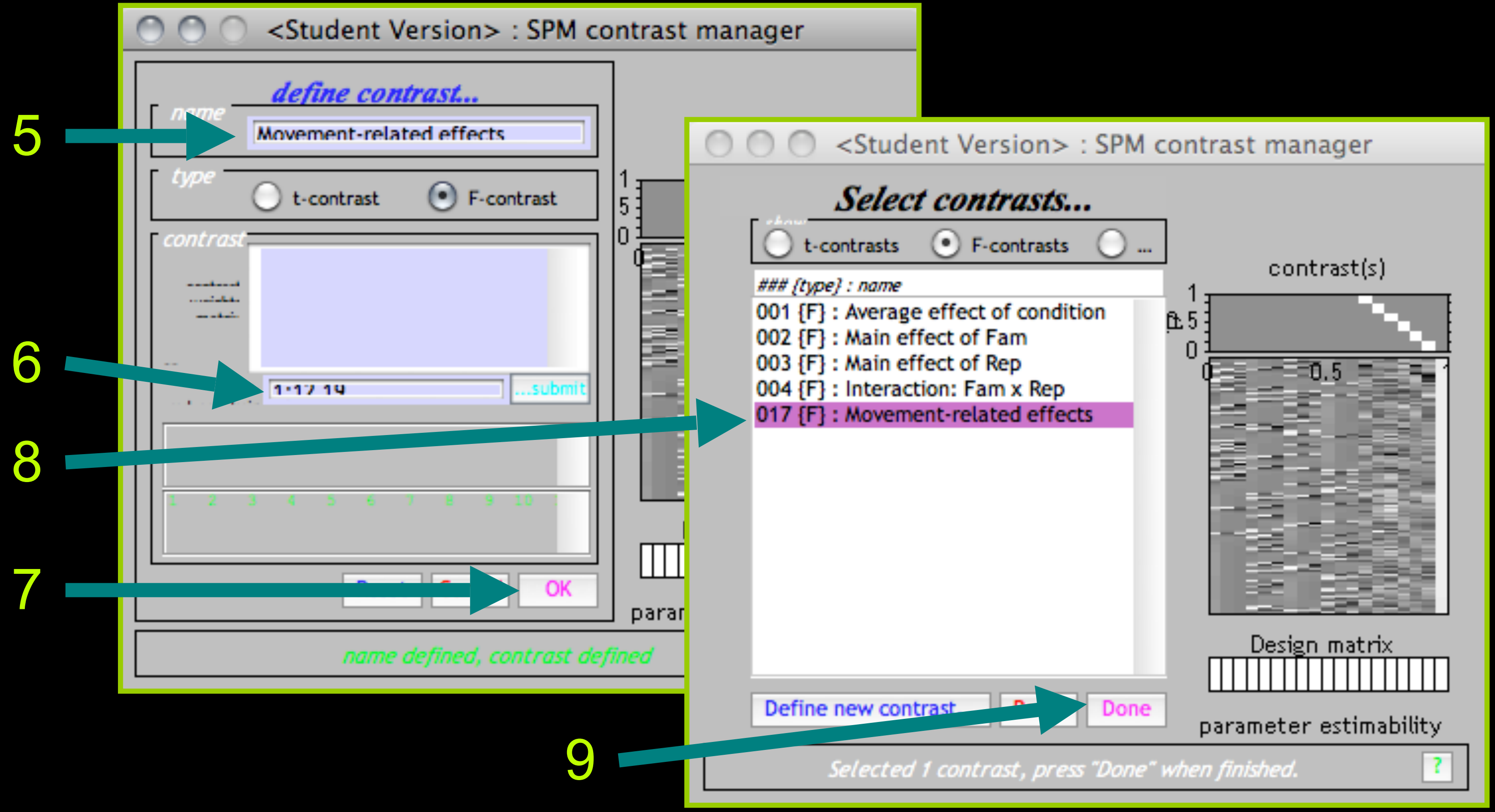
{type} : name

001 {F} : Average effect of condition
002 {F} : Main effect of Fam
003 {F} : Main effect of Rep
004 {F} : Interaction: Fam x Rep
005 {T} : Positive effect of condition_1
006 {T} : Positive effect of condition_2
007 {T} : Positive effect of condition_3
008 {T} : Positive effect of Fam_1
009 {T} : Positive effect of Fam_2
010 {T} : Positive effect of Fam_3
011 {T} : Positive effect of Rep_1
012 {T} : Positive effect of Rep_2
013 {T} : Positive effect of Rep_3
014 {T} : Positive Interaction: Fam x Re

Selected 0 contrasts.

