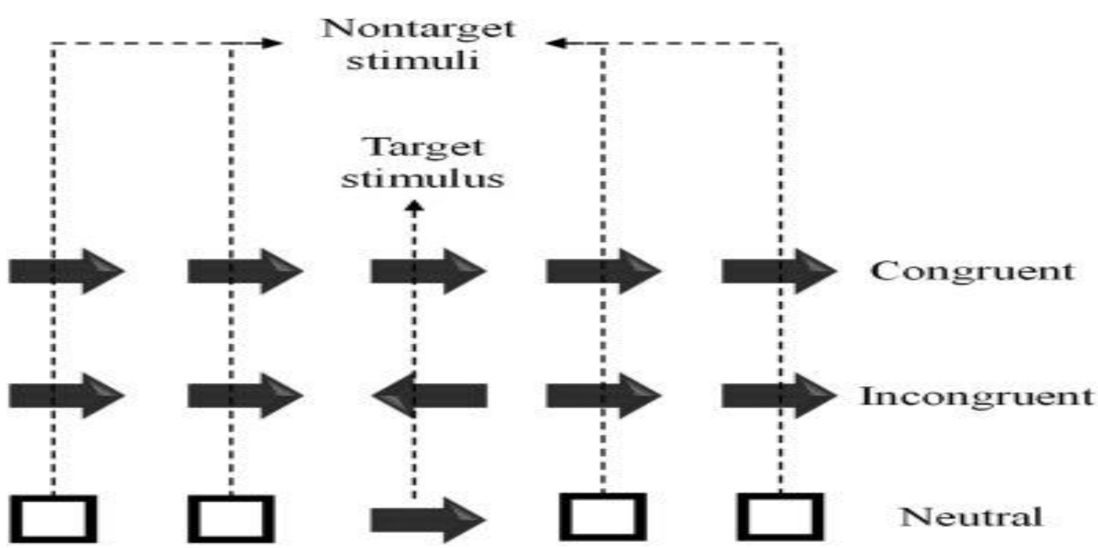
FSL analysis on flanker data set

Problem definition:

Eriksen flanker task is a set of tests to assess selective attention and inhibitory function. In this task the target is positioned in the center and is flanked by a nontarget stimuli. The individual is requested to press either the left or wright arrow key depending on the target direction.

The task contains three types of nontarget stimuli:

1. The congruent, here target is in the same direction as the nontarget.
2. The incongruent, target is in the opposite direction.
3. The neutral, target is neither the same nor the opposite direction.



The data set contains FMRI recording for 26 subjects, each has an anatomical record and functional record which has two runs.

What are we trying to do?

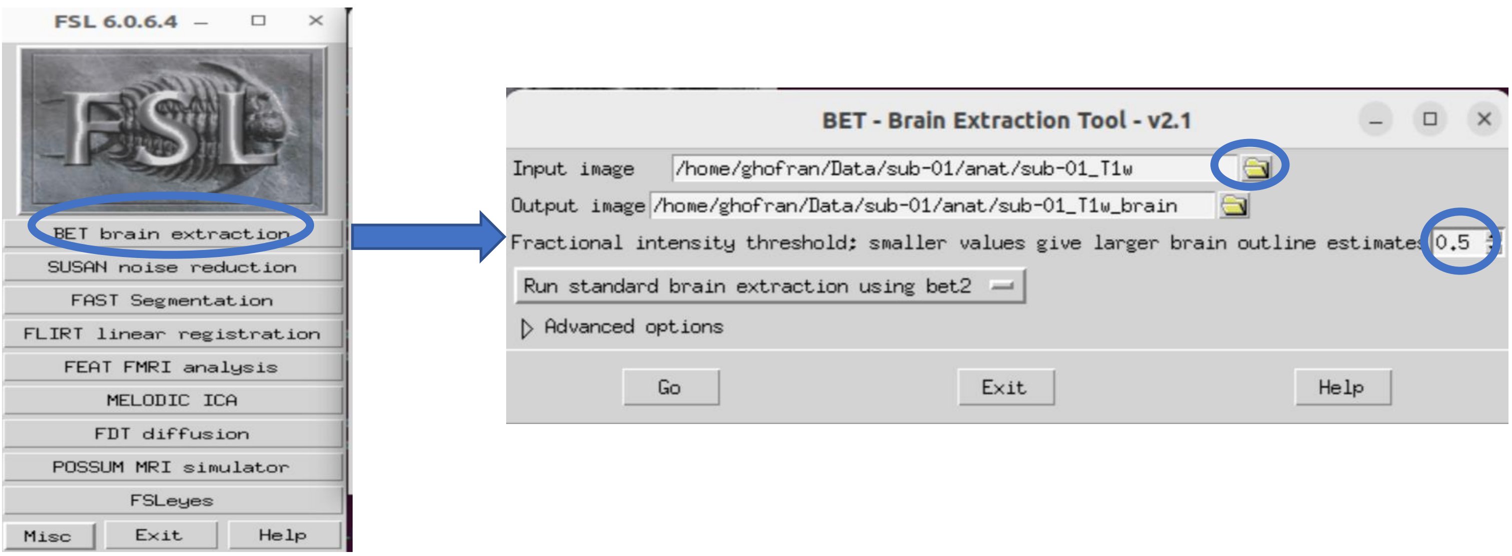
We want to analyze these data set by first applying enhancing, standardization, generalization and statistical methods to find the ROI.

ROI

The brain regions which are activated during each stimuli of the task.

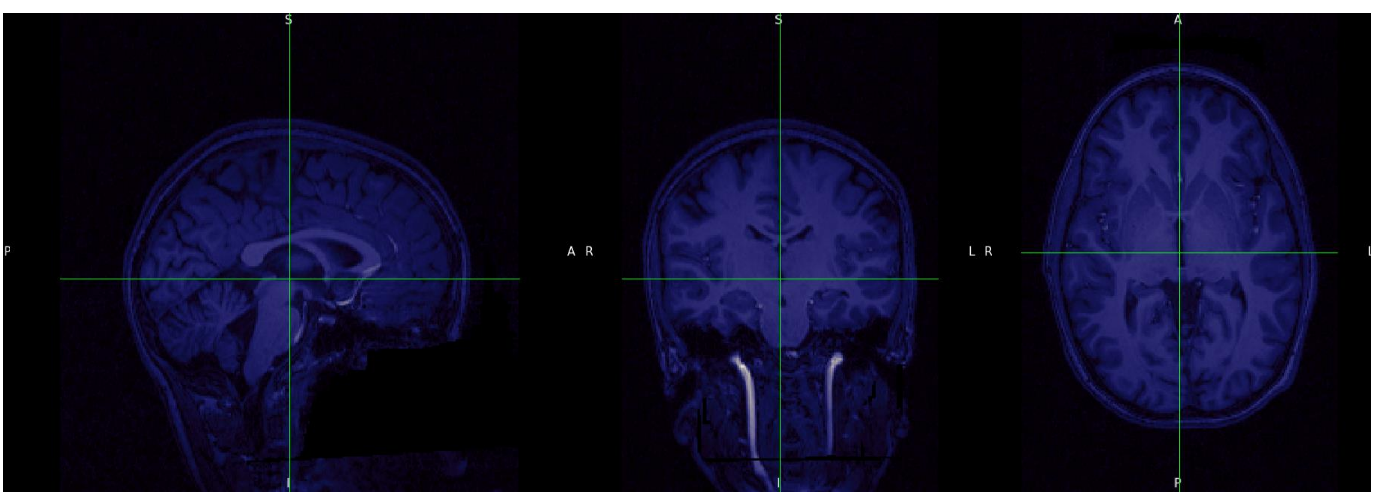
Preprocessing with FSL

1. Removing the skull

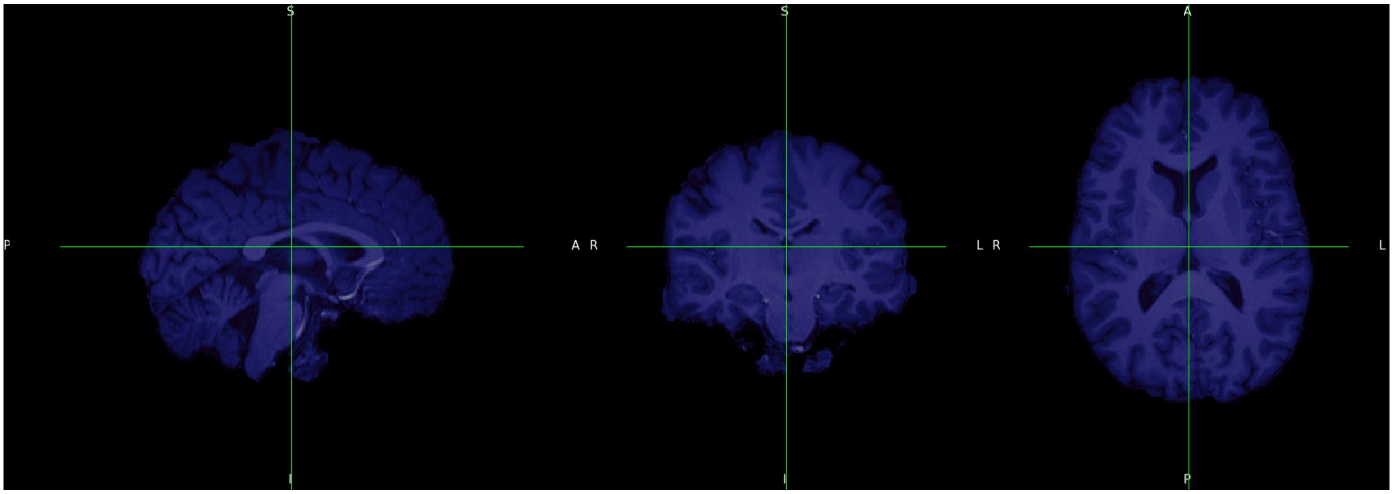


By changing the fractional intensity threshold we notice how more skull is removed when increasing the value and vise-versa.

