Flanker Dataset

Report1

Under supervision of:

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by:

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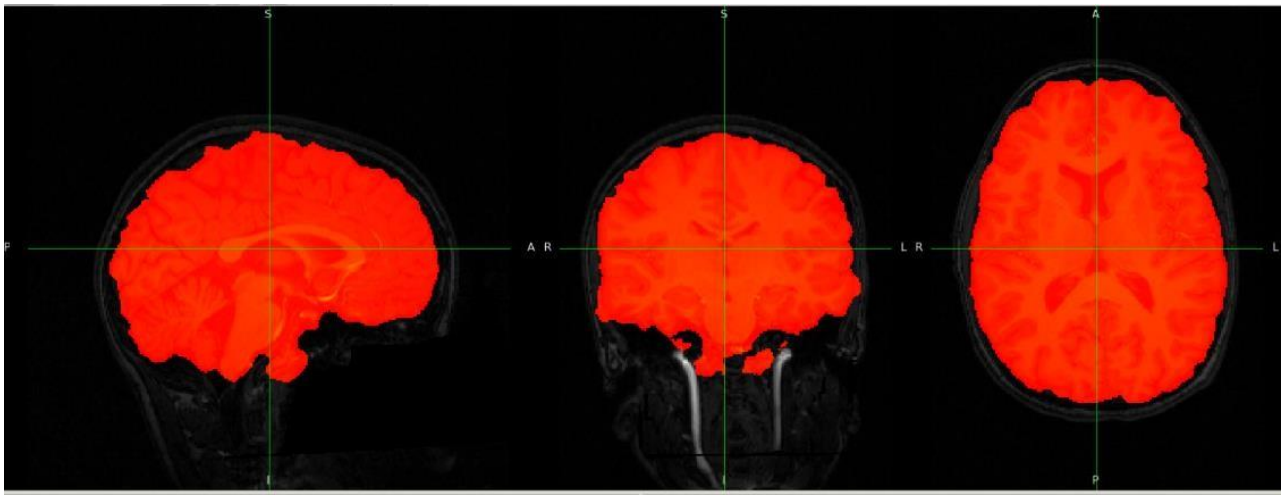
Table of content:

1)quality control of all subjects:

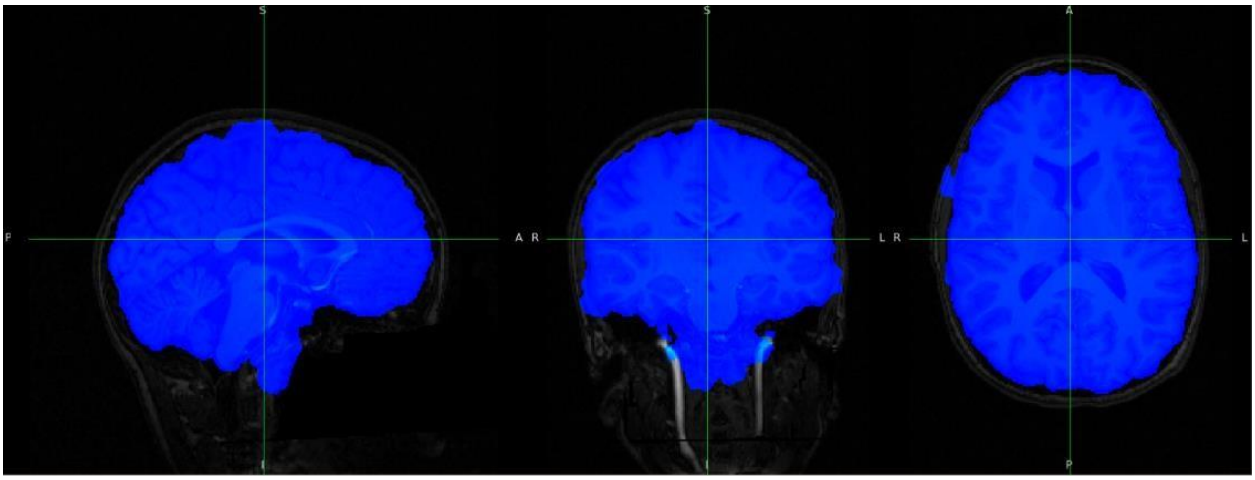
	Quality Control			Fraction intensity
subjects	T1(contrast)	Functional (motion artifacts)		suitable threshold
		Run1	Run2	
Sub-01	good	no motion	no motion	0,3
Sub-02	good	no motion	no motion	0,2
Sub-03	good	exist	exist	0,2
Sub-04	good	no motion	no motion	0,3
Sub-05	good	exist	exist	0,3
Sub-06	good	no motion	exist	
Sub-07	good	no motion	no motion	
Sub-08	good	no motion	no motion	
Sub-09	good	exist	exist	0,2
Sub-10	good	no motion	no motion	
Sub-11	good	no motion	exist	
Sub-12	good	no motion	no motion	
Sub-13	good	no motion	no motion	
Sub-14	bad	high motion	high motion	
Sub-15	good	exist	exist	
Sub-16	good	exist	exist	
Sub-17	bad	high motion	high motion	
Sub-18	good	exist	exist	
Sub-19	good	no motion	no motion	
Sub-20	bad	high motion	high motion	
Sub-21	good	exist	exist	
Sub-22	good	exist	exist	
Sub-23	good	good	good	
Sub-24	good	no motion	no motion	
Sub-25	bad	high motion	high motion	
Sub-26	good	no motion	no motion	

2) First Level Analysis:

