# fMRI Lab – Pre-processing and GLM modeling

This is an example of blocked fMRI data acquired on a modified 2T Siemens Magnetom Vision System. There are 96 functional scans (BOLD/EPI images; fM00223_004 – fM00223_009 and one structural T1-weighted image (sM00223_002).

The blocked design task is auditory stimulation (two-syllable words presented at a rate of 1 per second) alternating with periods of silence/rest.

The BOLD/EPI parameters are:

64 contiguous slices (64x64x64)
Voxel size: 3mm x 3mm x 3mm
TR =7s

In this lab, you will:

1) normalize the structural and functional data
2) smooth the functional data
   - You can play around with different smoothing kernels or examine the difference between smoothing and not smoothing the data
3) specify a design matrix (model)
4) estimate the model
5) inspect the results
6) specify contrasts.

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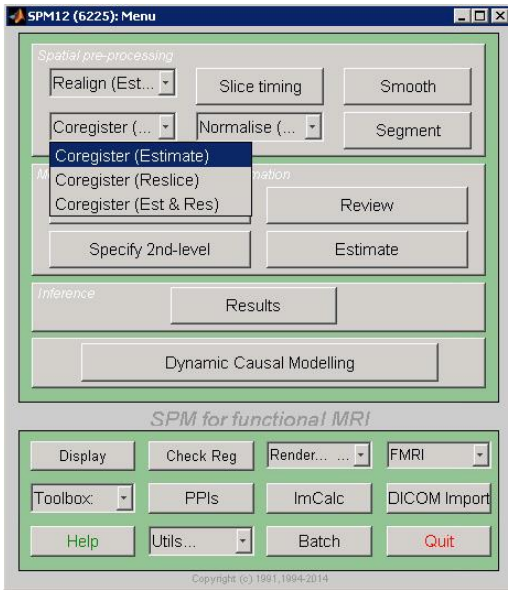
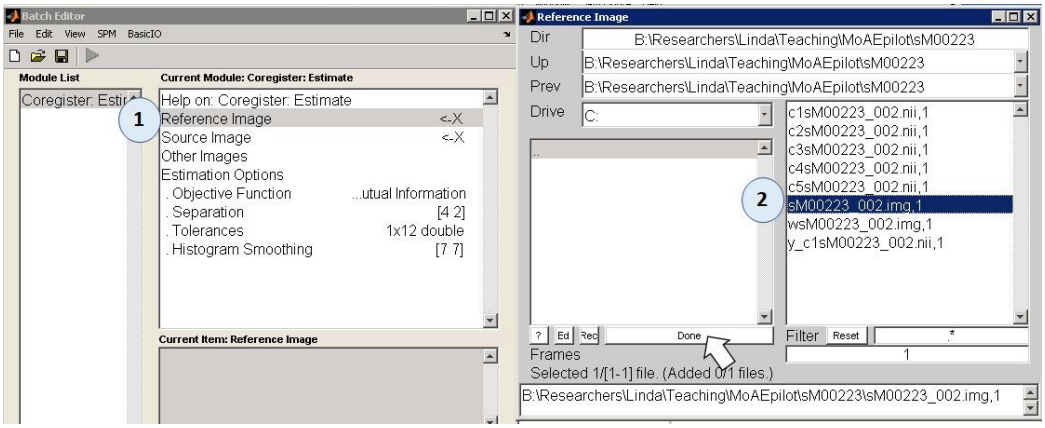
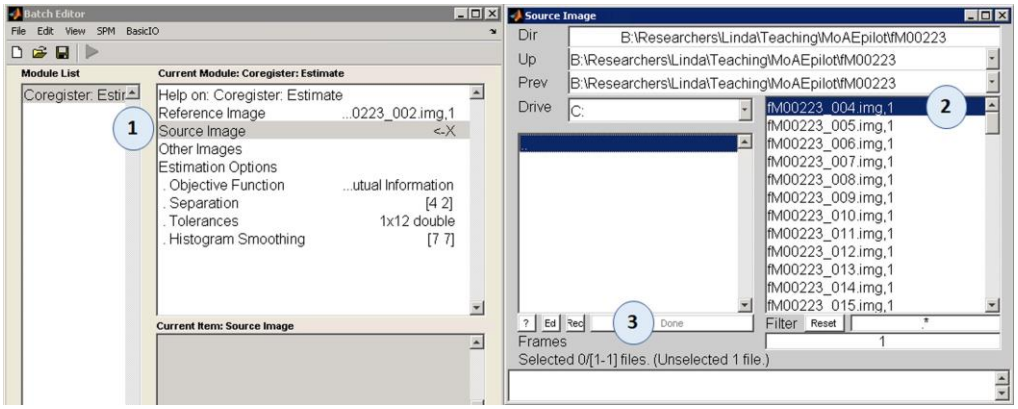
I. Launch SPM12 from Matlab