4

Step 14
Testing Effects of Movement



name: Movement-related effects

type: F-contrast

contrast: 1:17 19

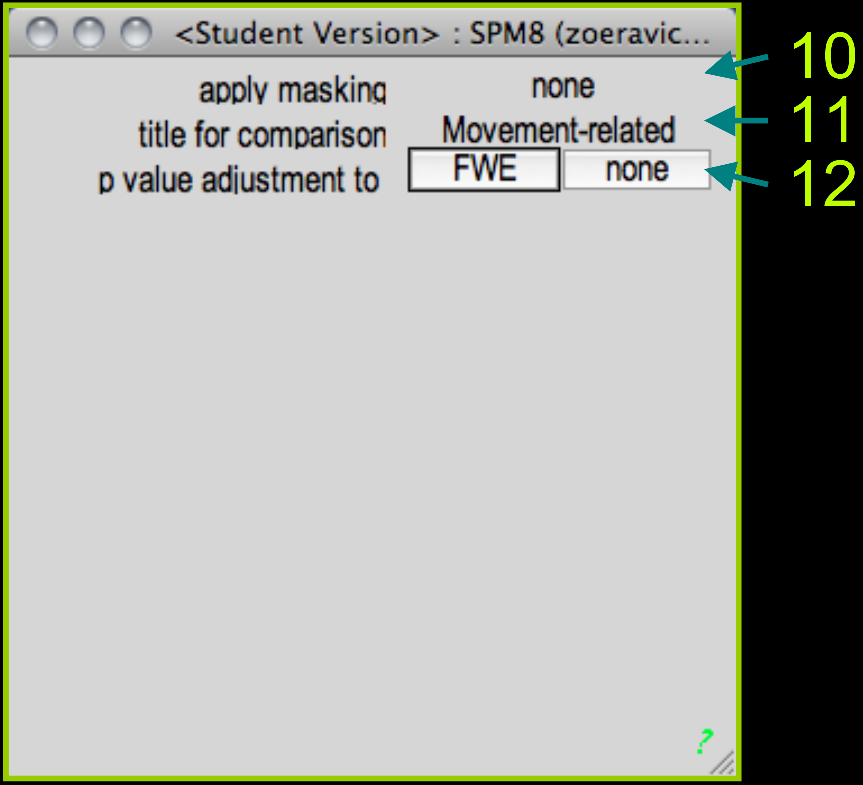
name defined, contrast defined

{type} : name
001 {F} : Average effect of condition
002 {F} : Main effect of Fam
003 {F} : Main effect of Rep
004 {F} : Interaction: Fam x Rep
017 {F} : Movement-related effects

Selected 1 contrast, press "Done" when finished.