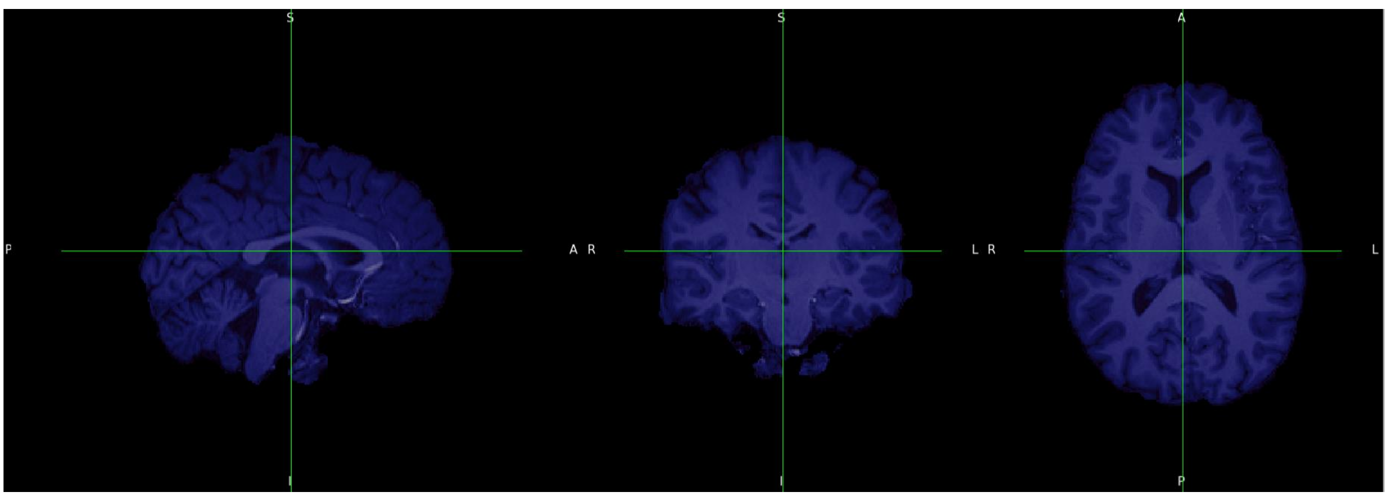
a. Sub-01 anatomical without skull removing



b. Sub-01 with 0.2 threshold

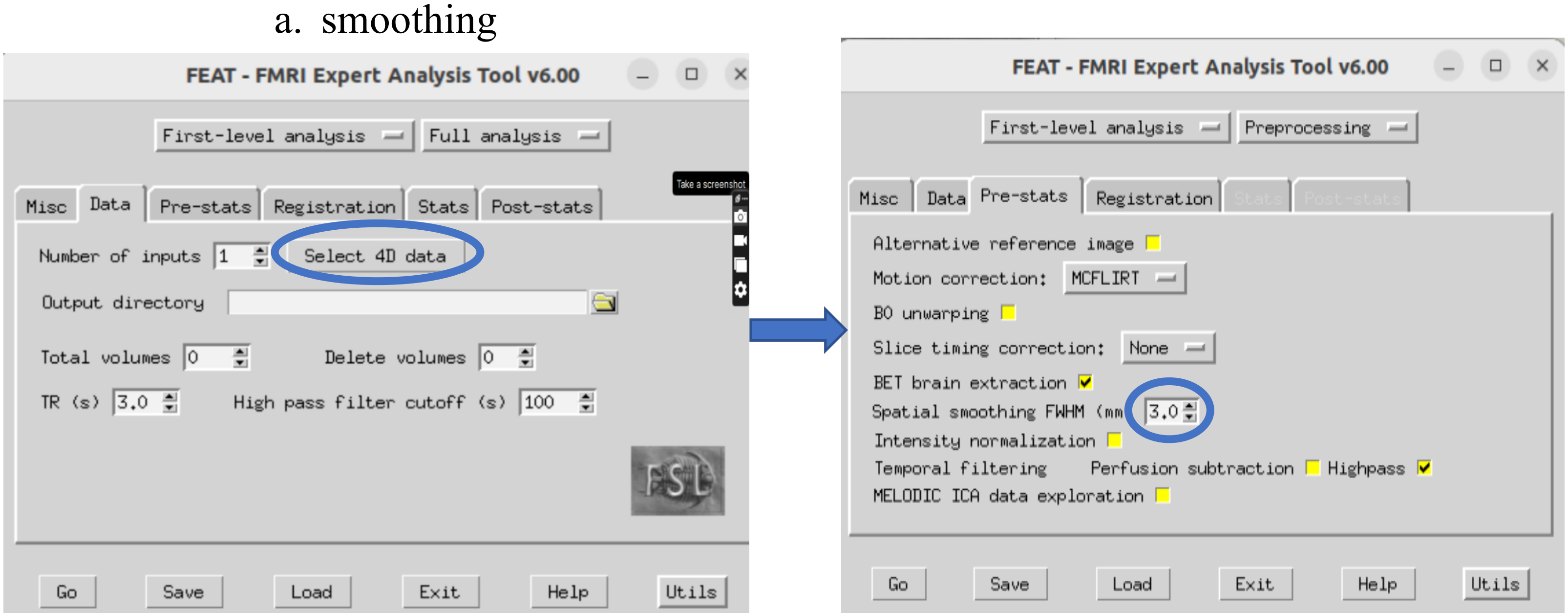


c. Sub-01 with 0.9 threshold



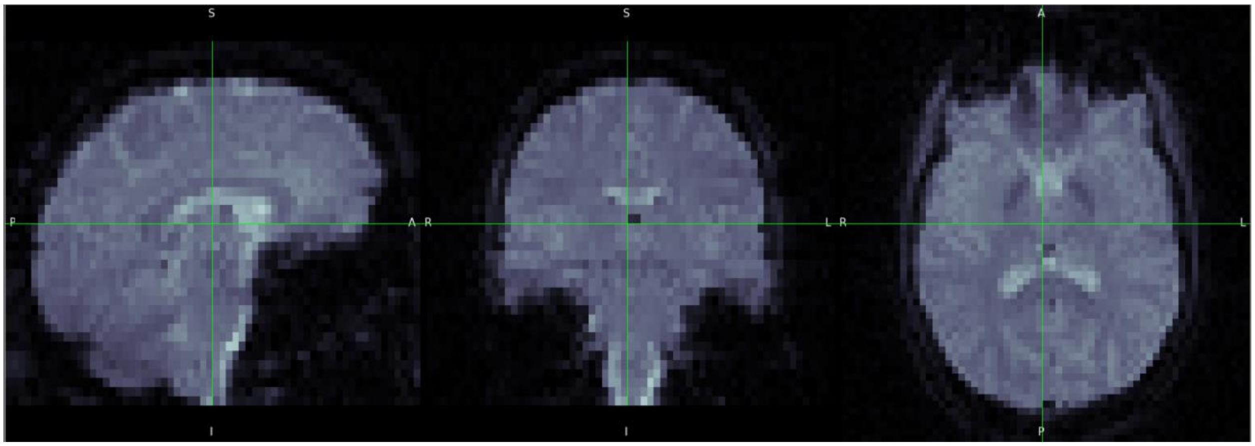
2. FEAT FMRI analysis

a. smoothing

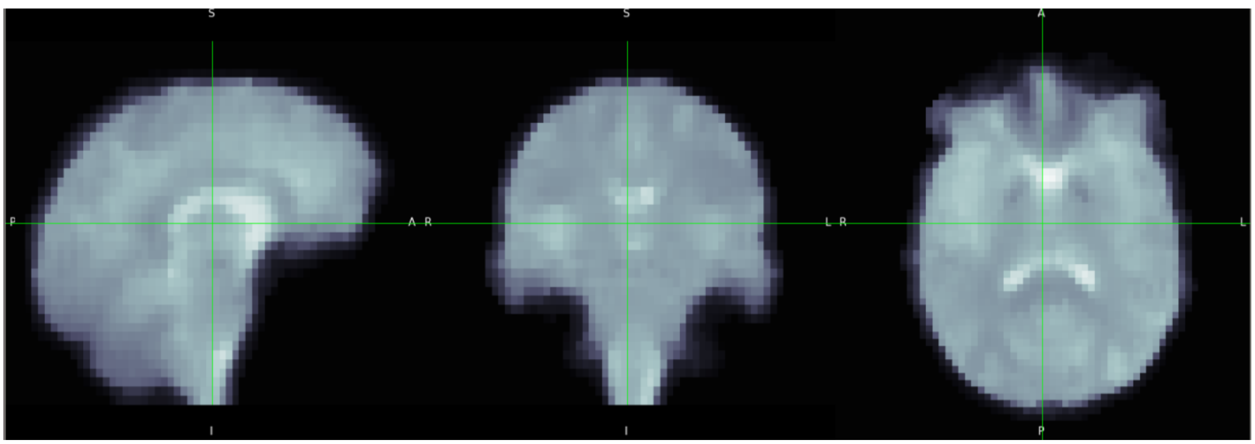


Trying different smoothing kernels on Sub-02, the bigger the value of the kernel the smoother the image will be.

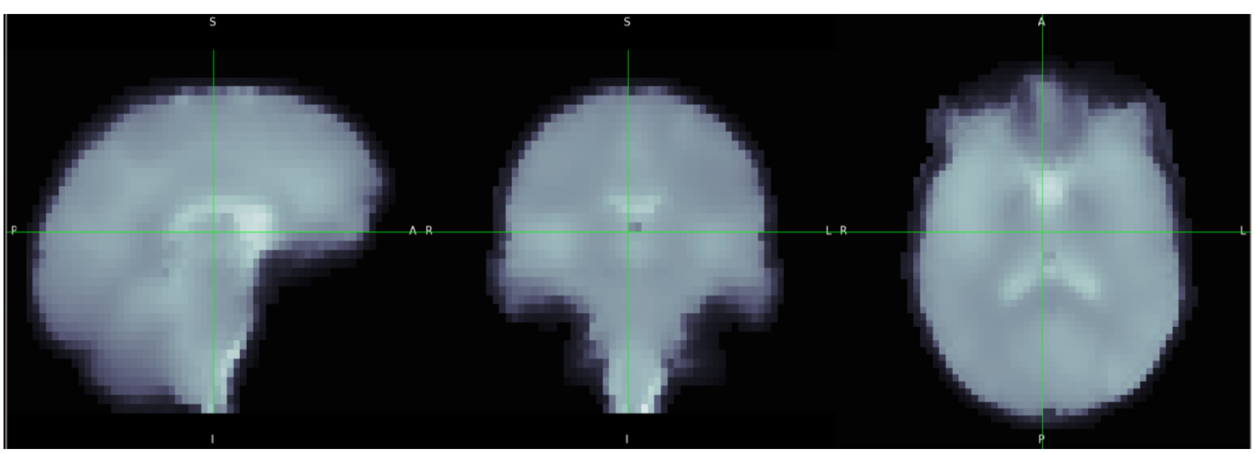
- Sub-02 run-1 without smoothing.