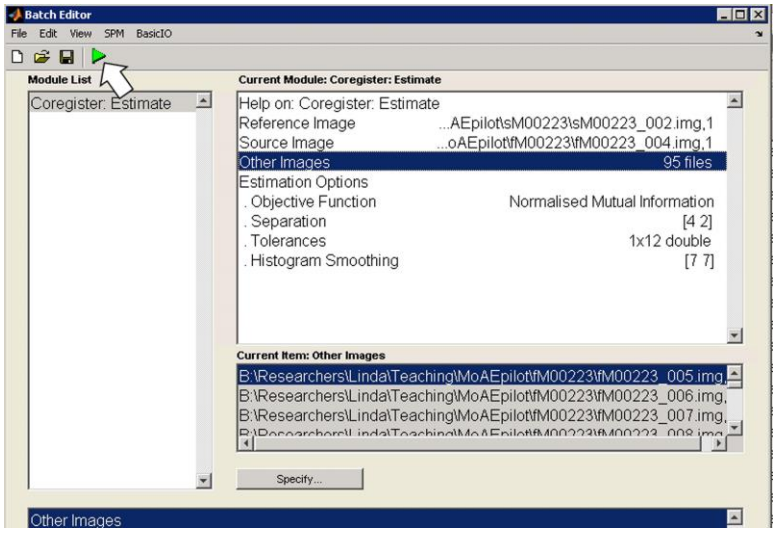
II. Co-register structural and functional data:





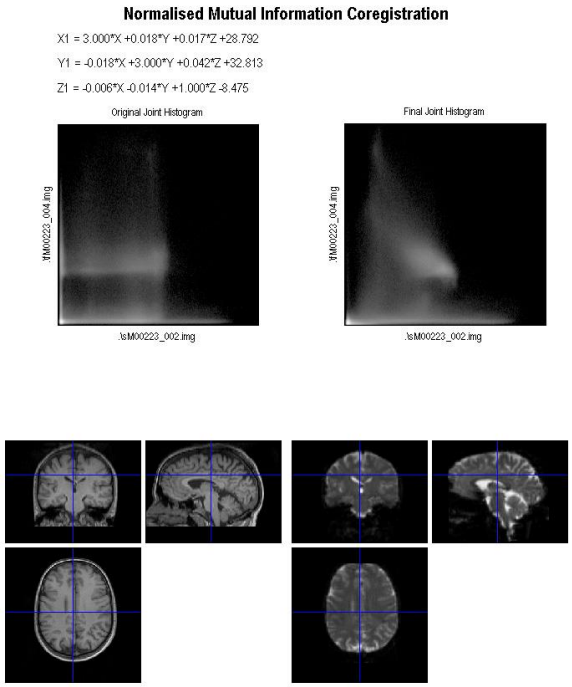

A. For the "Reference Image," select sM00223_002.img and then click "Done"
B. For the "Source Image," select the first functional image in the functional image directory: "fM00223_004.img" and then click "Done"



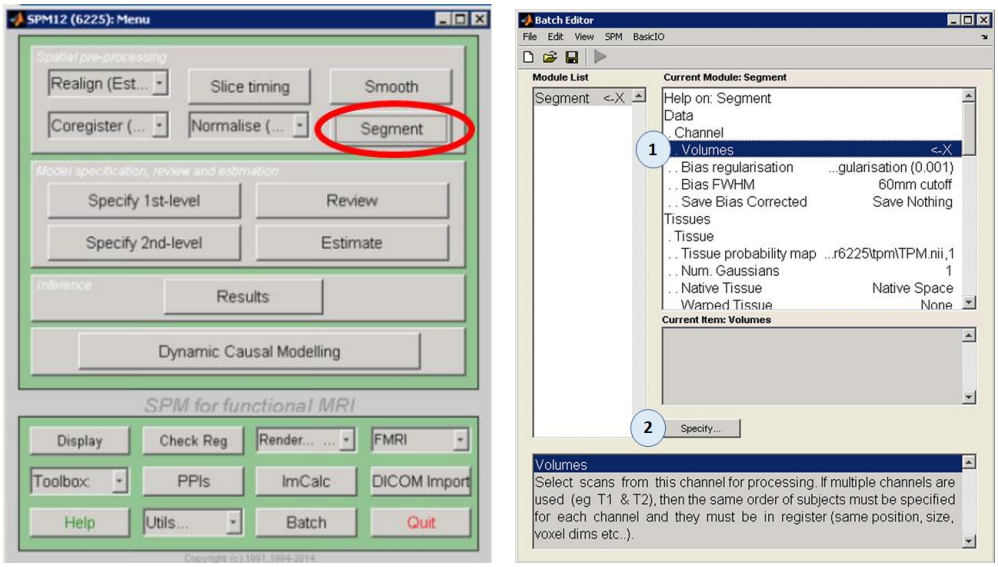




When all the files have been specified in the Batch Editor, click on the green arrow.

When the co-registration is done, you will see this in the SPM Graphics window:

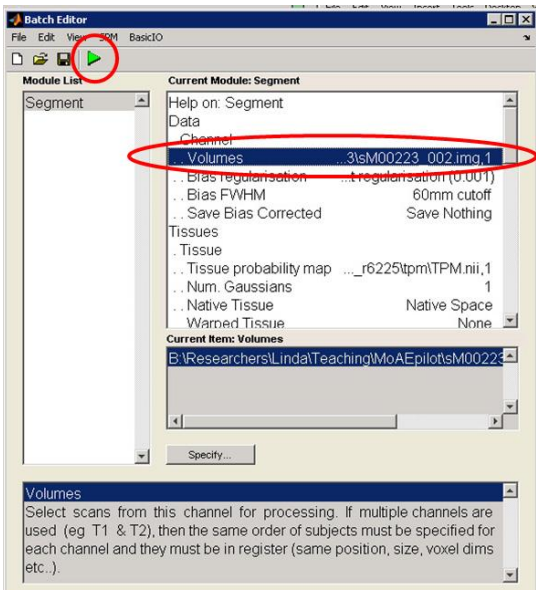



II. Segment the structural data



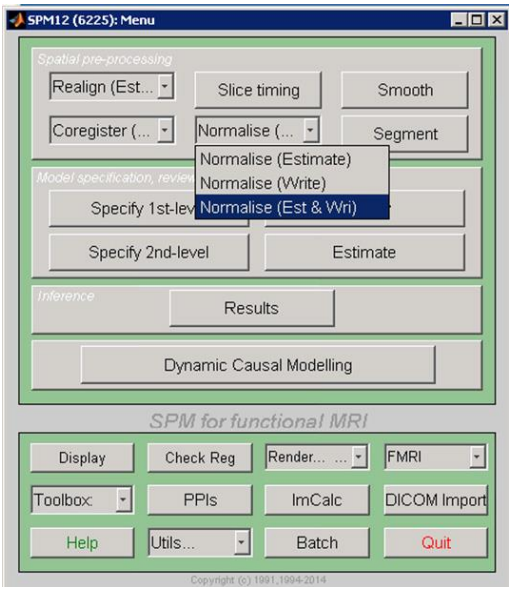

1) Click on Volumes
2) Click Specify
3) Navigate to the sM00223 directory and highlight “M00223_002.img”; then click “Done”

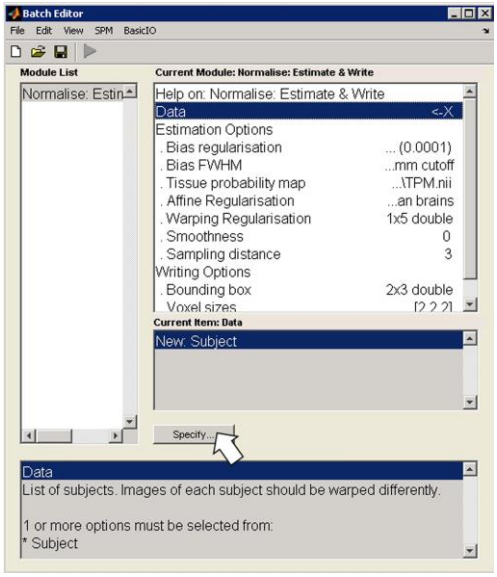
4) After you see the structural image in the Volumes field, click the green button to segment. This will take a few of minutes.



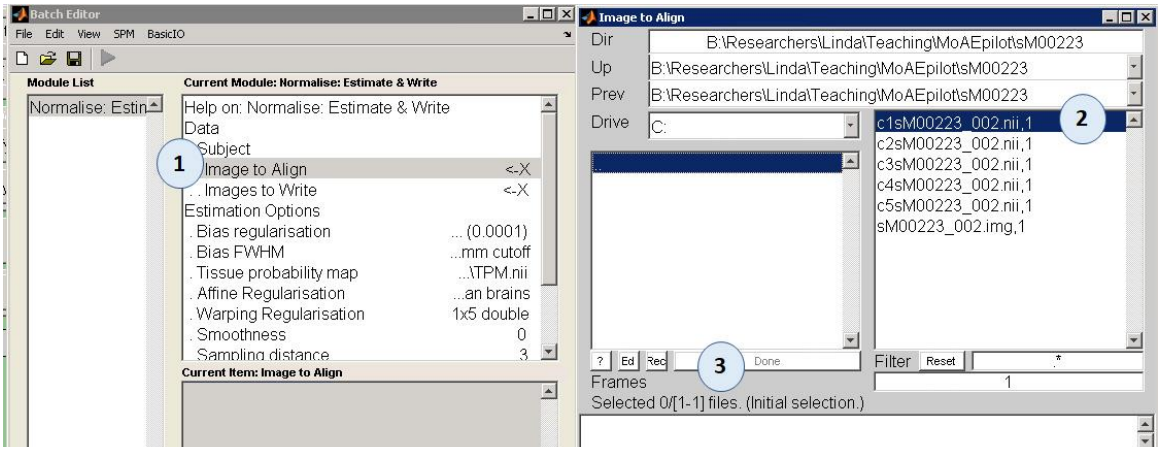

5) When the segmentation is complete, in the sM00223 directory, you should see 6 new files: c1sM00223_002, c2sM00223_002, c3sM00223_002, c4_sM00223_002, c5sM00223_002, and sM00223_002_seg8.