Step 14

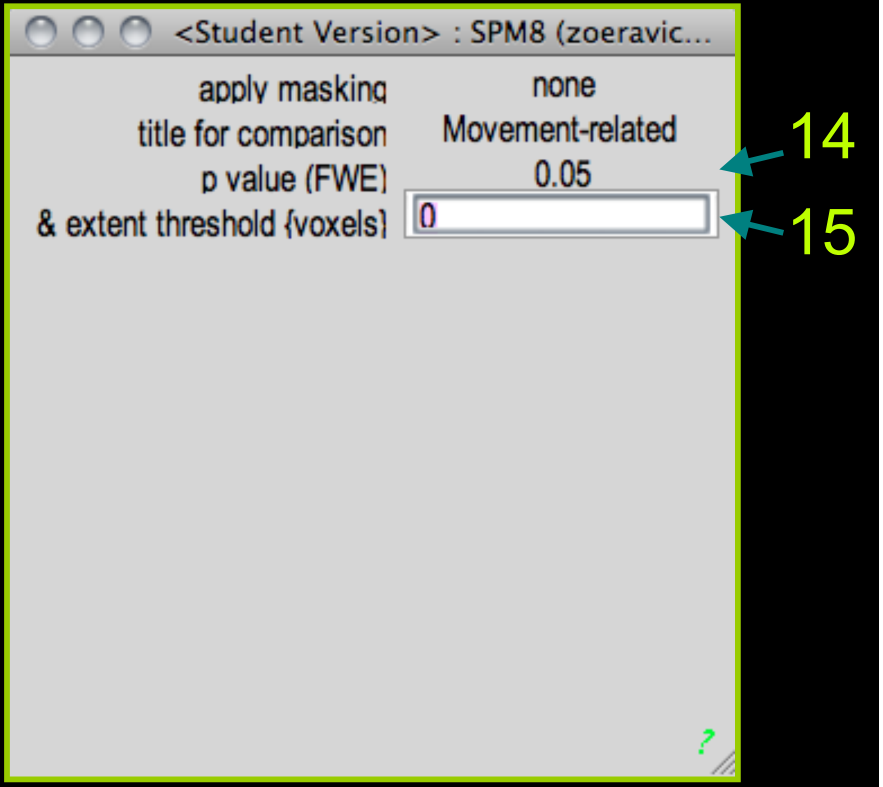
Testing Effects of Movement



apply masking: none

title for comparison: Movement-related

p value adjustment to: FWE | none



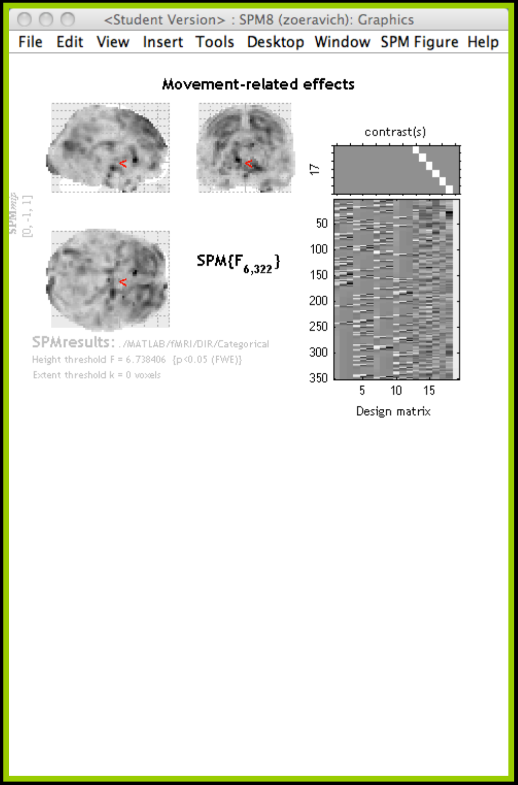
apply masking: none

title for comparison: Movement-related

p value (FWE): 0.05

& extent threshold {voxels}: 0

Step 14
Testing Effects of Movement



SPMresults: ./MATLAB/fMRI/DIR/Categorical
Height threshold F = 6.738406 {p<0.05 (FWE)}
Extent threshold k = 0 voxels

Step 14

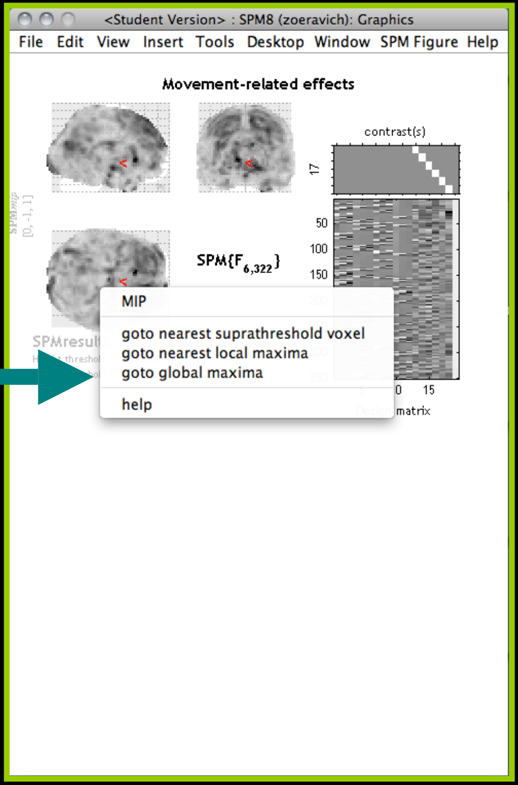
Testing Effects of Movement (Optional)