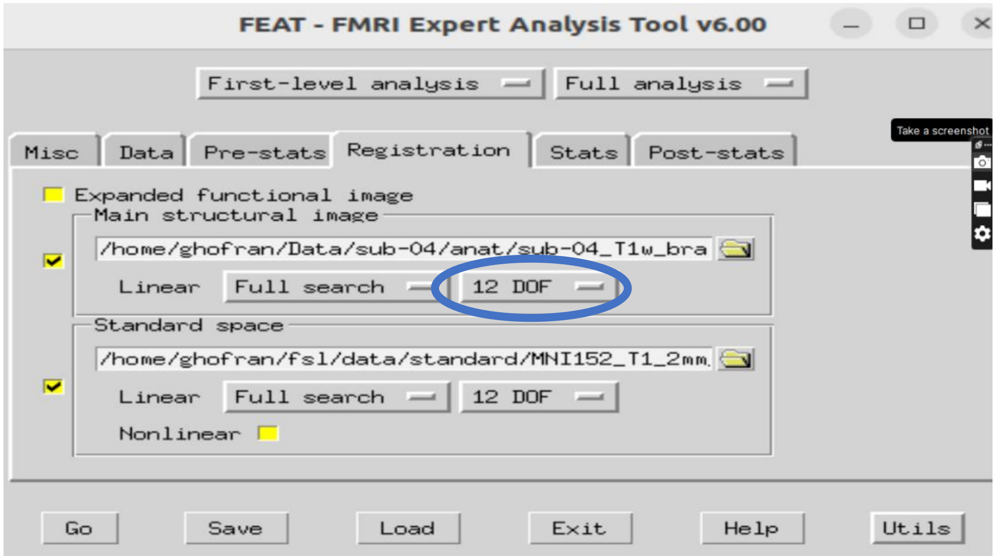
- 3mm kernel



- 12mm kernel

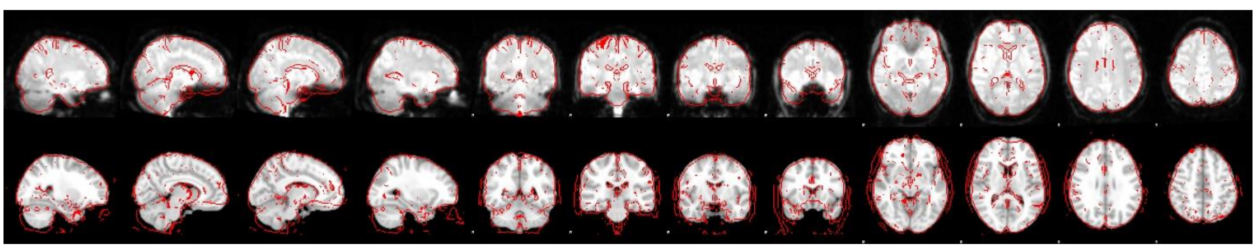


b. Registration

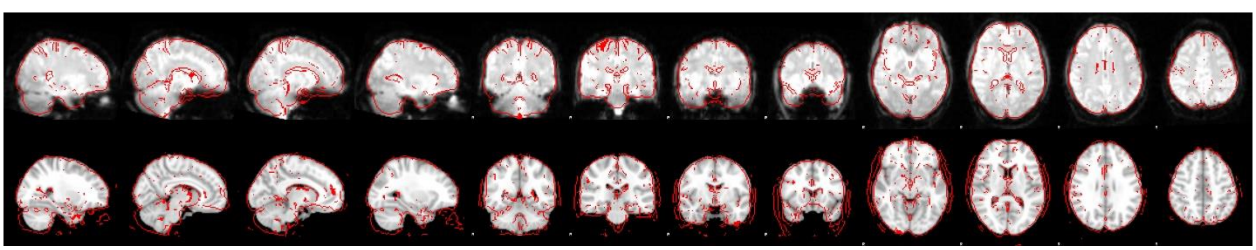


Changing degrees of freedom for sub-03 run-1 and examining the functional to standard registration output.

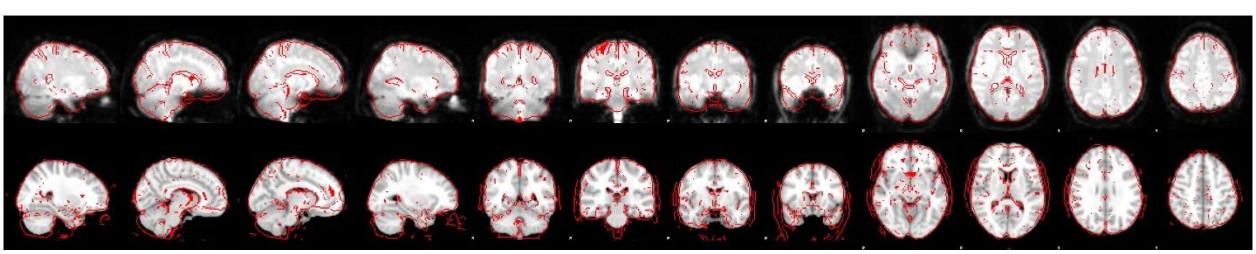
- 12 DOF



- 3 DOF

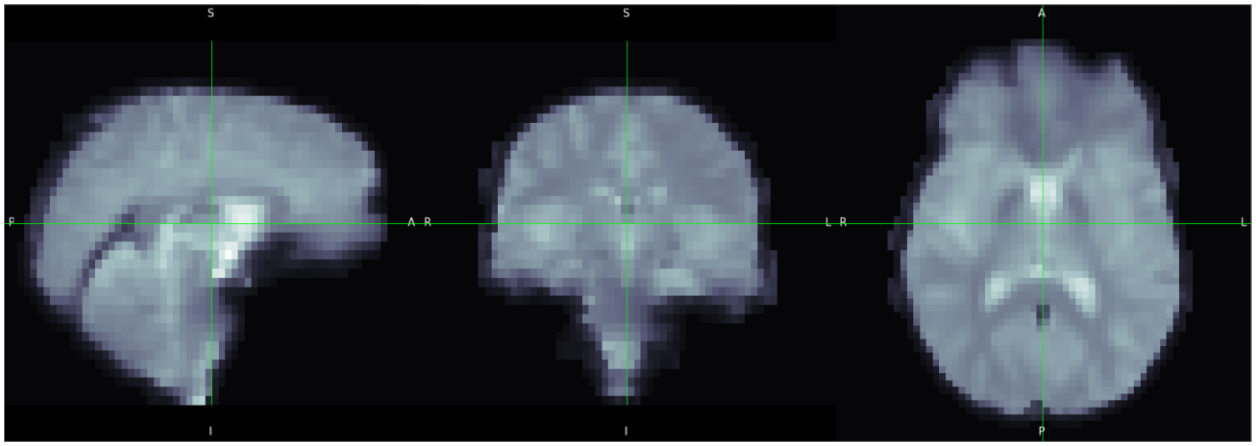


- Brain-Boundry registration (BBR)



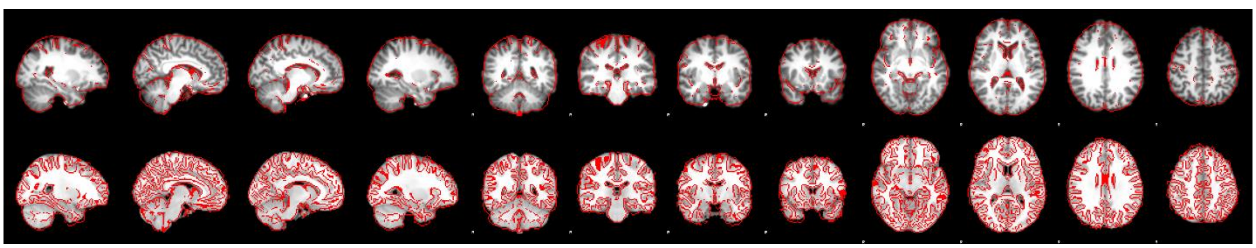
Applying all the steps with standard values (0.5 threshold, 5mm smoothing kernel, 12 DOF) for Sub-04 run 1.