III. Normalize the structural data:

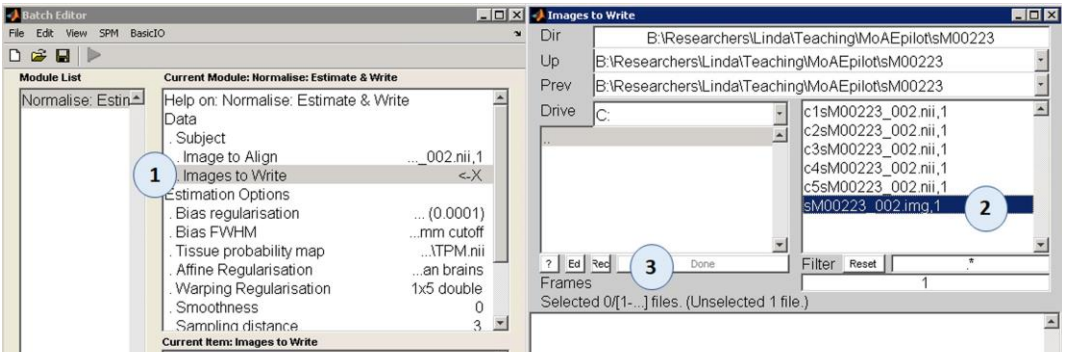


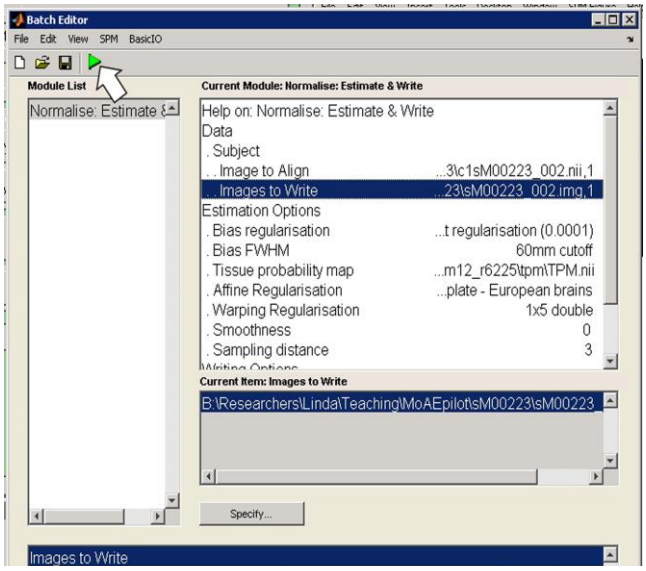

1) After clicking “Specify”, highlight “Image to Align” and select c1sM00223_002.nii (click Done).




2) Highlight “Images to Write”; select “sM00223_002.img”; click “Done”:

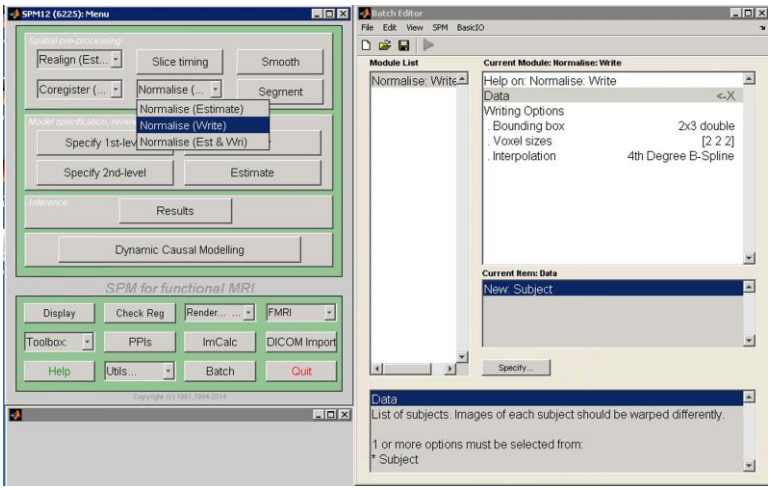


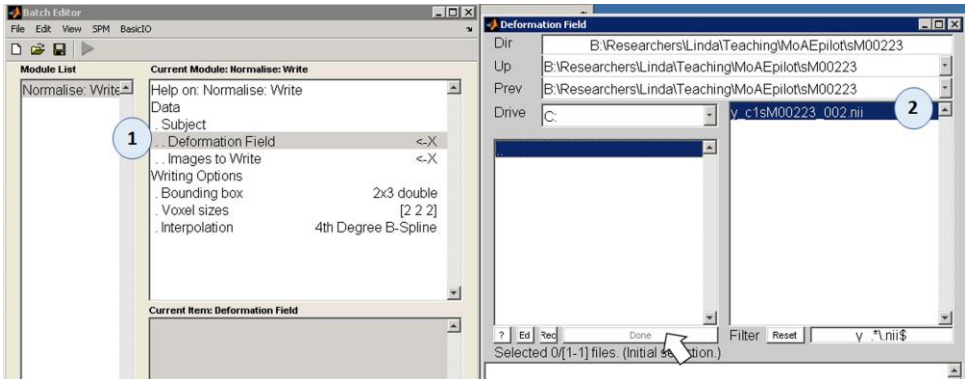

3) After selecting both files, click on the green arrow to Normalize. This step will take several minutes.
   a. When this step is finished, there will be 3 new files in the sM00223 folder: wsM00223_002.img, wsM00223_002.hdr, (normalized structural image) and y_cs1sM00223_002 (deformation field)