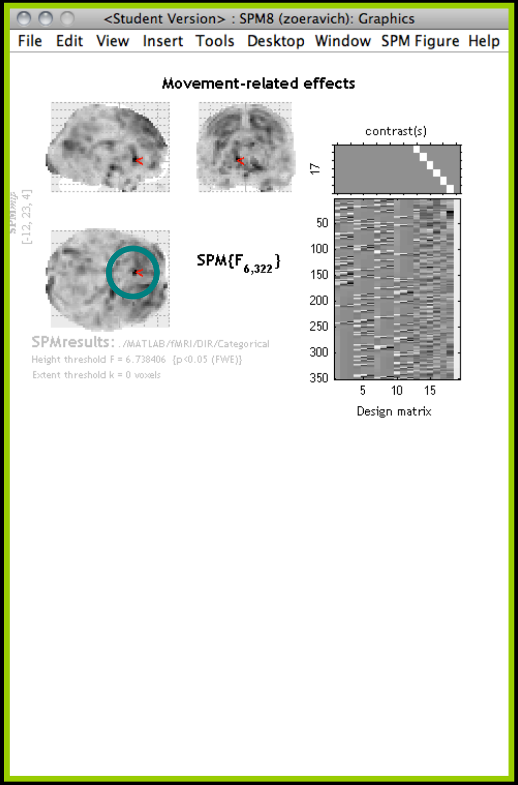
- Press the RESULTS button
  - Select the SPM.mat file saved in the DIR/categorical directory
  - Specify "F-contrast" in the Contrast Manager and "Movement-related effects" in the "Contrasts weight matrix" window
  - Submit and select the contrast
    - "Mask with other contrast?"; Click "No"
    - "Title for comparison?"; Accept the default
    - "Corrected height threshold"; Select "FWE"
    - "Corrected p value"; Accept the default value, "0.05"

Step 14

Testing Effects of Movement (Optional)

16

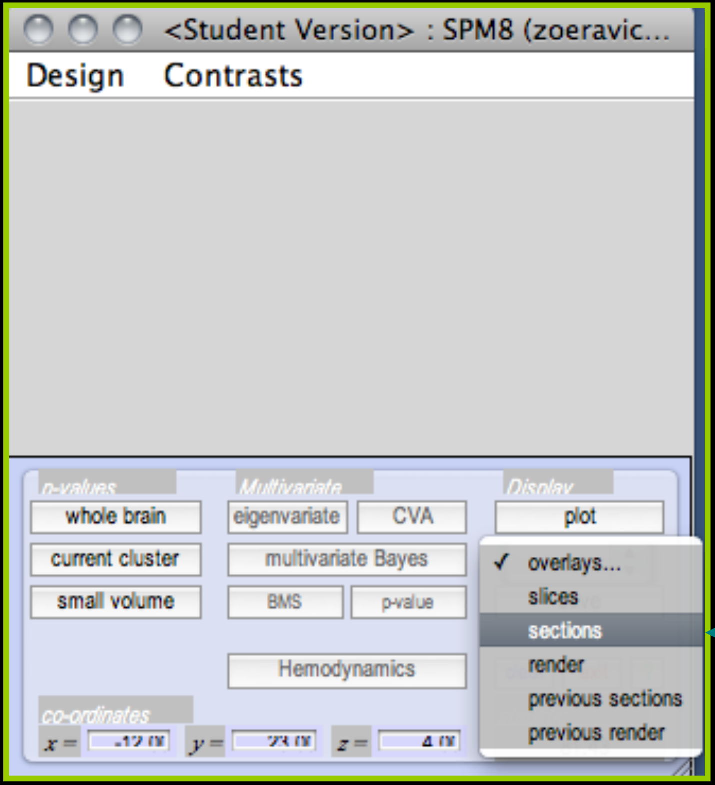




SPMresults: ./MATLAB/fMRI/DIR/Categorical
Height threshold F = 6.738406 {p<0.05 (FWE)}
Extent threshold k = 0 voxels