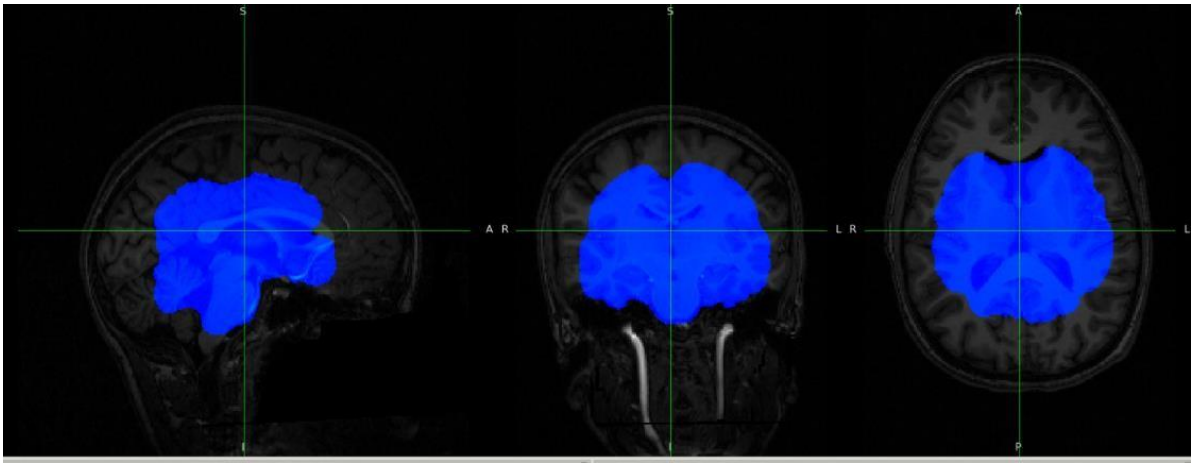
First, I will applay skull stripping on subject 1 with suitable threshold=0.3 so the output will be:



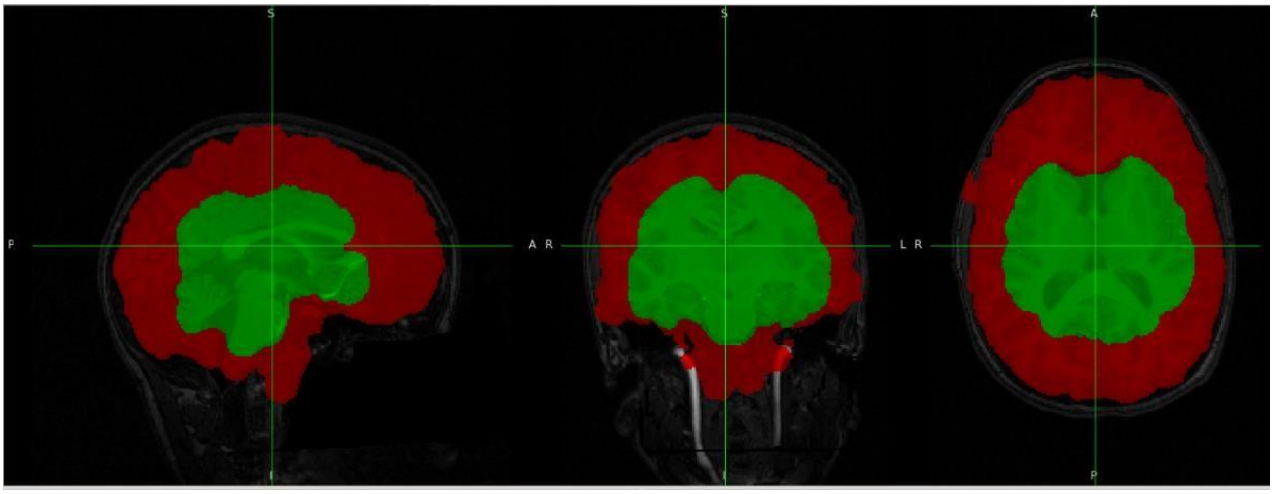
Exercise on brain extraction: I will do skull stripping with 0.1 and 0.9 fractional intensity to see what will happen, so by seeing the result we notice that when fractional intensity decrease the large volume of brain extracted well so 0.1 is better than 0.9 but it's cost increase due to computational process. **output for 0.1 threshold:**



output for 0.9 threshold:

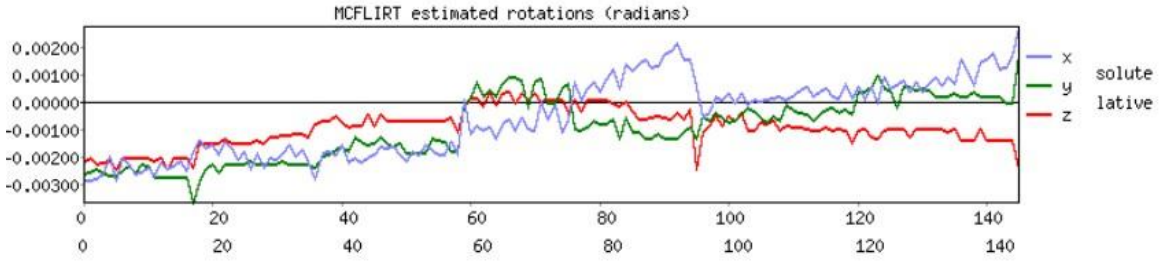


2)the mixed image with 0.1 and 0.9:

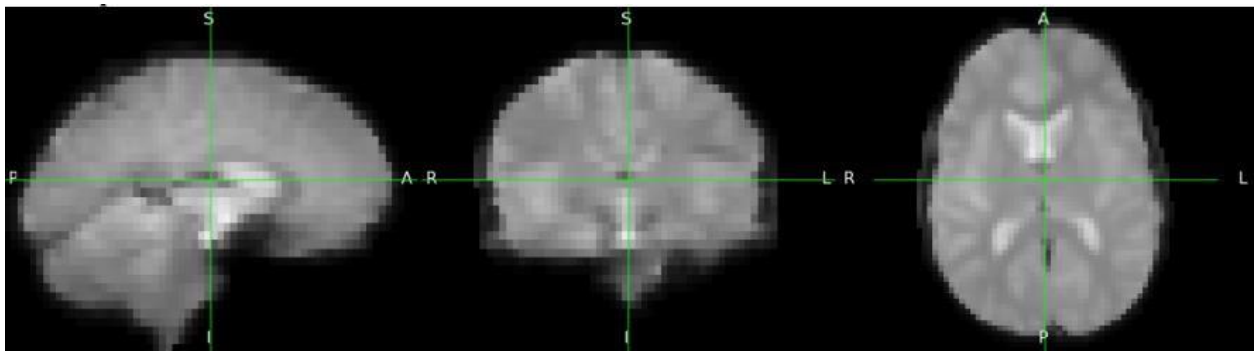


Secondly , I will apply motion correction on this subject:

MCFLIRT Motion correction

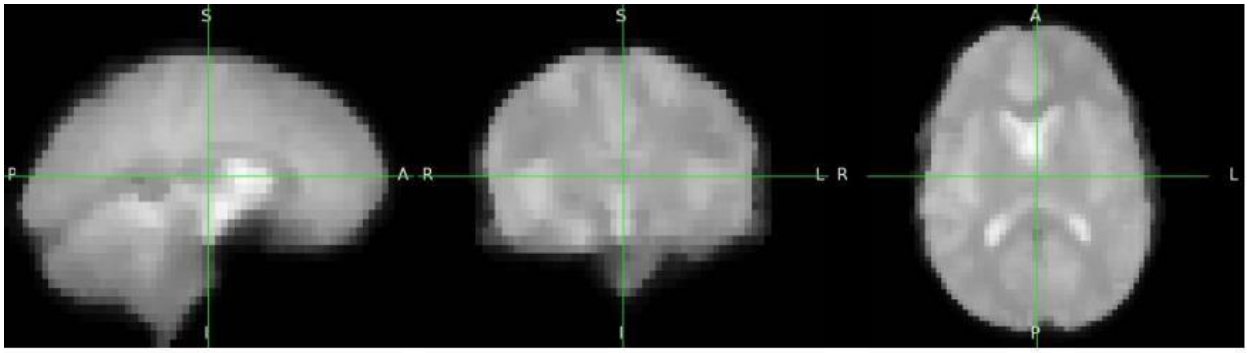


Then I will apply Smoothing: using 5mm kernel. The smoothing kernel will average the signal intensity of each voxel with its neighboring voxels within a 5mm radius. This help me to reduce noise of the run1



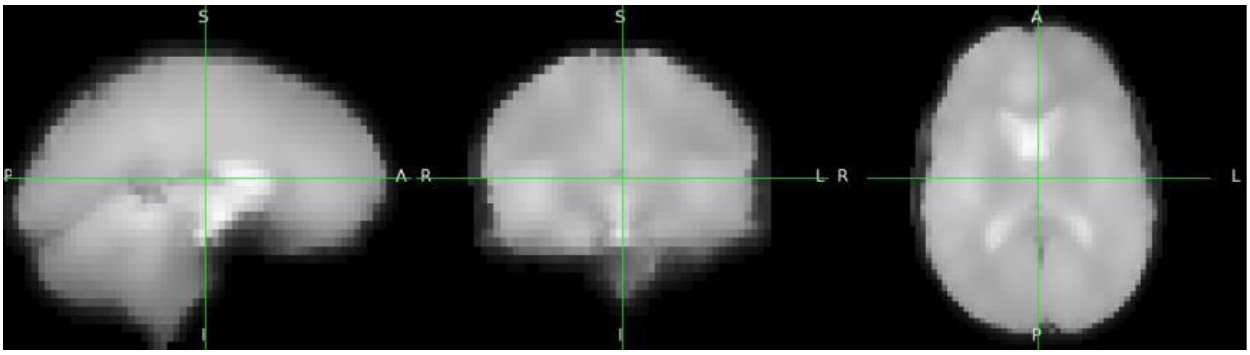
Exercice on smoothing:

1)in case of using kernel =3mm : - The images will appear slightly smoother compared to the original data. But some details of image will remove as well as noise **the output is**



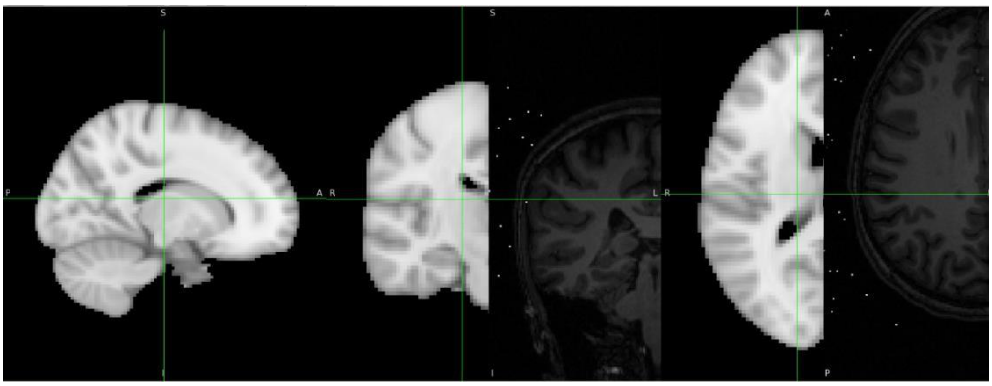
2) in case using kernel = 12mm: - The images will appear significantly smoother compared to both the original data and the 3mm smoothed images