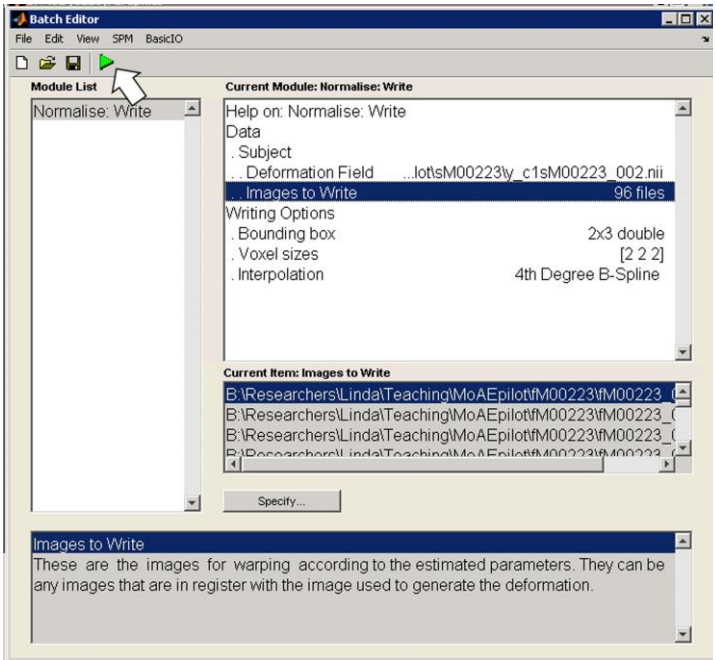
IV. Apply the deformation field to the co-registered functional data:

1) choose “Normalize (Write)
2) click “Data” and “specify:

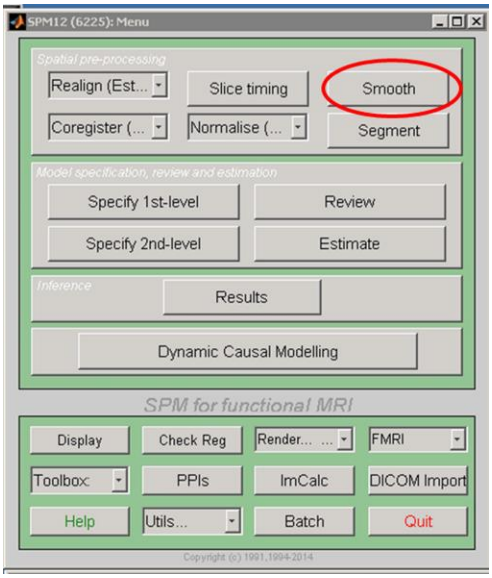


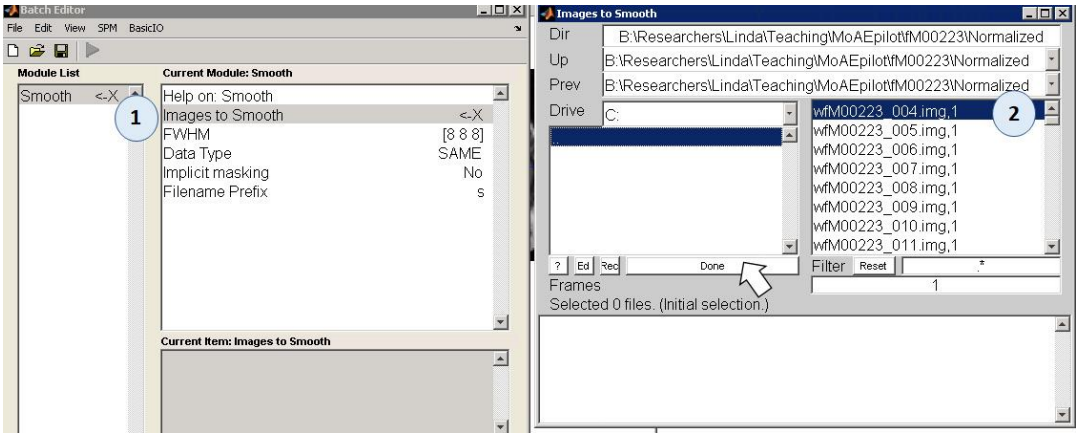




3) For “Deformation Field,” select “y_c1sM00223_002.nii” in the structural folder and click “Done”
4) For “Images to write,” select all the functional images in the “fM00223” folder then click the green arrow.
5) After this step is complete, there will be 192 new functional images with the prefix “w” (e.g., wfM00223_004).
6) Move these ‘normalized’ functional images into a separate folder called Normalized within the “fM00223” folder