Step 14

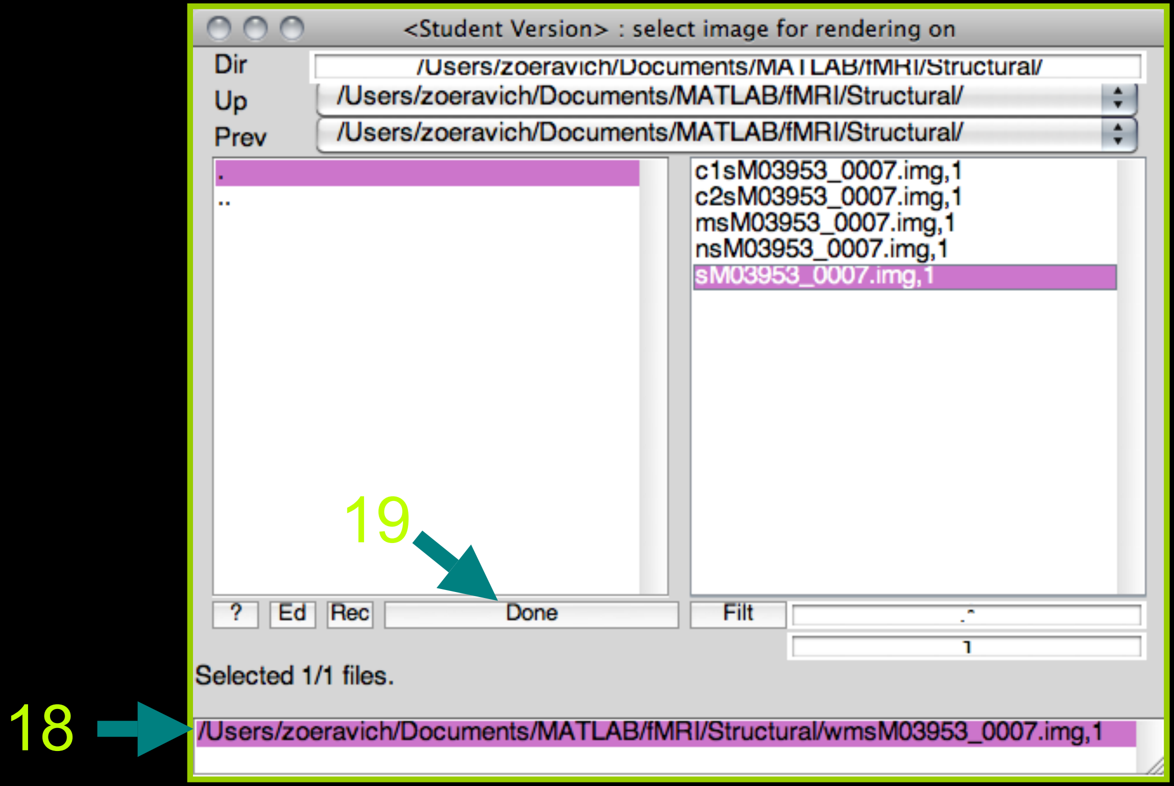
Testing Effects of Movement (Optional)



17

Step 14

Testing Effects of Movement (Optional)