The output is

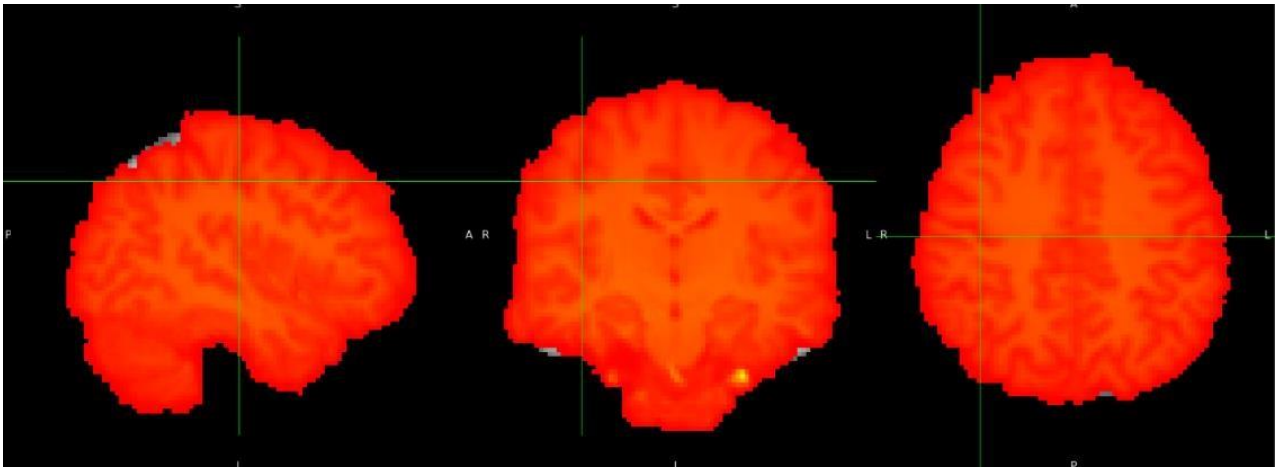


Finally I will do **registration and normalization:**

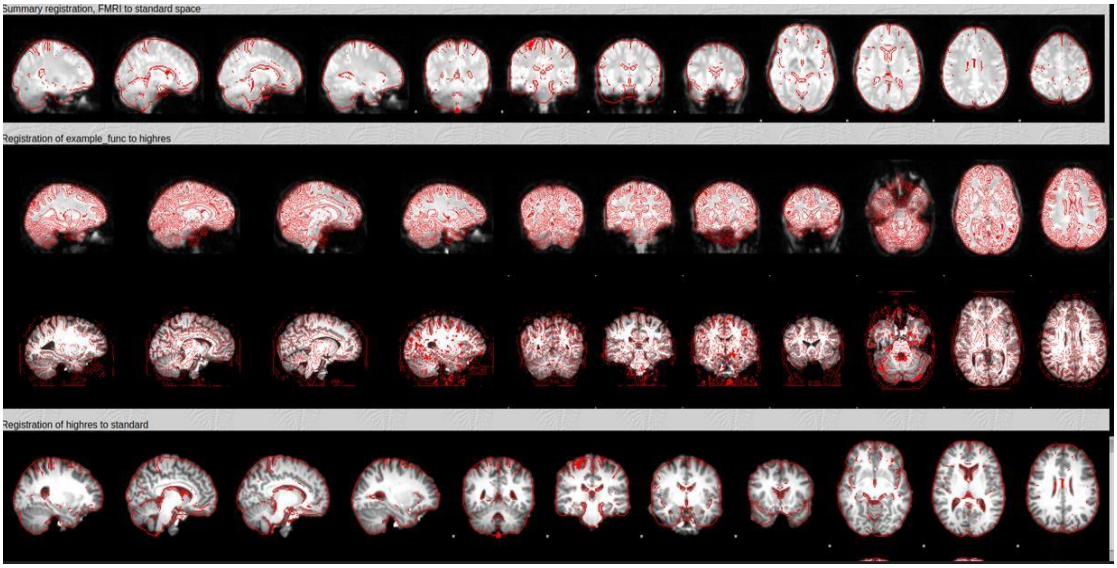
This image before registration:

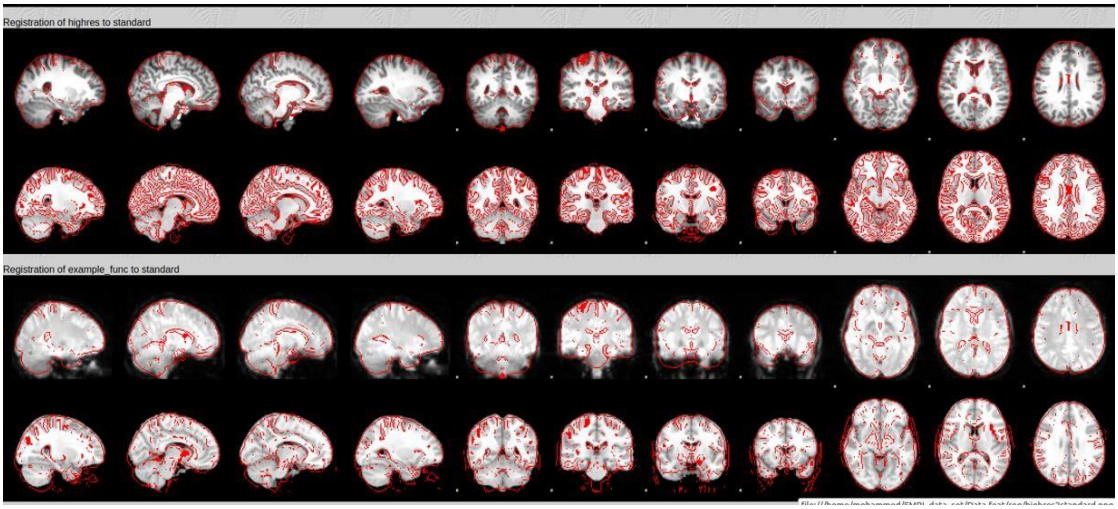


This image after registration:



Here is the result of registration and normalization:





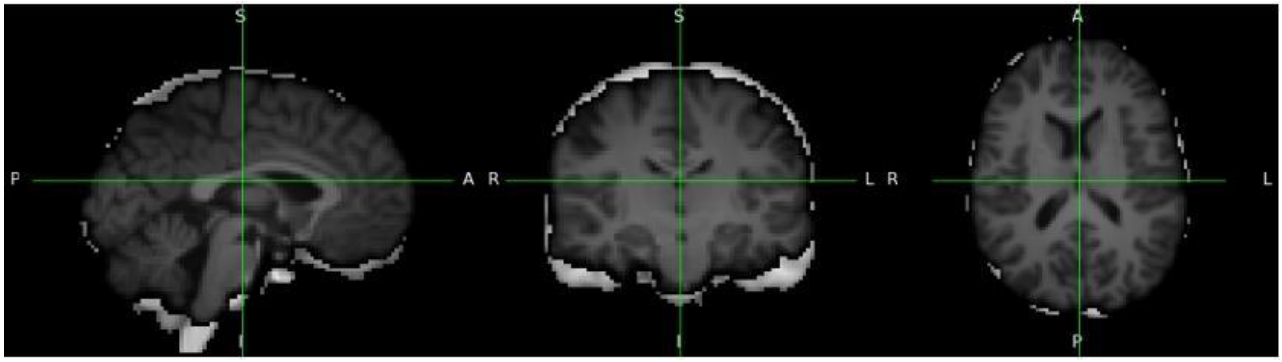
3) **Exercise for registration and normalization:**

1)When we runn the preprocessing with 3DOF for registration and normalization instead of 12DOF: The output will surely differ from the preprocessing in terms of the alignment and spatial normalization of the functional data .