V. Smooth the normalized functional data.

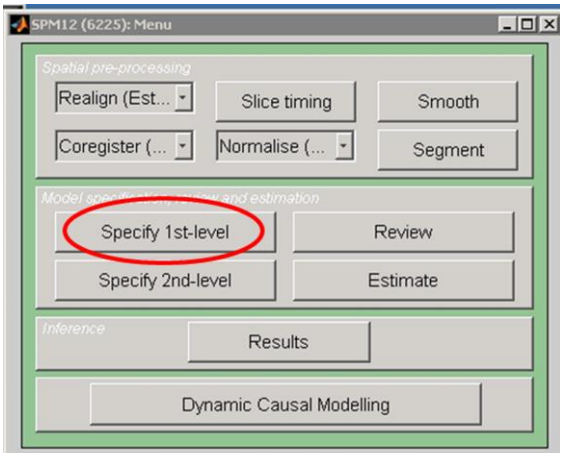


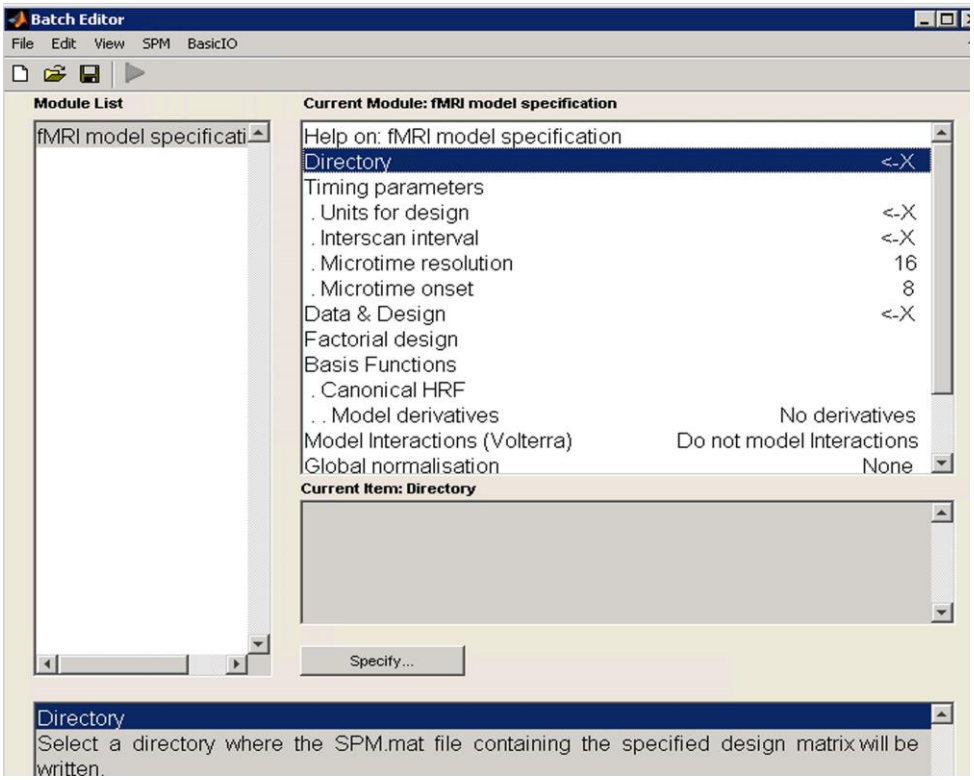




1) For "Images to Smooth," select all the normalized functional scans and then click done.
2) Then click the green arrow.
    a. You can leave the FWHM at the default 8,8,8 for now. If there is time, you can play around with different smoothing kernels or not smoothing the functional data at all.
3) When this step is finished, you should have 192 new files with the prefix "s" in the Normalized folder (e.g., swfM00223_004).
4) Move these smoothed, normalized functional images into a separate folder called Smooth888 within the "fM00223" folder
5) Because there were no "dummy" lead in scans in the experiment, we can remove the first few scans (i.e., you can move the first 6 scans into a separate folder so the experiment starts with a sound block).

VI. Specify the design matrix:

1) Within the MoAEpilot directory, make a directory called "Stats888" to put the files generated from the 1st level analysis.
2) Click on "Specify 1st-level"