a. Smoothing output

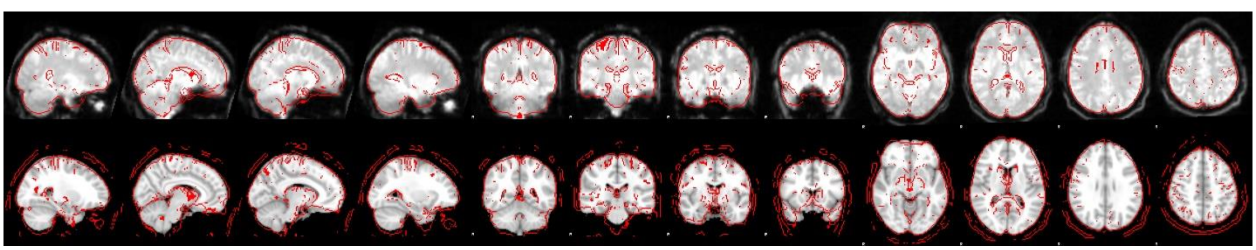


b. Registration

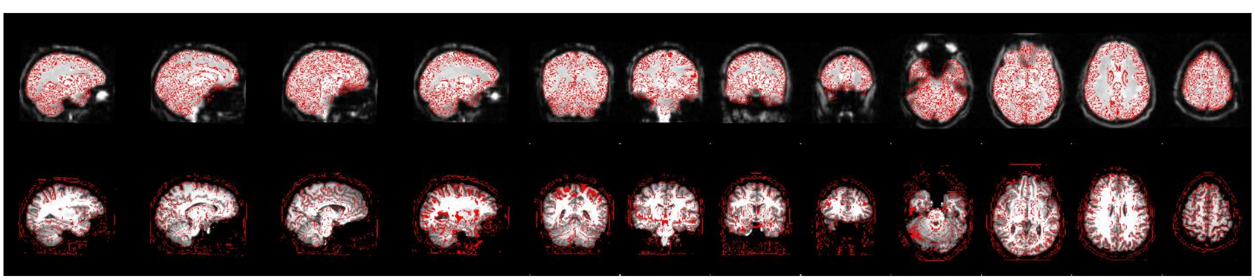
- Highres to standard



- Functional to standard

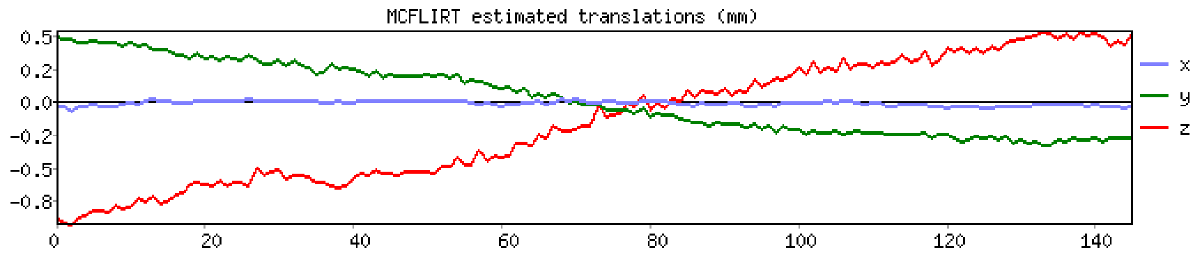


- Functional to highres

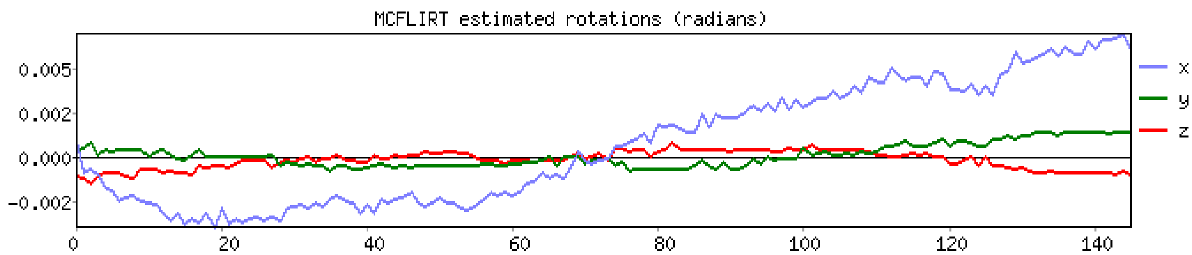


c. Pre-stats motion correction

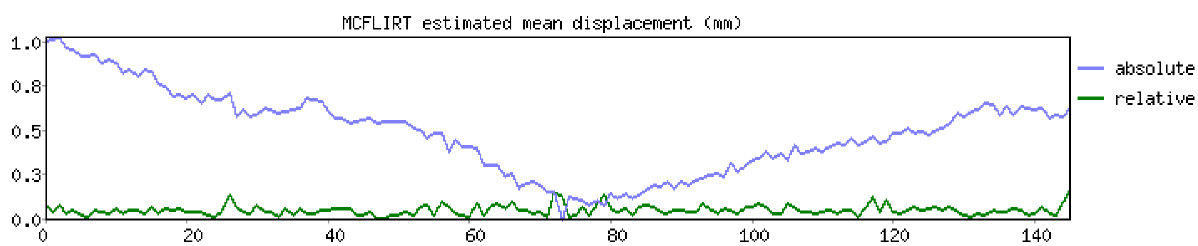
- Translation



- Rotation



- Mean displacement



Scripting

a. Make_timing script

```
#1/bin/bash
#check if the file subjlist.txt exsist; if not, create it.
if [ ! -f  subjlist.txt ]; then
         ls | grep ^sub- > subjlist.txt
fi
#Looping all over the subjects and convert timing files into
FSL format
```

```
for subj in `cat subjlist.txt`; do
    cd $subj/func
    cat ${subj}_task-flanker_run-1_events.tsv | awk '{if
($3=="incongruent_correct") {print $1, $2, 1}}' >
incongruent_run1.txt
    cat ${subj}_task-flanker_run-1_events.tsv | awk '{if
($3=="congruent_correct") {print $1, $2, 1}}' >
congruent_run1.txt

    cat ${subj}_task-flanker_run-2_events.tsv | awk '{if
($3=="incongruent_correct") {print $1, $2, 1}}' >
incongruent_run2.txt
    cat ${subj}_task-flanker_run-2_events.tsv | awk '{if
($3=="congruent_correct") {print $1, $2, 1}}' >
congruent_run2.txt

    cd ../..

done
```

b. Looping at all subjects starting from sub-05

```
for id in `seq -w 5 26`; do
    subj="sub-$id"
    echo "Start processing $subj"
    echo

    cd $subj
    if [ ! -f anat/${subj}_T1w_brain.nii.gz ]; then
    bet2 anat/${subj}_T1w.nii.gz anat/${subj}_T1w_brain.nii.gz
-f 0.4
    fi
    cp ../design.fsf design1.fsf
    #using "sed" command changes the subject
```

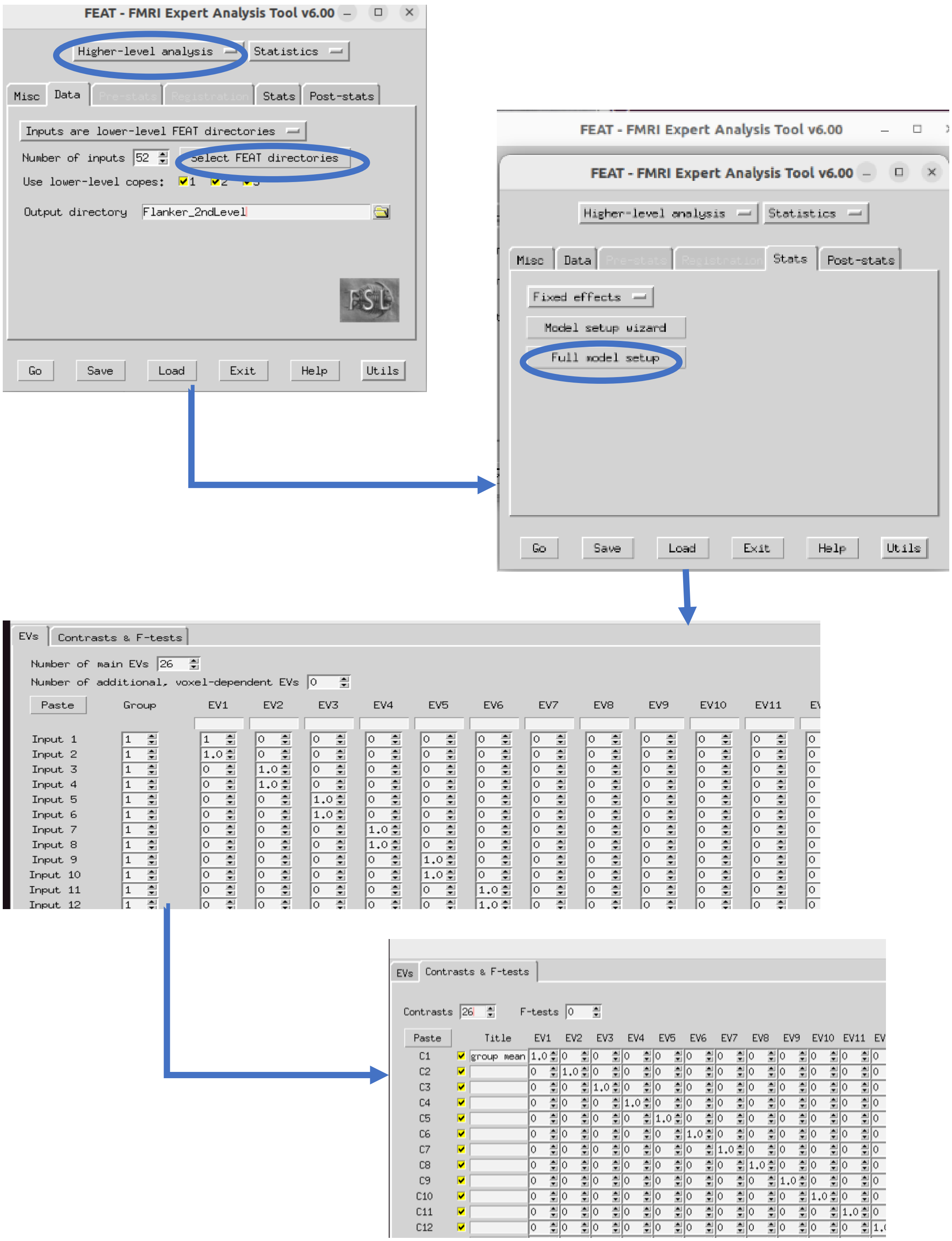
```
    sed -i "s/sub-05/${subj}/g" design1.fsf
    cp design1.fsf design2.fsf
    #using “sed” command to change run1 with run2 in
destgn2.fsf
    sed -i "s/run1/run2/g" design2.fsf
    sed -i "s/run-1/run-2/g" design2.fsf
    echo "FLA RUN 1"
    echo
    feat design1.fsf
    echo "FLA RUN 2"
    echo
    feat design2.fsf
    cd ..
done
echo
```

running the script in terminal:

```
ghofran@ghofran-VirtualBox:~/Data$ chmod +x runs.sh
ghofran@ghofran-VirtualBox:~/Data$ ./runs.sh
Start processing sub-06

FLA RUN 1

FLA RUN 2

Start processing sub-07

FLA RUN 1

FLA RUN 2

Start processing sub-08

FLA RUN 1

FLA RUN 2

Start processing sub-09

FLA RUN 1

FLA RUN 2

Start processing sub-10

FLA RUN 1
```

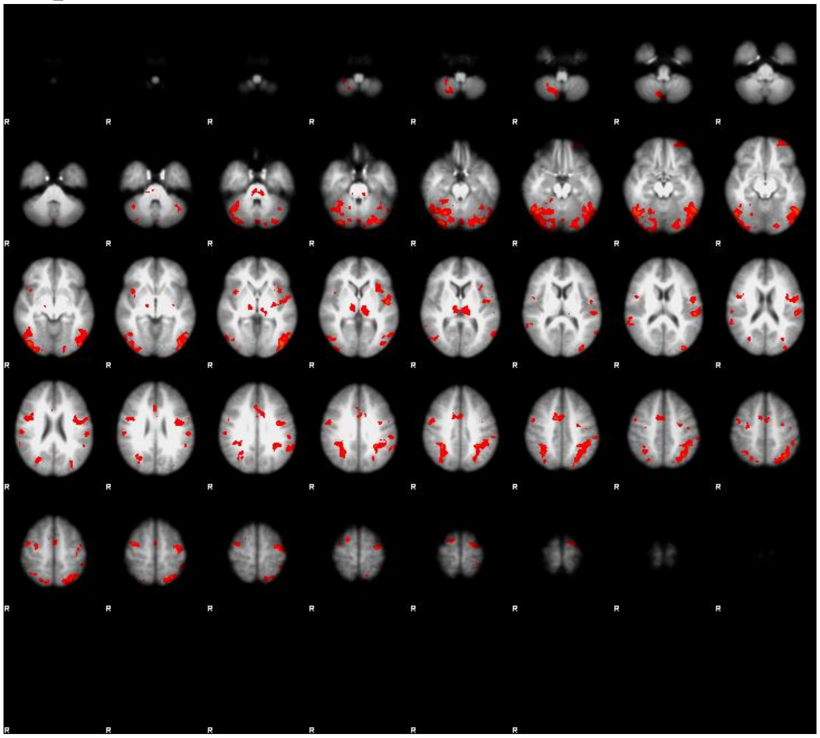
2nd level analysis

2nd level analysis is taking the average of the runs. First step is to choose the directory of the required runs.

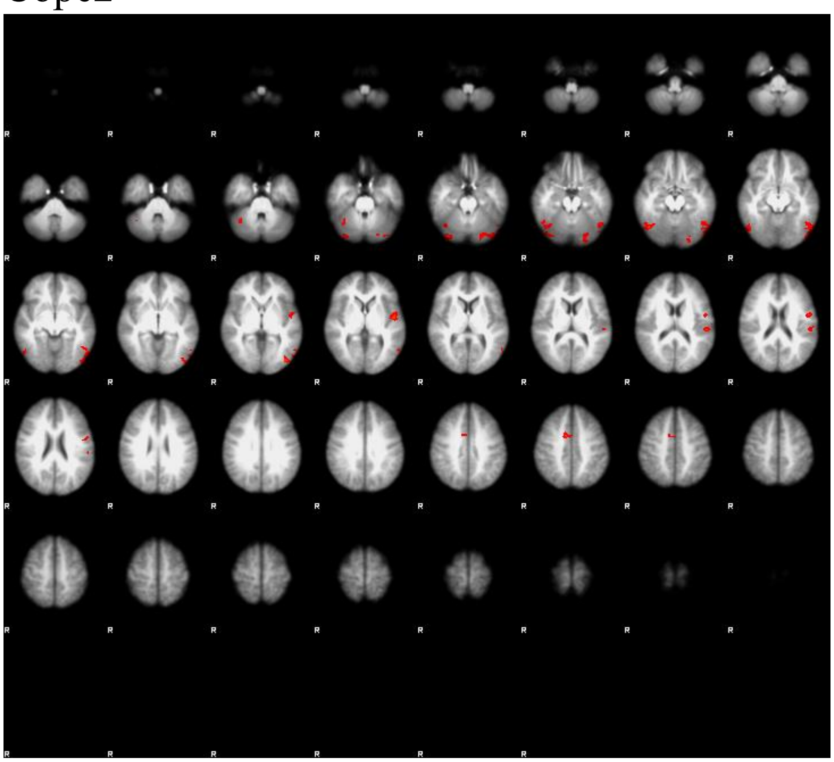


In the results marks on the ventricular indicates an error, and marks around the whole brain indicates movement.