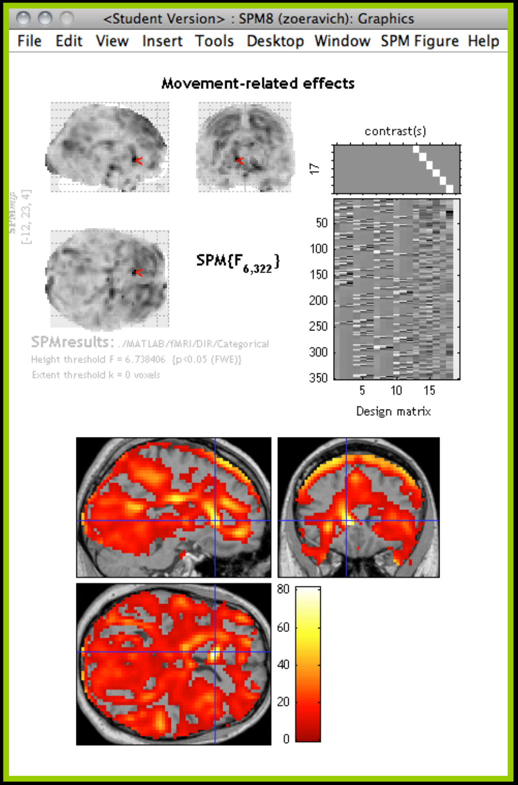


Selected 1/1 files.

/Users/zoeravich/Documents/MATLAB/fMRI/Structural/wmsM03953_0007.img,1

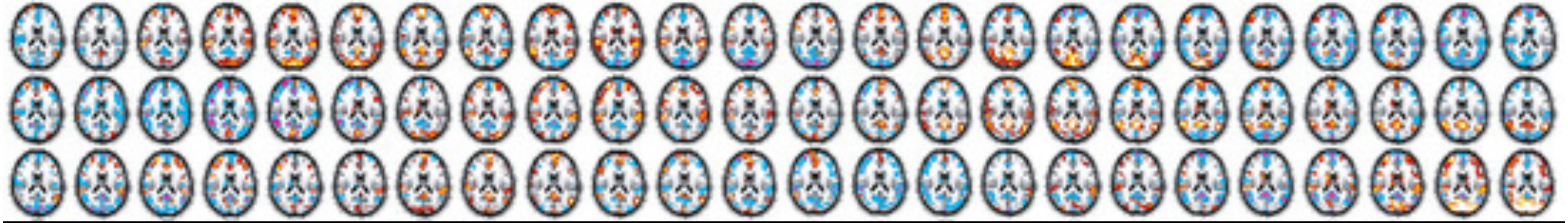
Step 14

Testing Effects of Movement (Optional)



SPMresults: ./MATLAB/fMRI/DIR/Categorical
Height threshold F = 6.738406 {p<0.05 (FWE)}
Extent threshold k = 0 voxels

fMRI Second-Level Data Analysis



fMRI Data Files

- **M2i** (Using contrast images from an “informed” basis set,consisting of the canonical HRF and its two partial derivatives with respect to time (onset latency) and dispersion)
  - 12 (subjects) x 3 (basis functions) con*.imgs from the first level model using the informed basis (M1i)

Create an “Informed” subdirectory

Step 1
One-Way ANOVA (Part 1)

- Press the SPECIFY 2ND-LEVEL button
  - In “Factorial design specification”, highlight “Design” and then choose “Full Factorial”
  - Under “Factors” create a single “New Factor”
    - “Factor”; Type in “Basis”
    - “Levels”; Type “3”
  - Highlight “Independence” and select “No”
  - Highlight “Specify cells” and create 3 new cells
    - “Levels”; Enter “1”, “2”, and “3” consecutively
    - Enter the canonical contrast images under scans (0003 to 0014, 0015 to 0026, and 0027 to 0038, respectively

Step 1
One-Way ANOVA (Part 2)

  - Highlight "Directory", then select "Specify files", and choose the subdirectory "informed" to place the design matrix in
  - Save the job files as DIR/informed.mat
  - Press the "Run" button
- Press the ESTIMATE button to estimate the parameters of the model
  - Select the SPM.mat file just created
  - Press the "Run" button