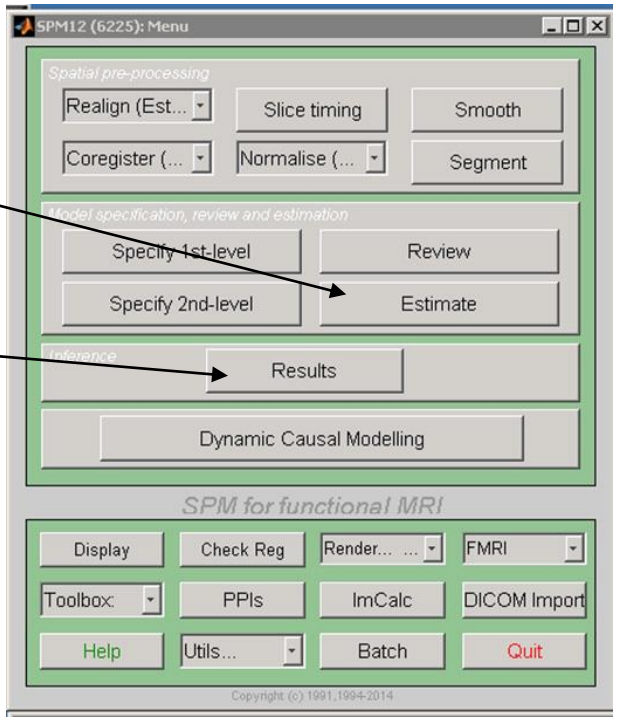


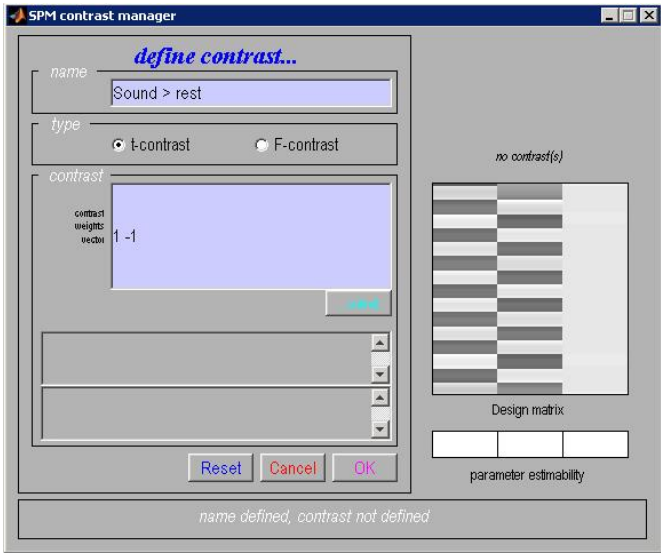

3) For Directory, select the Stats888 folder you just created
4) Units for design, select seconds
5) Interscan interval, 7
6) For Data & Design, select New Subject/Session
7) For Scans, select all smoothed, normalized, functional scans
8) Click on Conditions and select “New: Condition”
    a. Name, call first condition something like “Sound”
    b. Onsets, this is asking for the time in seconds when the sound blocks occur.

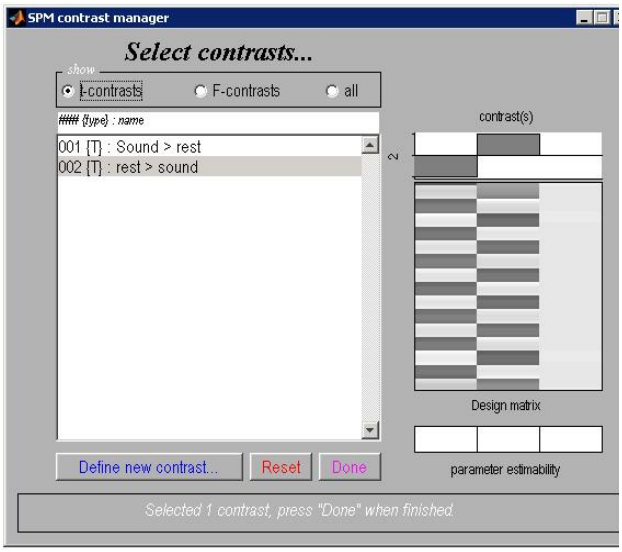
VII. Estimated the model:
1) Click Estimate
2) Click Select SPM.mat, then specify
3) Click the SPM.mat file in the Stats888 folder
4) Click green arrow.

VII. Estimated the model:
1) Click Results
2) Select the SPM.mat file in the Stats888folder

VII. Estimated the model:
1) Select t-contrasts
2) Then click “Define new contrast”





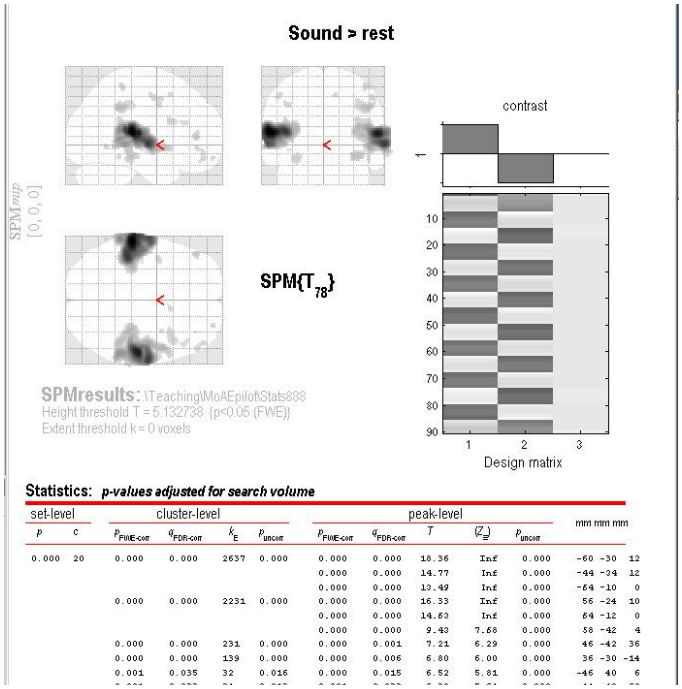




Contrast 1: Sound > Rest, specify 1 -1

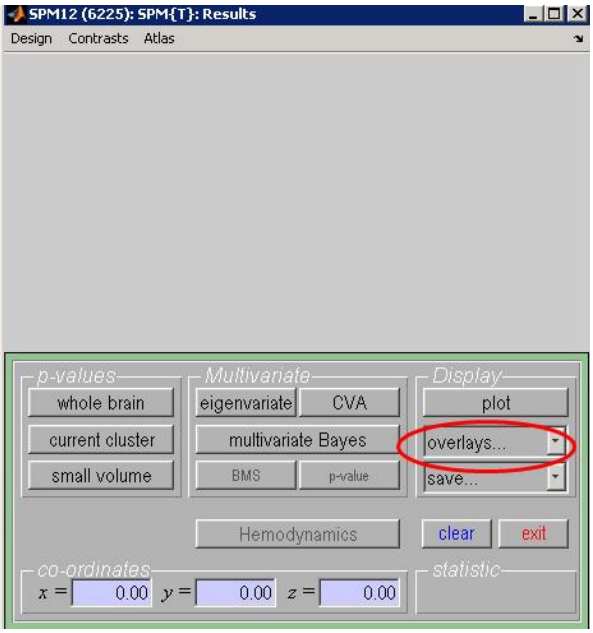
Contrast 2: Rest > sound, specify -1 1

To view results:

1) Click results
2) Click SPM.mat file, done
3) Pick contrast to look at, select 001{T} Sound > rest, then Done
4) Apply masking: none
5) p value adjustment to control: FEW
6) p value (PWE): 0.05
7) & extent threshold [voxels]: 0
8) You should see Glass Brain rendition of activations



9) You can also over lay the activations on the subject's structural image:




10) Can overlay activations on slices or section (this option allows you to click around a 3D volume)
    a. Select normalize structural image for the overlay.