- Cope1

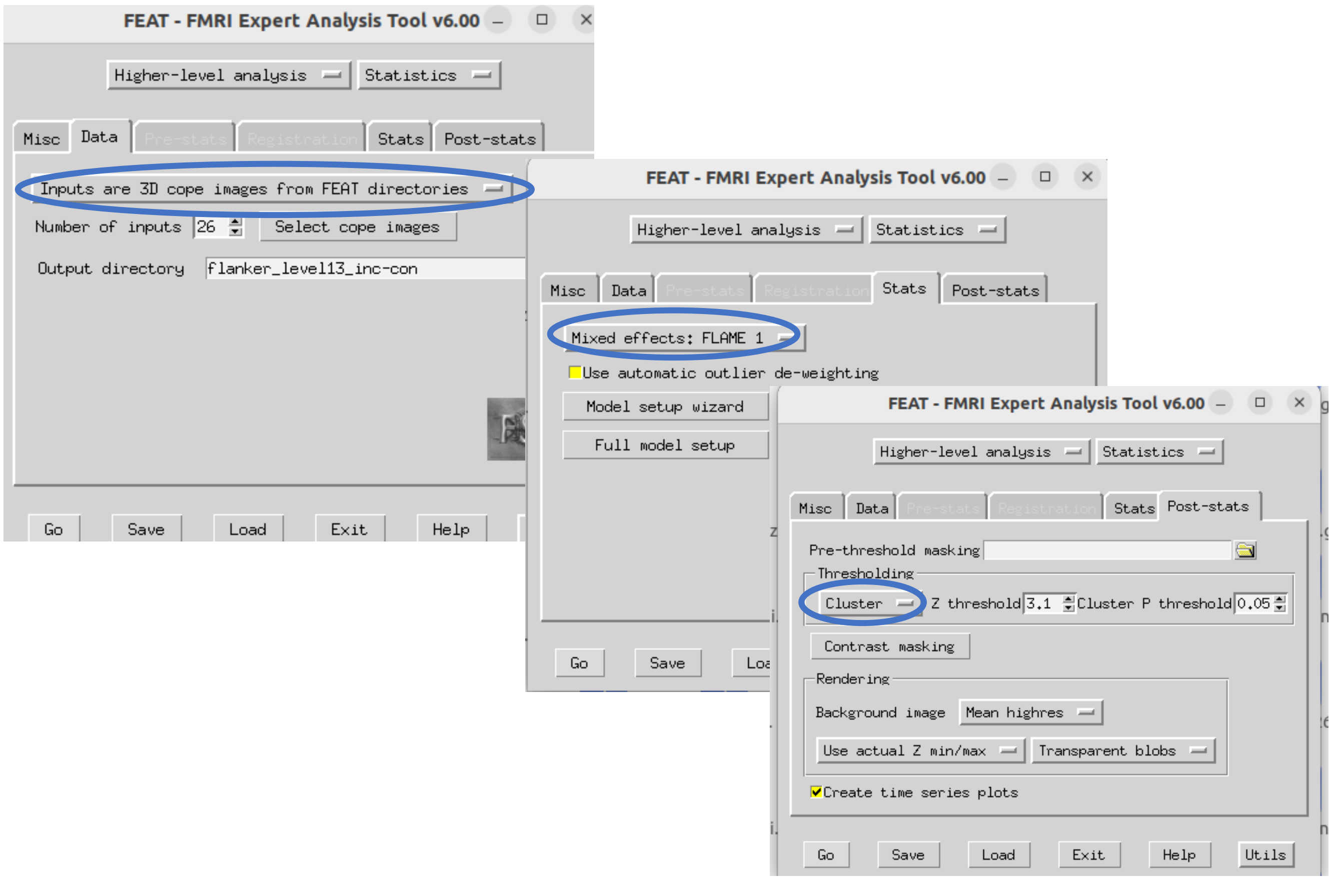


- Cope2



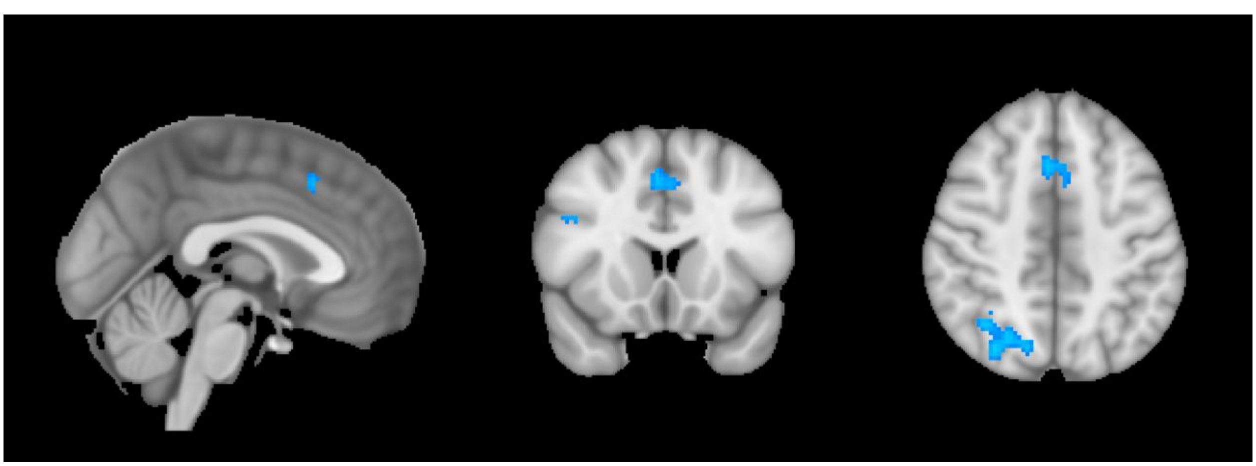
3rd level analysis

3rd level analysis basically is generalizing the samples.

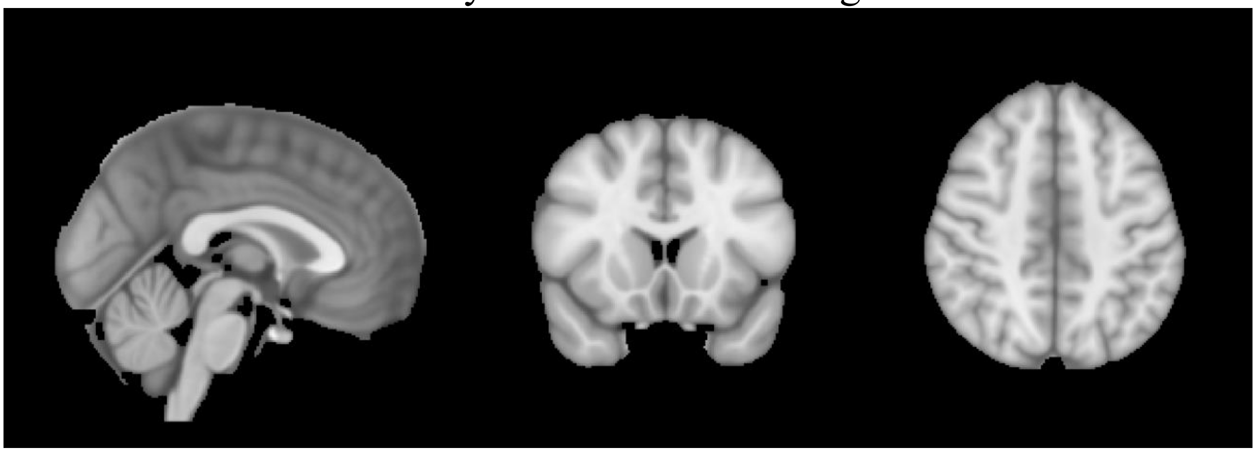


we'll try different thresholding methods with cope3 using mixed effect flame1.

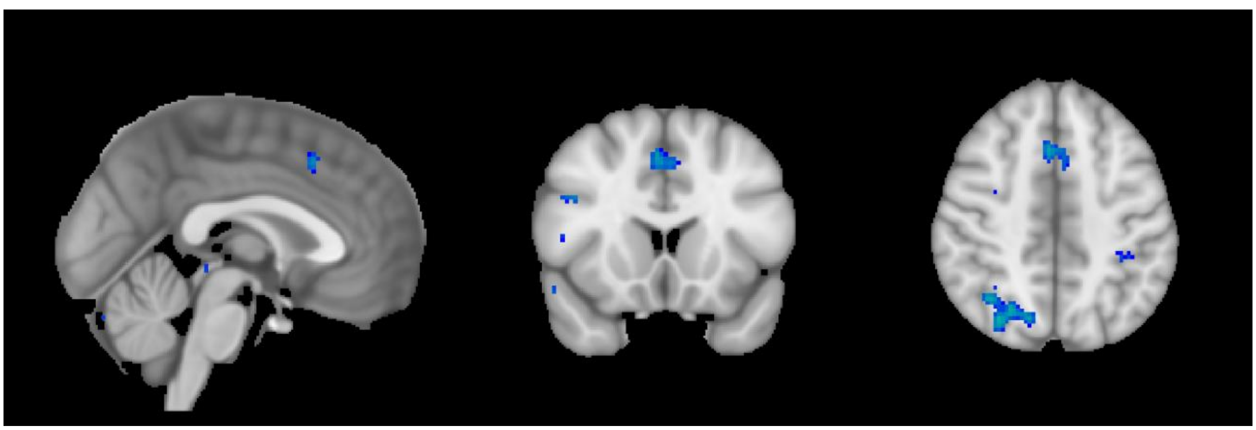
a. Mixed effect flame 1 with cluster thresholding.