Step 2
Nonsphericity

- Go to “Review” → “Design” → “Explore” → “Covariance Structure” to show the estimated covariance matrix
  - **SPM.xVI.Vi{1}** (variance of the canonical derivative)
  - **SPM.xVi.Vi{2}** (variance of the temporal derivative)
  - **SPM.xVi.Vi{3}** (variance of the dispersion derivative)
  - **SPM.xVi.Vi{4}** (covariance between canonical and temporal derivative)
  - **SPM.xVi.Vi{5}** (covariance between canonical and dispersion derivative)
  - **SPM.xVi.Vi{6}** (covariance between temporal and dispersion derivatives)

Step 3
Informed Results (Part 1)

- Press the RESULTS button
  - Select the SPM.mat file
  - Press “Define new contrast” and select “F”
    - “Contrast”; Type “eye(3)”
    - “Name”; Enter “Faces vs. Baseline: Informed”
    - Press the “Submit” button and then press OK
    - Press the “Done” button
  - “Mask with other contrast(s)?”; Click “No”
  - “Title for comparison?”; Type “Faces vs Baseline: Informed”
  - “p value adjustment to control”; Click “FWE”
  - “Family-wise p-value”; Type “0.05”
  - “Extent threshold {voxels}”; Accept the default value, “0”

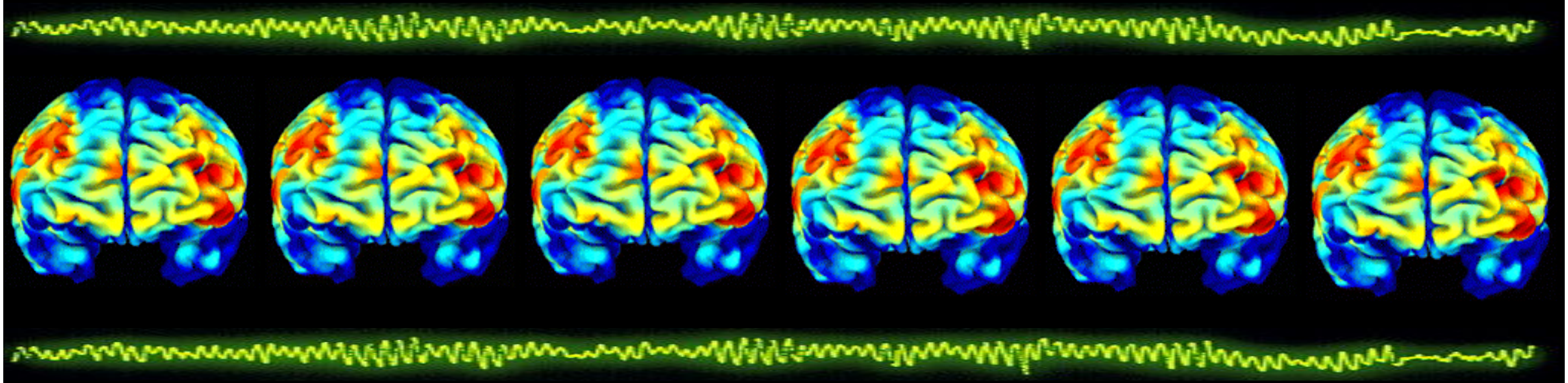
Step 3
Informed Results (Part 2)

- Right click on the MIP and select “goto global maxima”
  - Press “plot”, select “Contrast estimates and 90% C.I.”, and then select the “Faces vs Baseline: Informed” contrast
  - Compare the size of the first, second, and third bars to the error bars in order to accurately determine the contributions of the different basis functions

Step 4
T- and F-Contrasts

- Press the RESULTS button
  - Select the SPM.mat file
  - Press “Define new contrast” and select “T”
    - “Contrast”; Type “eye(3)”
    - “Name”; Enter “Faces vs. Baseline: Informed”
    - Press the “Submit” button and then press OK
    - Press the “Done” button
  - “Mask with other contrast(s)?”; Click “No”
  - “Title for comparison?”; Type “Faces vs Baseline: Informed”
  - “p value adjustment to control”; Click “FWE”
  - “Family-wise p-value”; Type “0.05”
  - “Extent threshold {voxels}”; Accept the default value, “0”

Congratulations!



You Successfully Processed and Explored SPM’s fMRI Dataset!