# Auditory Experiment Timing Parameters

| | | |
|---|---|---|
| fM00223_004 | 1 | |
| fM00223_005 | Rest | |
| fM00223_006 | (discard) | |
| fM00223_007 | | |
| fM00223_008 | | |
| fM00223_009 | | seconds |
| fM00223_010 | 2 | 1-7 |
| fM00223_011 | Sound | 8-14 |
| fM00223_012 | | 15-21 |
| fM00223_013 | | 22-28 |
| fM00223_014 | | 29-35 |
| fM00223_015 | | 36-42 |
| fM00223_016 | 3 | 43-49 |
| fM00223_017 | Rest | 50-56 |
| fM00223_018 | | 57-63 |
| fM00223_019 | | 64-70 |
| fM00223_020 | | 71-77 |
| fM00223_021 | | 78-84 |
| fM00223_022 | 4 | 85-91 |
| fM00223_023 | Sound | 92-98 |
| fM00223_024 | | 99-105 |
| fM00223_025 | | 106-112 |
| fM00223_026 | | 113-119 |
| fM00223_027 | | 120-126 |
| fM00223_028 | 5 | 127-133 |
| fM00223_029 | Rest | 134-140 |
| fM00223_030 | | 141-147 |
| fM00223_031 | | 148-154 |
| fM00223_032 | | 155-161 |
| fM00223_033 | | 162-168 |
| fM00223_034 | 6 | 169-175 |
| fM00223_035 | Sound | 176-182 |
| fM00223_036 | | 183-189 |
| fM00223_037 | | 190-196 |
| fM00223_038 | | 197-203 |
| fM00223_039 | | 204-210 |
| fM00223_040 | 7 | 211-217 |
| fM00223_041 | Rest | 218-224 |
| fM00223_042 | | 225-231 |
| fM00223_043 | | 232-238 |
| fM00223_044 | | 239-245 |
| fM00223_045 | | 246-252 |
| fM00223_046 | 8 | 253-259 |
| fM00223_047 | Sound | 260-266 |
| fM00223_048 | | 267-273 |
| fM00223_049 | | 274-280 |
| fM00223_050 | | 281-287 |

| | Onsets |
|---|---|
| rest | 43 127 211 295 379 463 547 |
| sound | 1 85 169 253 337 421 505 589 |

| | | |
|---|---|---|
| fM00223_051 | | 288-294 |
| fM00223_052 | **9** | 295-301 |
| fM00223_053 | **Rest** | 302-308 |
| fM00223_054 | | 309-315 |
| fM00223_055 | | 316-322 |
| fM00223_056 | | 323-329 |
| fM00223_057 | | 330-336 |
| fM00223_058 | **10** | 337-343 |
| fM00223_059 | **Sound** | 344-350 |
| fM00223_060 | | 351-357 |
| fM00223_061 | | 358-364 |
| fM00223_062 | | 365-371 |
| fM00223_063 | | 372-378 |
| fM00223_064 | **11** | 379-385 |
| fM00223_065 | **Rest** | 386-392 |
| fM00223_066 | | 393-399 |
| fM00223_067 | | 400-406 |
| fM00223_068 | | 407-413 |
| fM00223_069 | | 414-420 |
| fM00223_070 | **12** | 421-427 |
| fM00223_071 | **Sound** | 428-434 |
| fM00223_072 | | 435-441 |
| fM00223_073 | | 442-448 |
| fM00223_074 | | 449-455 |
| fM00223_075 | | 456-462 |
| fM00223_076 | **13** | 463-469 |
| fM00223_077 | **Rest** | 470-476 |
| fM00223_078 | | 477-483 |
| fM00223_079 | | 484-490 |
| fM00223_080 | | 491-497 |
| fM00223_081 | | 498-504 |
| fM00223_082 | **14** | 505-511 |
| fM00223_083 | **Sound** | 512-518 |
| fM00223_084 | | 519-525 |
| fM00223_085 | | 526-532 |
| fM00223_086 | | 533-539 |
| fM00223_087 | | 540-546 |
| fM00223_088 | **15** | 547-553 |
| fM00223_089 | **Rest** | 554-560 |
| fM00223_090 | | 561-567 |
| fM00223_091 | | 568-574 |
| fM00223_092 | | 575-581 |
| fM00223_093 | | 582-588 |
| fM00223_094 | **16** | 589-595 |
| fM00223_095 | **Sound** | 596-602 |
| fM00223_096 | | 603-609 |
| fM00223_097 | | 610-616 |
| fM00223_098 | | 617-623 |
| fM00223_099 | | 624-630 |