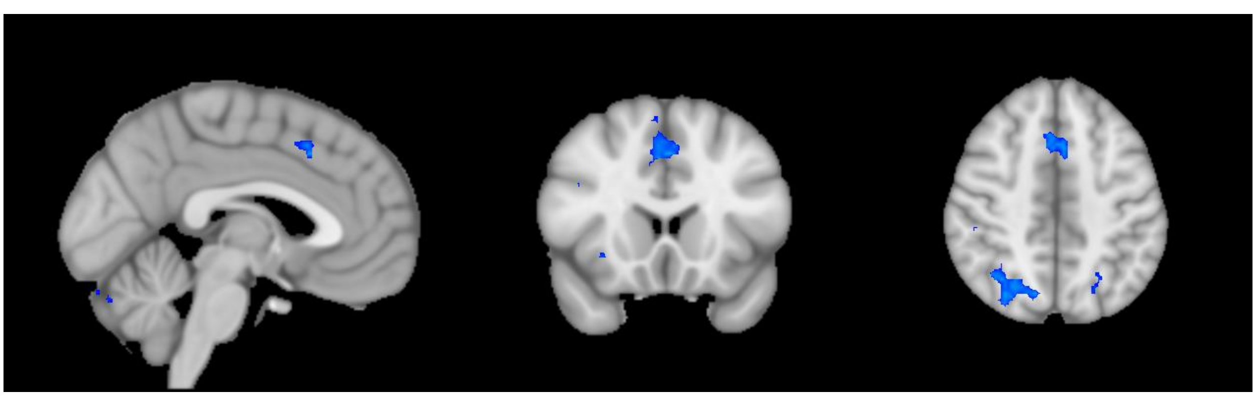
b. Mixed effect flame 1 without thresholding.
   No results showed in this part.
c. Mixed effect flame1 with voxel thresholding. Nothing is showing due to the conservativity of voxel thresholding.



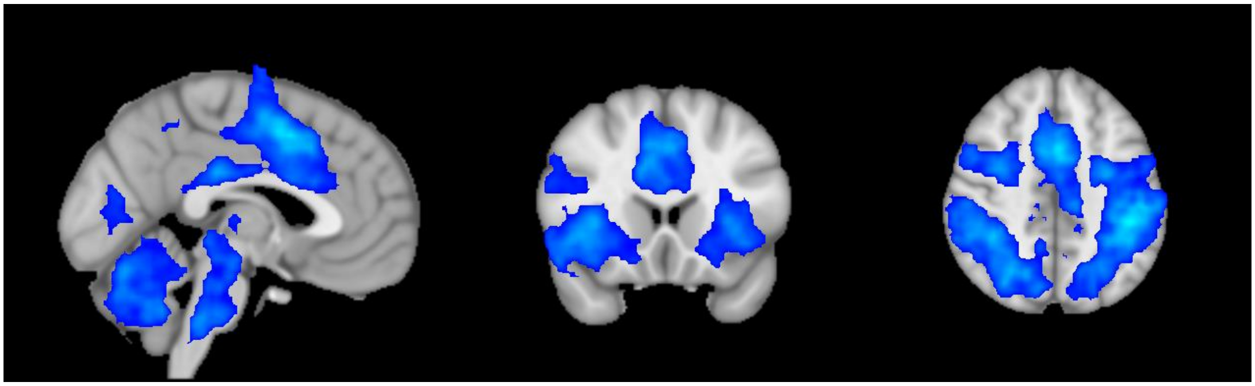
d. Mixed effect flame1 with uncorrected thresholding. Uncorrected means that p <0.001 we notice how more regions are present here unlike clustering which take only voxels grouped together.



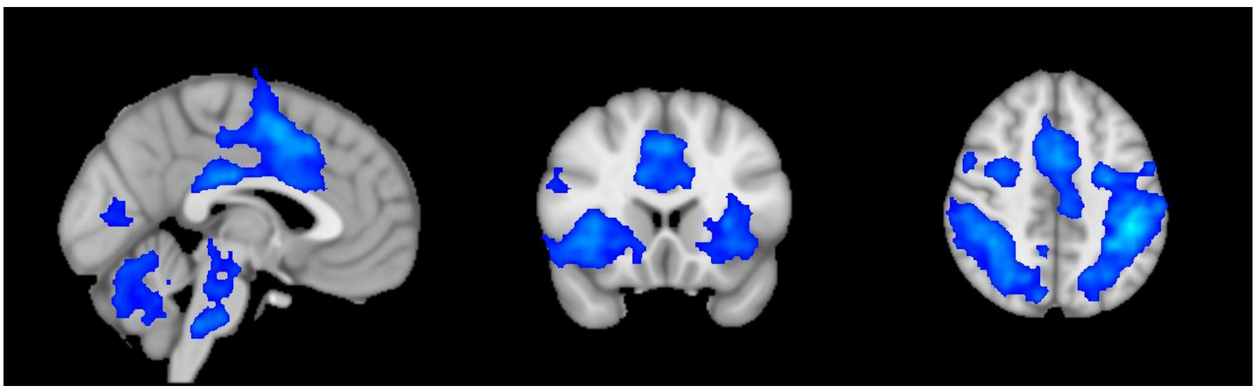
Flame1+2



Cope1 (incongruent):



Cope2 (congruent):

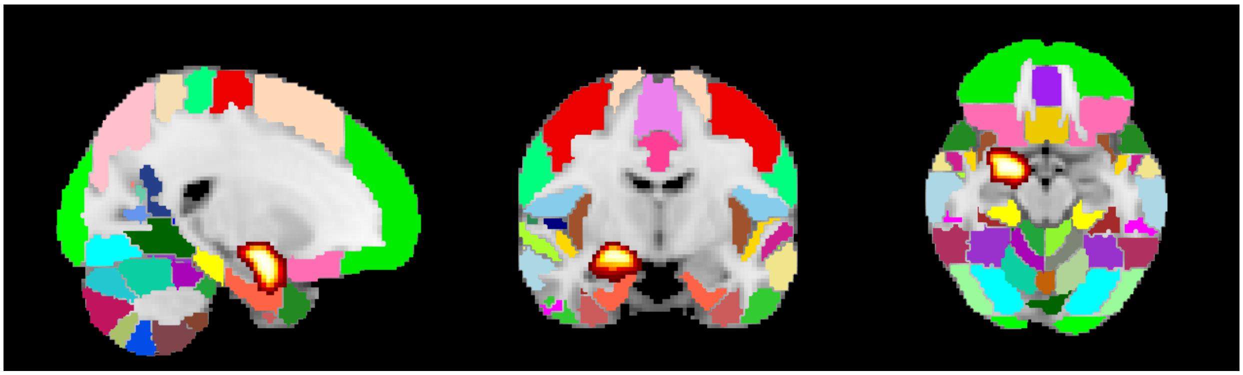


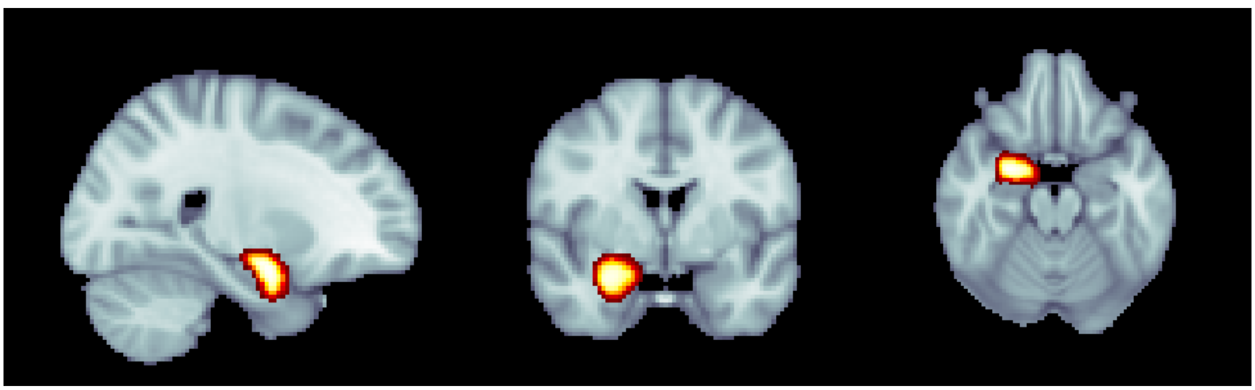
Brain regions activated during each task and their functions:

Region	Task	Function
Postcentral gyrus	Incongruent, congruent	proprioception
Paracingulate gyrus	Incongruent - congruent	Cognitive, affective regulation
Precentral gyrus	Incongruent - congruent	Control of voluntary motor movement
Middle temporal gyrus (posterior)	Incongruent, congruent	Visual perception, multimodal sensory integration.
Lateral occipital cortex (superior)	Incongruent - congruent	Object recognition
Lateral occipital cortex (inferior)	Incongruent - congruent	Object recognition
Frontal pole	Incongruent, congruent	Cognitive abilities, human behavior

Region of Interest Analysis

Now we have the brain activation regions we want to take a closer look on them so we'll apply ROI analysis.





1. Using atlas to create a mask for the right amygdala
2. Extracting data from an anatomical mask
    a. Online t-test results, using a binarized mask

```
ghofran@ghofran-VirtualBox:~/Data$ fslmeants -i allZstats.nii.gz -m Paracingulate_Gyrus.nii.gz
1.374285
0.228257
1.068700
-0.207075
-0.108233
0.209038
0.722659
0.714245
0.263621
0.039633
-0.278655
0.267740
-0.078758
-0.140070
-0.107444
-0.420694
0.196609
-0.912506
-0.634238
-0.186155
-0.021917
0.368279
1.007405
-0.371045
-0.550958
0.214812
```

```
Output
Rscript /tmp/CVWbMbJXHk.r
One Sample t-test

data:  average
t = 0.96296, df = 25, p-value = 0.3448
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.1163947  0.3208205
sample estimates:
mean of x
0.1022129
```

b. T-test results using a probabilistic mask, as we notice numbers are better when we give weights.

```
ghofran@ghofran-VirtualBox: ~/Data
ghofran@ghofran-VirtualBox:~/Data$ fslmeants -i allZstats.nii.gz -m Paracingulate_Gyrus.nii.gz -w
1.543797
0.422185
1.066061
-0.164290
0.003104
0.165445
0.865238
0.938731
0.266401
0.027486
-0.307196
0.413430
-0.149076
-0.352902
-0.086373
-0.473124
0.265195
-1.074649
-0.530052
-0.152277
0.037431
0.415161
1.065170
-0.476600
-0.597434
0.155895
```

```
Output
Rscript /tmp/CVWbMbJXHk.r
One Sample t-test

data:  average
t = 1.0668, df = 25, p-value = 0.2963
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.1176478  0.3704752
sample estimates:
mean of x
0.1264137
```

c. Applying the process on cope1 but using the right amygdala mask we extracted earlier.

```
ghofran@ghofran-VirtualBox: ~/Data
ghofran@ghofran-VirtualBox:~/Data$ fslmeants -i allZstats1.nii.gz -m Right-Amygdala.nii.gz
0.550887
0.863091
-0.352744
1.261628
0.625165
-0.275202
0.312775
0.352634
0.422126
0.868695
0.031623
0.418529
0.708788
-0.120761
1.762946
-0.005751
0.944165
-1.572193
0.721885
0.655587
1.981811
-0.529280
0.623320
0.640953
-0.291614
0.244498
```

```
Output
Rscript /tmp/CVWbMbJXHk.r
One Sample t-test

data:  average
t = 2.9343, df = 25, p-value = 0.007066
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 0.124335 0.709785
sample estimates:
mean of x
  0.41706
```