1. 3DOF:

- The normalization step will transform the functional data to match the overall size and position of the MNI template and registration will primarily correct for translations in the functional data
- The resulting output will have limited capacity to account for local anatomical deformations

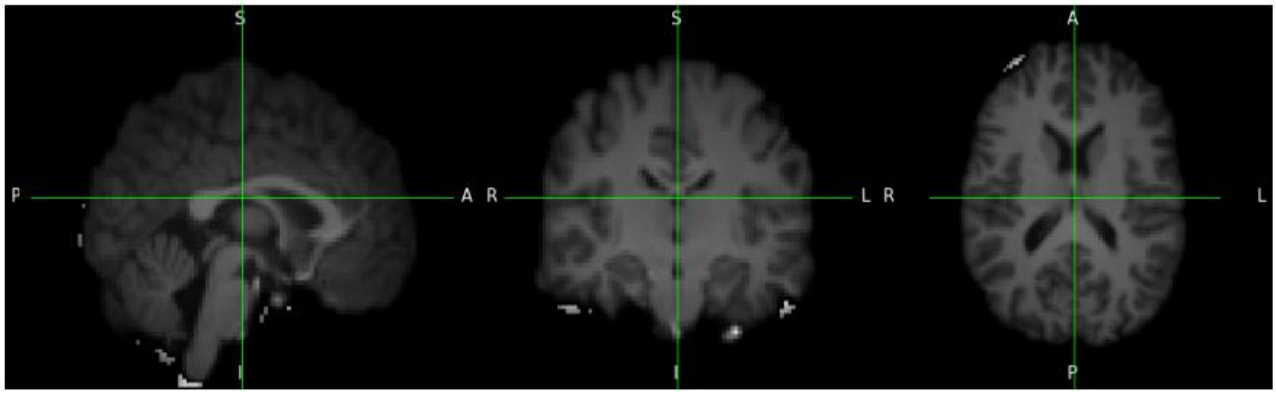
The visualization of highers2standard image(the black one) using 3DOFs on MNI template:



2. 12DOF:

- The registration will include additional parameters to account for shearing and nonlinear deformations (scaling and rotations).
- The normalization step will perform a more detailed mapping of the functional data to the MNI template, considering local anatomical variations and deformations.
- The resulting output will have a higher level of spatial alignment and better account for subtle anatomical differences across individuals

The visualization of highers2standard image(the black one) using 12DOFs on MNI template:

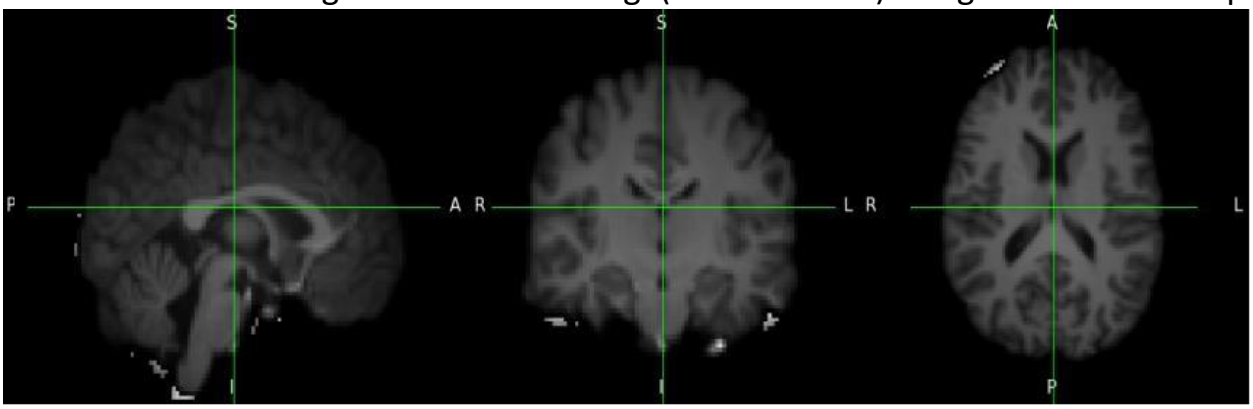


2) Utilizing BBR (Boundary-Based Registration) for preprocessing offers several advantages over traditional 12DOF registration methods:

- Enhanced precision in alignment: BBR leverages boundary information, resulting in more accurate alignment between high-resolution anatomical and functional data.
- Improved capture of local anatomical variations and deformations: By considering boundary features, BBR can better accommodate subtle anatomical differences, leading to more accurate registration results.

- Longer processing time: Due to its more complex optimization process, BBR typically requires more time to complete compared to 12DOF registration methods.

The visualization of highers2standard image(the black one) using BBR on MNI template:



Neuroanatomy

What is the brain?

1. Its an essential organ. All of your emotions, sensations, aspirations and everything that makes you uniquely individual come from your brain.

What is the brain's function?

It receives information from your five senses: sight, smell, sound, touch and taste. it also receives inputs including touch, vibration, pain and temperature from the rest of your body as well as autonomic (involuntary) inputs from your organs. It interprets this information so you can understand and associate meaning with what goes on around you.

Your brain enables:

- Thoughts and decisions.
- Memories and emotions.
- Movements (motor function), balance and coordination.
- Perception of various sensations including pain.
- Automatic behavior such as breathing, heart rate, sleep and temperature control.
- Regulation of organ function.
- Speech and language functions.

What are the main parts of the brain?

The brain structure is complex. It has three main sections:

- **Cerebrum:** the cerebrum interprets sights, sounds and touches. It also regulates emotions, reasoning and learning. It also makes up about 80% of your brain.
- **Cerebellum:** Your cerebellum maintains your balance, posture, coordination and fine motor skills. It's located in the back of your brain.

- **Brainstem:** Your brainstem regulates many automatic body functions. You don't consciously control these functions, like your heart rate, breathing, sleep and wake cycles, and swallowing. brainstem is in the lower part of the brain.

  It connects the rest of brain to spinal cord.

1) **Cerebrum**

What is the cerebrum?

it handles a wide range of responsibilities. Located at the front and top of the skull,

it gets its name from the Latin word meaning "brain."

cerebrum is instrumental in everything you do in day-to-day life, ranging from thoughts to actions. In essence, it's responsible for the brain functions that allow us to interact with our environment and make us who we are.

Function

What does the cerebrum do?