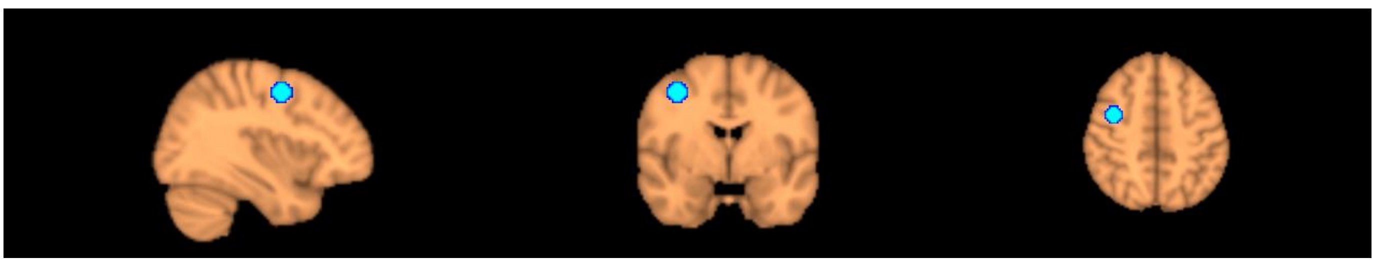
R code used:

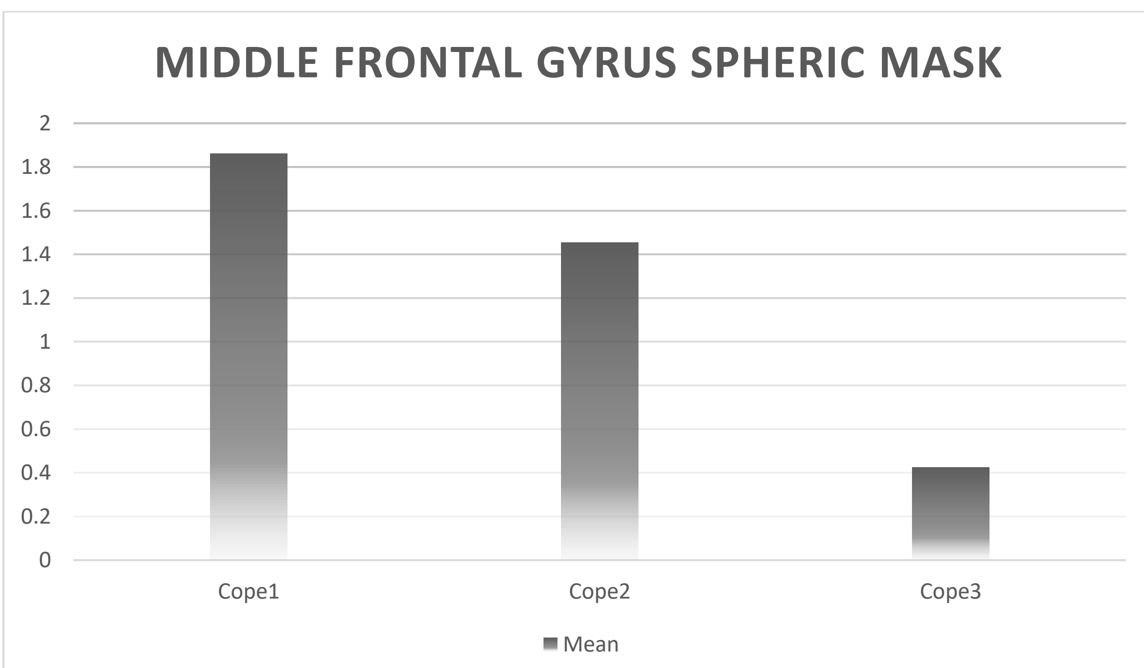
```r
average <- c(
    values
)
t.test(average)
```

3. Extracting data from a sphere

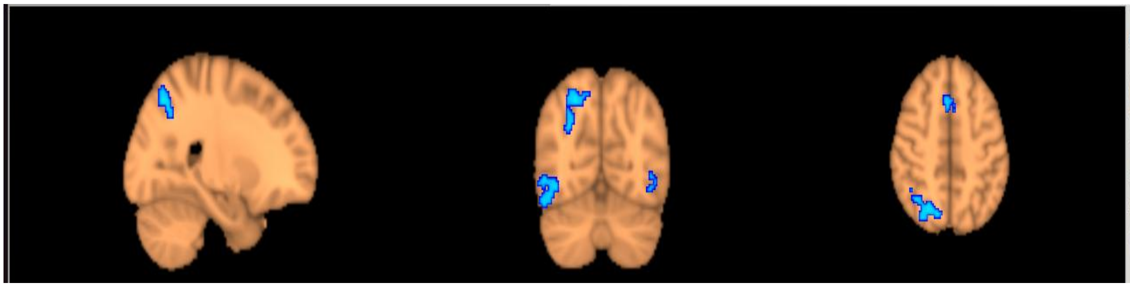
- Sphere mask with 7mm radius and MNI coordinates (37, -2, 48) this corresponds to the following voxel location (26, 62, 60) in the middle frontal gyrus.
  By running these commands respectively in the terminal we'll get a group of 26 numbers, which we we'll take the average of them and draw our bar chart.

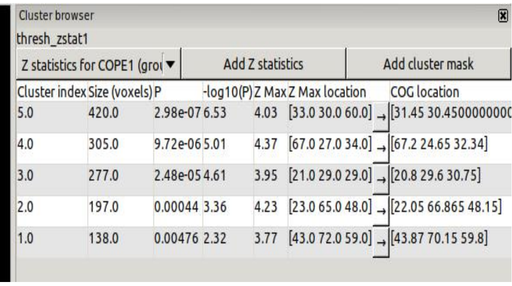
```
ghofran@ghofran-VirtualBox:~/Data$ fslmaths $FSLDIR/data/standard/MNI152_T1_2mm.nii.gz -mul 0 -add 1 -roi 26 1 62 1 60 1 0 1 ghofran_ROI_dmMFG_37_2_48.nii.gz -odt float
ghofran@ghofran-VirtualBox:~/Data$ fslmaths ghofran_ROI_dmMFG_37_2_48.nii.gz -kernel sphere 7 -fmean ghofran_Sphere_dmMFG_37_2_48.nii.gz -odt float
ghofran@ghofran-VirtualBox:~/Data$ fslmaths ghofran_Sphere_dmMFG_37_2_48.nii.gz -bin ghofran_Sphere_bin_dmMFG_37_2_48.nii.gz
ghofran@ghofran-VirtualBox:~/Data$ fslmeants -i allZstats2.nii.gz -m ghofran_Sphere_bin_dmMFG_37_2_48.nii.gz
```





- In cope3 we have 5 regions we'll apply spherical mask on the three copes with each one of them with 5mm radius.





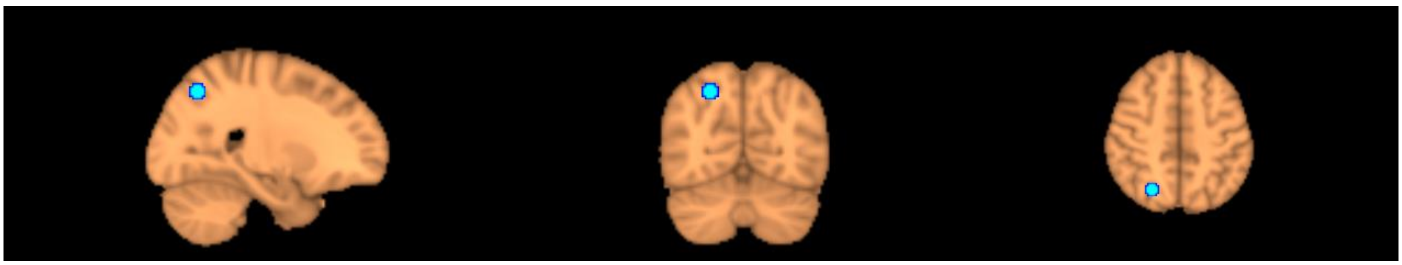
Cluster browser

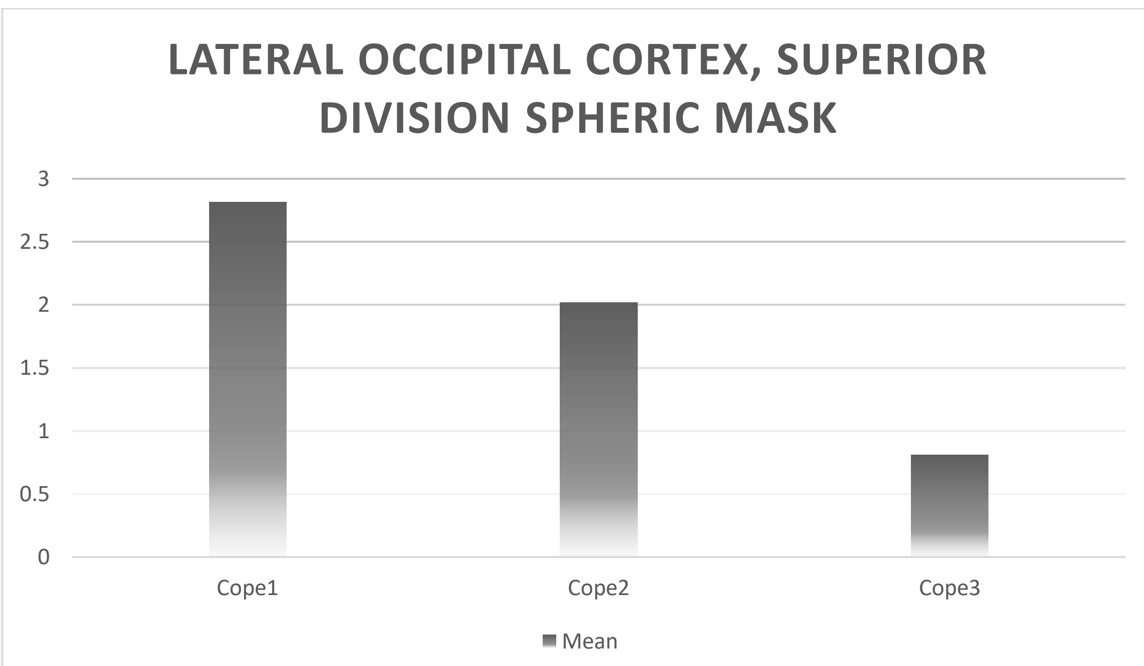
thresh_zstat1

Z statistics for COPE1 (grou | Add Z statistics | Add cluster mask

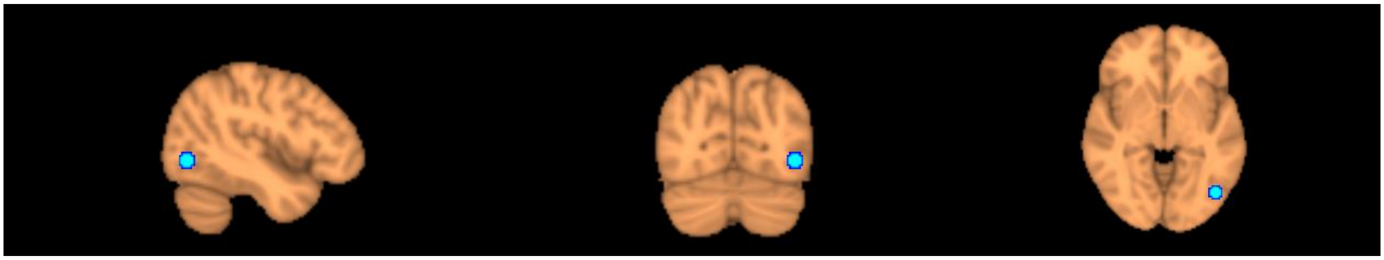
Cluster index	Size (voxels)	P	-log10(P)	Z Max	Z Max location	COG location
5.0	420.0	2.98e-07	6.53	4.03	[33.0 30.0 60.0]	[31.45 30.450000000
4.0	305.0	9.72e-06	5.01	4.37	[67.0 27.0 34.0]	[67.2 24.65 32.34]
3.0	277.0	2.48e-05	4.61	3.95	[21.0 29.0 29.0]	[20.8 29.6 30.75]
2.0	197.0	0.00044	3.36	4.23	[23.0 65.0 48.0]	[22.05 66.865 48.15]
1.0	138.0	0.00476	2.32	3.77	[43.0 72.0 59.0]	[43.87 70.15 59.8]

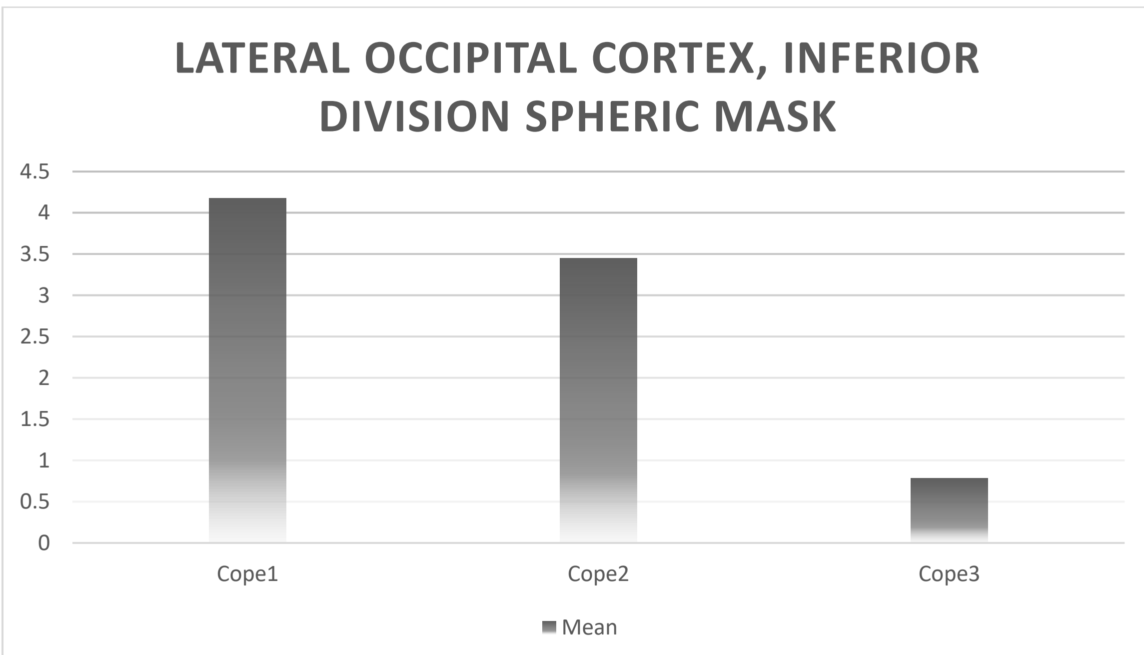
a. First region with the three copes (lateral occipital cortex, superior division):



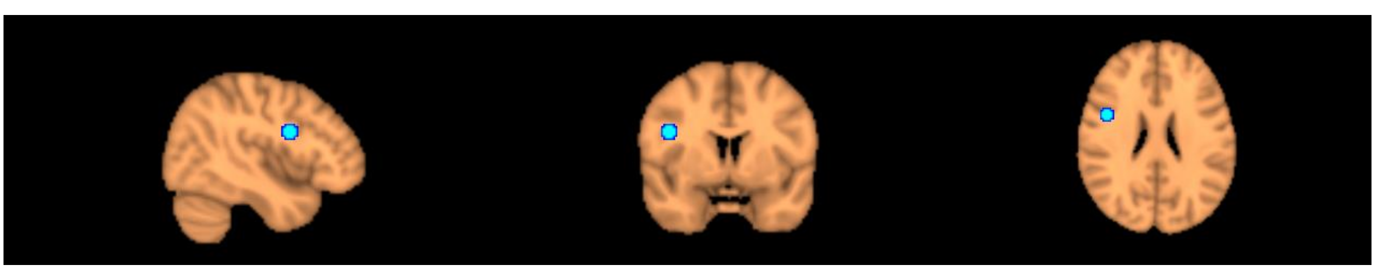


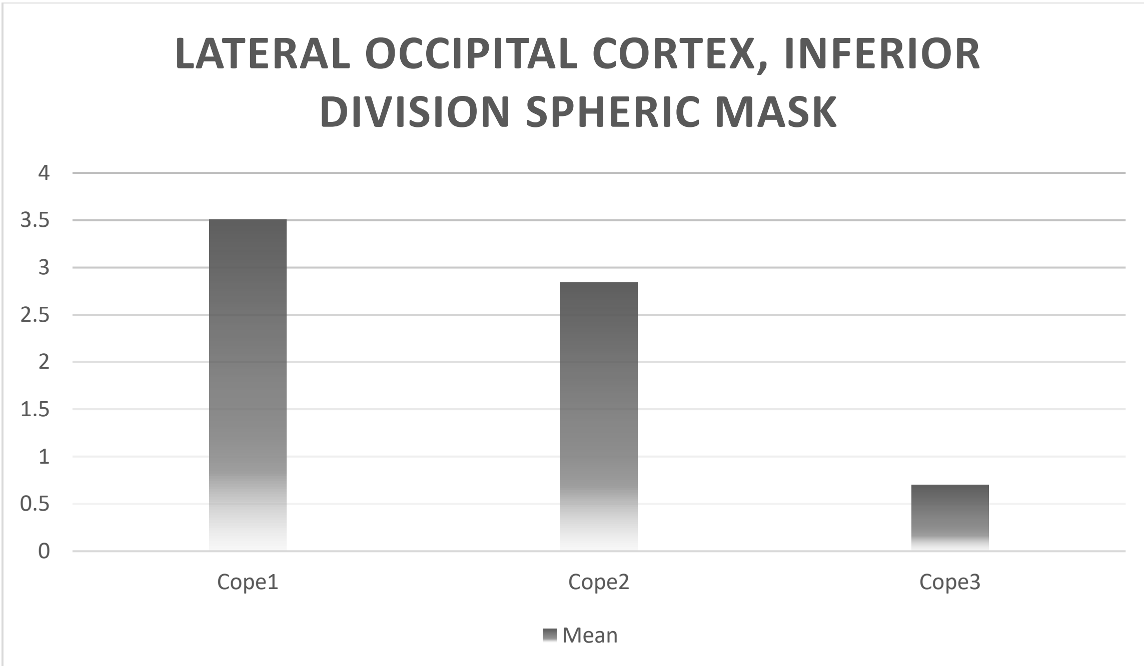
b. Second region with the three copes (lateral occipital cortex, inferior division):



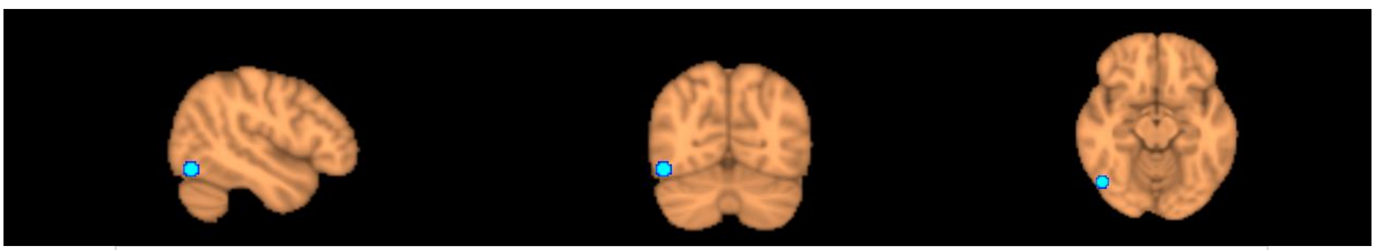


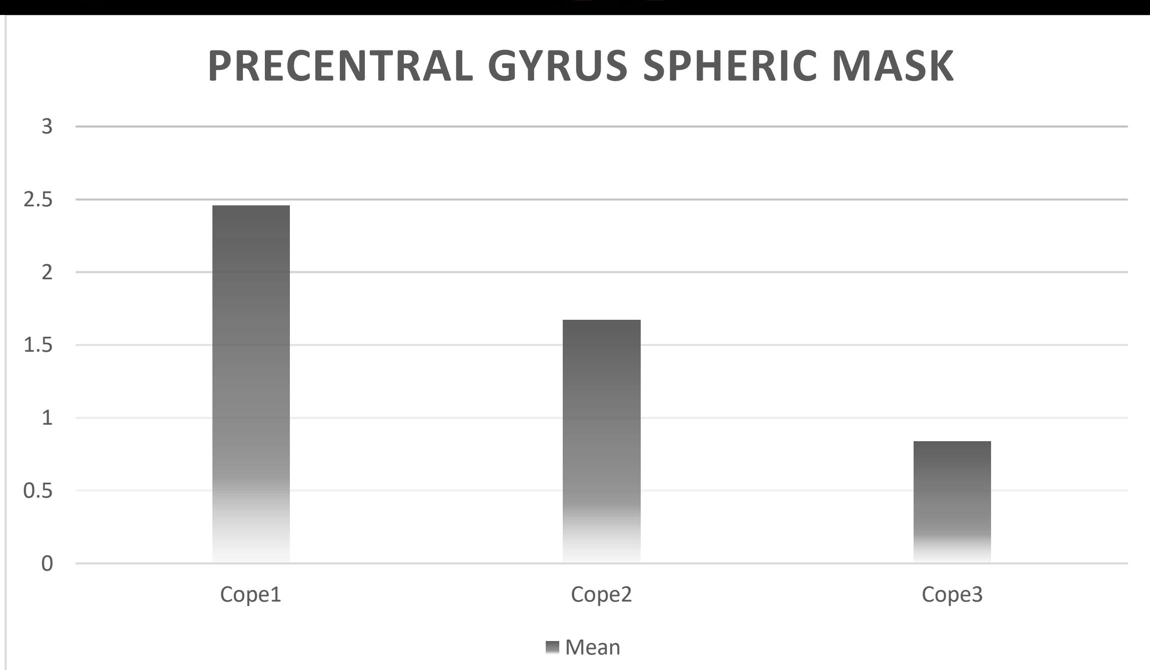
c. Third region with the three copes (lateral occipital cortex, inferior division but different coordinates):





d. Fourth region with the three copes (precentral gyrus):





e. Fifth region with the three copes (paracingulate gyrus):