It handles much of your brain's "conscious" actions. That means it's responsible for elements that require thinking, including:

- **Your five senses**: the cerebrum manages and processes everything which man senses take in. That includes sight, sound, smell, taste and touch.
- **Language**: Various parts of your cerebrum control your ability to read, write and speak.
- **Working memory**: This is a type of short-term memory. An example of working memory is when you remind yourself to pick up something from the grocery store.
- **Behavior and personality**: Part of your cerebrum is your frontal lobe, which manages your personality and behavior. It's the part of your brain that acts as a filter to stop you from doing or saying things you might later regret.
- **Movement**: Certain areas of your cerebrum send signals that tell the muscles what to do when you need to use them.
- **Learning, logic and reasoning**: Different areas of your cerebrum work together when you need to learn a new skill, make a plan of action or puzzle out a problem

Lobes

The outer surface of your cerebrum, your cerebral cortex, is mostly smooth but has many wrinkles, It's divided lengthwise into two halves, the left and right hemisphere, by a deep groove. The two hemispheres connect using a structure called the corpus callosum a collection of nerve tissue that transmits signals from one side of your brain to the other.

The two hemispheres of your brain also have five main lobes each:

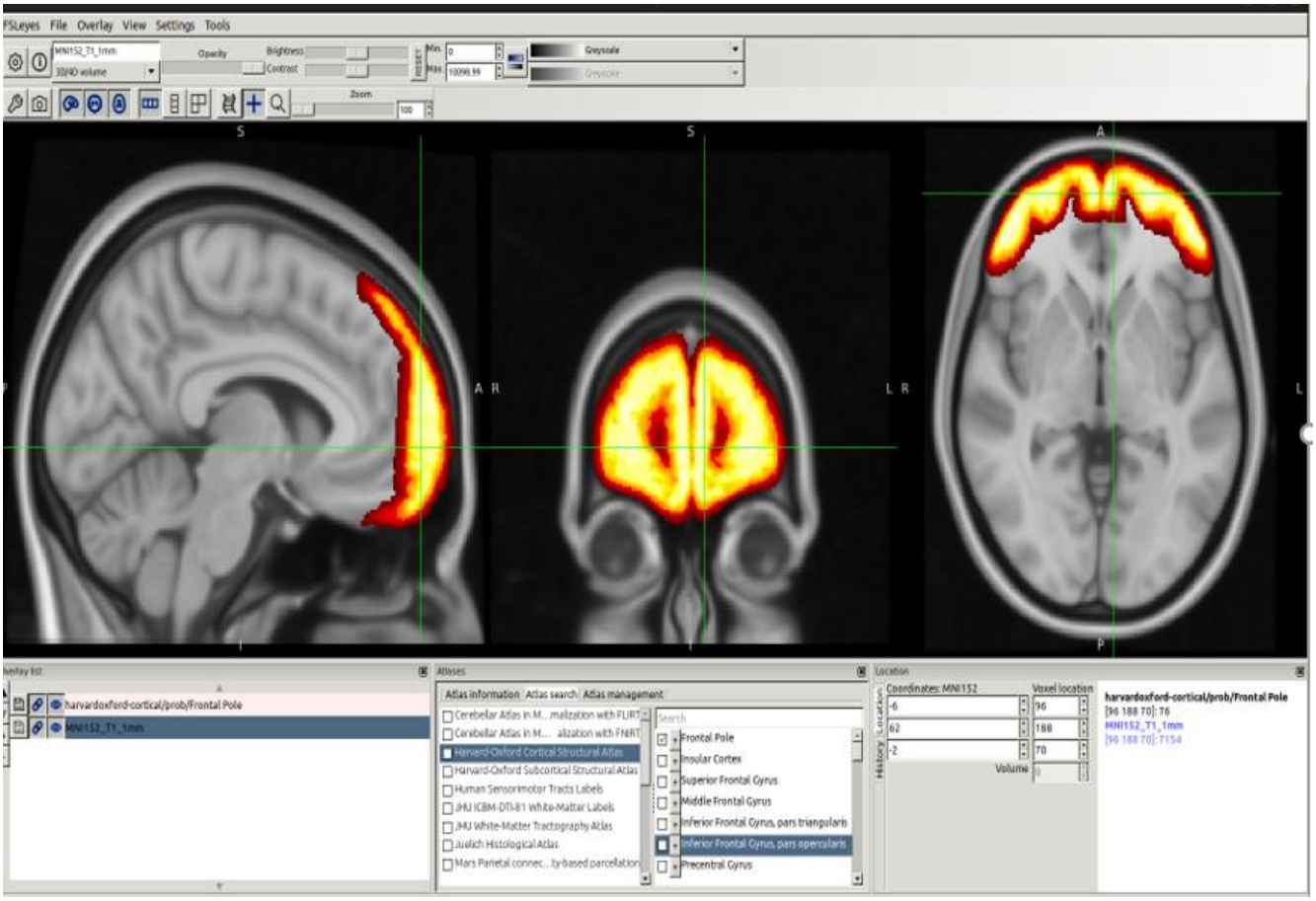
- **Frontal** (at the front of your head). This lobe handles things like attention, behavior control (your sense of what's appropriate and what's not), the ability to speak and certain types of muscle movements.
- **Parietal** (at the top of your head). This area handles touch, temperature and pain signals. It also helps with how you see the world around you, especially judging distance from and the size of objects. It also plays a role in processing sound, languages you speak, your ability to use numbers and count, and how you organize information and make decisions.
- **Temporal** (at the side of your head). This area helps you understand language when other people are speaking. It also helps you recognize people and objects. This part also helps you connect emotions with memories.
- **Insular** (deep inside of your brain, underneath your frontal, parietal and temporal lobes). This part of your brain handles taste senses. It may also help process certain types of emotions like compassion and empathy.
- **Occipital** (at the back of your head). This lobe manages much of your eyes' sensory input, including the ability to see movement and colors

Here is some cerebrum images with its lobes:

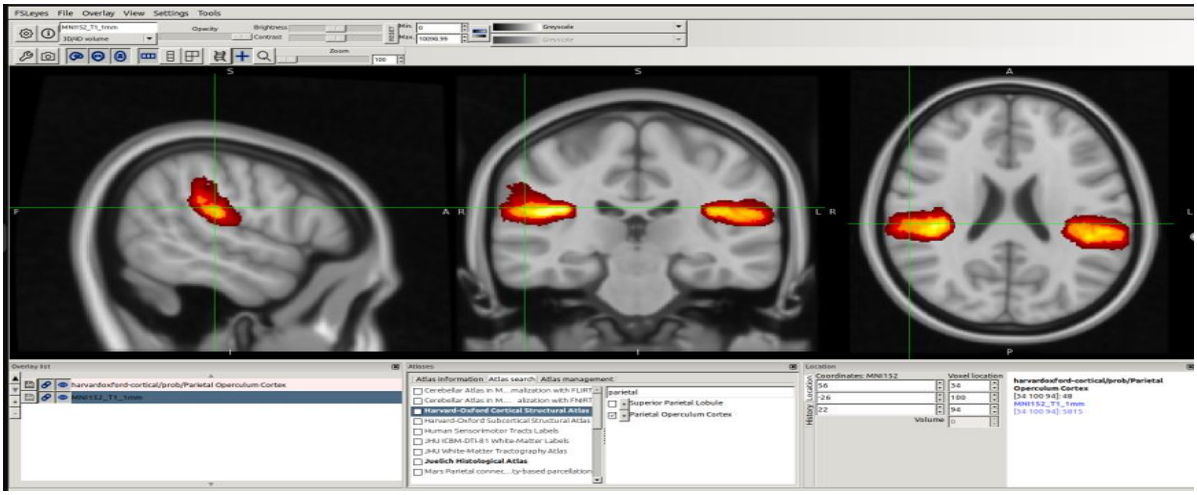
I use stander name MNI152_T1_1mm and atlases Harvard-Oxford in capture image.

cerebrum image:

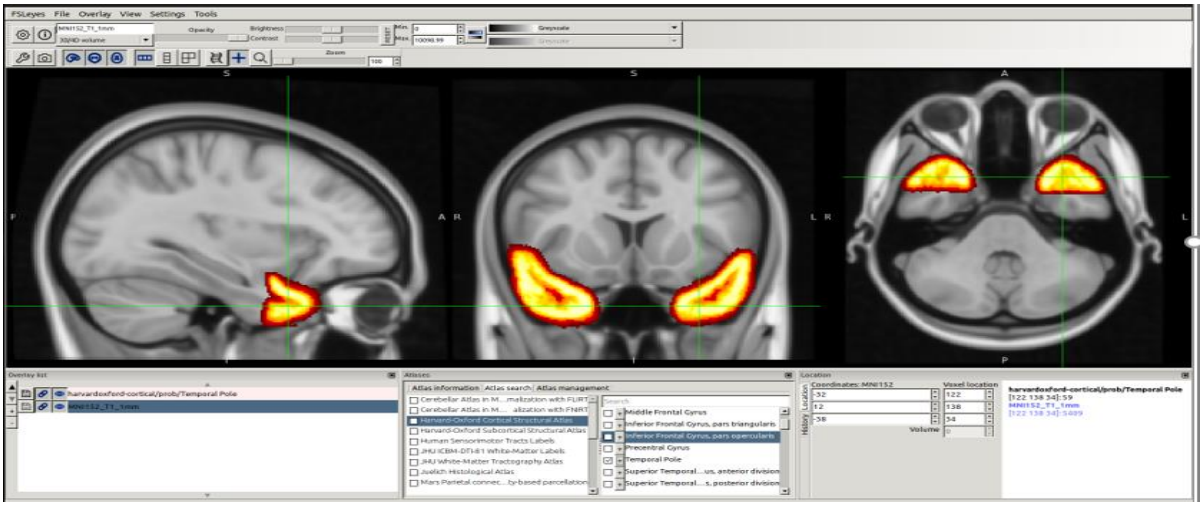
Frontal (at the front of your head)lobe:



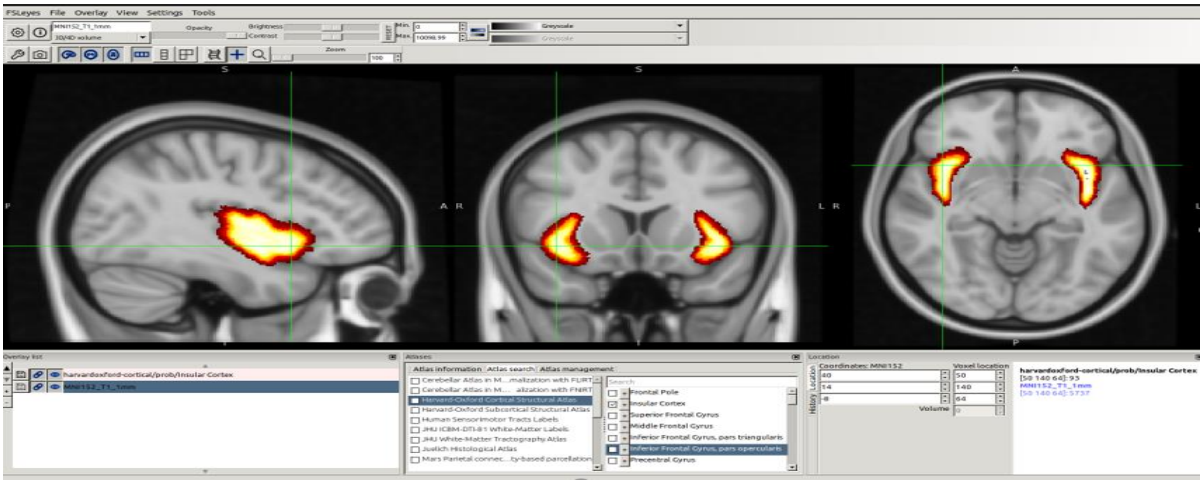
Parietal (at the top of your head)lobe:



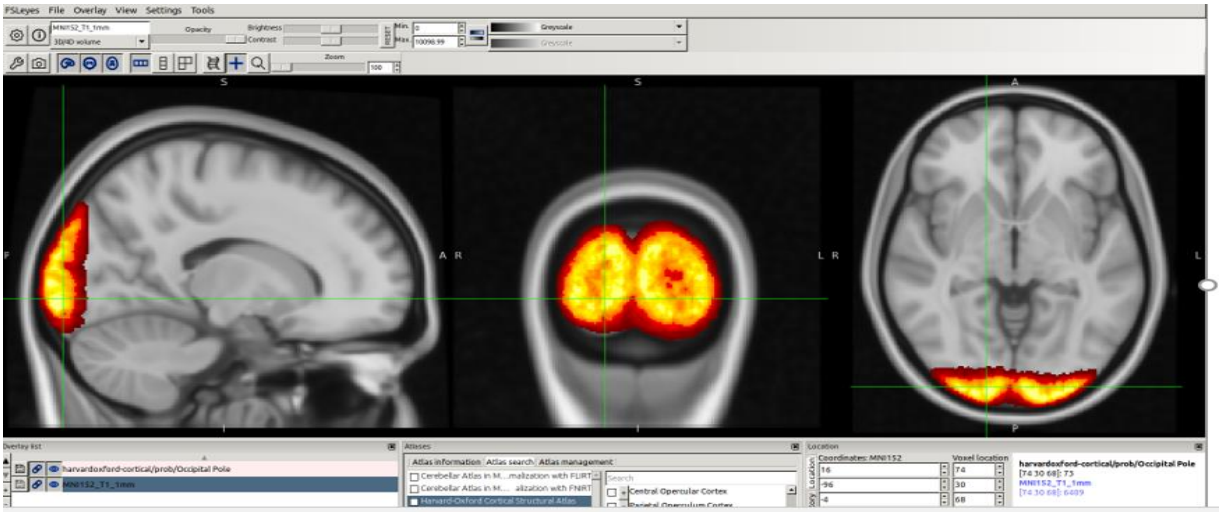
Temporal (at the side of your head)lobe:



Insular lobe:



Occipital lobe:



2)cerebellum:

What is the cerebellum?

it is a part of the brain located at the back of your head, just above and behind where your spinal cord connects to your brain itself. The name “cerebellum” comes from Latin

and means “little brain.”

Function

What does the cerebellum do?

➔ Motor Control and Coordination:

studies of individuals with cerebellar damage revealed impairments in balance,

walking, reaching for objects, and fine motor skills, muscle movements and maintaining smooth, precise motor control

➔ Learning and Skill Acquisition:

cerebellum plays a role in learning new skills and acquiring new information.

➔ Emotional Regulation and Decision Making:

Emerging evidence suggests that the cerebellum may also play a role in emotional processing and decision-making as Functional imaging studies have shown that

different parts of the cerebellum are active during emotional tasks and decision-making processes.

Anatomy

What are the parts of the Cerebellum?

Cerebellum can be divided through two kinds of anatomic divisions

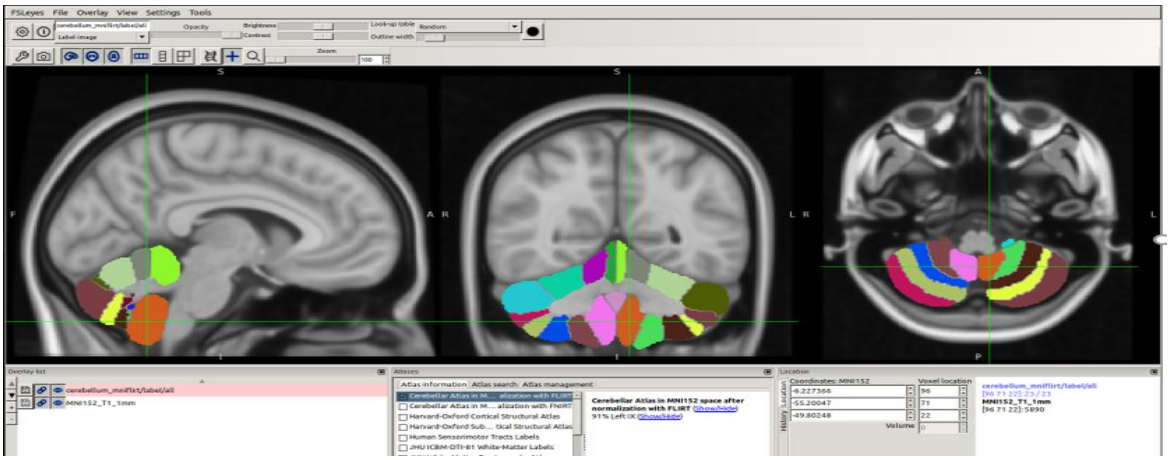
1) Vermis and hemispheres

- Vermis and hemispheres: The midline area is called the vermis, because it resembles a worm. Spreading out on either side from the vermis are the cerebellar hemispheres.

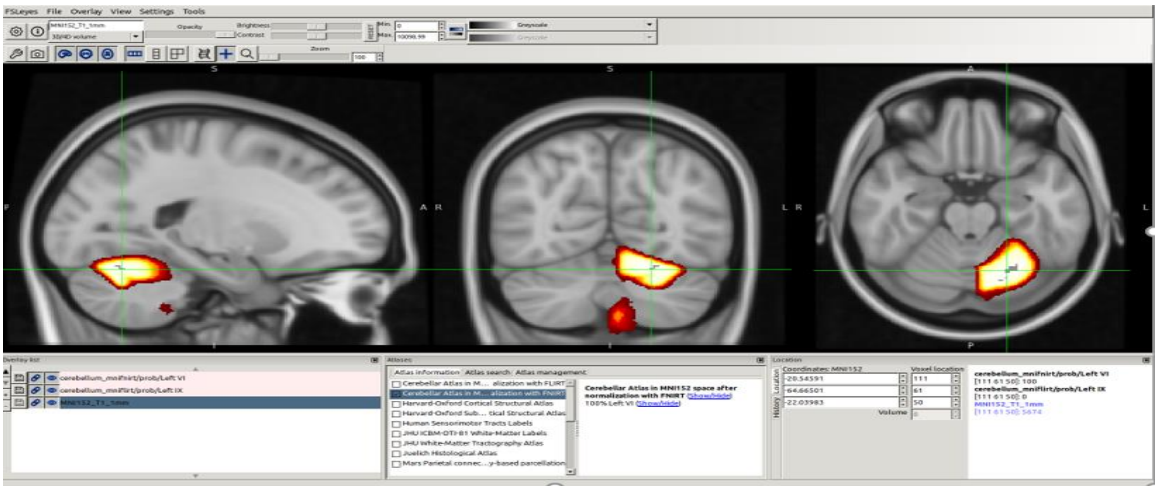
2) three lobes: The cerebellum is divided into three lobes by two fissures.

- The posterolateral fissure separates the flocculonodular lobe from the rest of the cerebellum that is further divided by the primary fissure into an anterior lobe and a posterior lobe.
- The anterior lobe is rostral to the primary fissure while the posteriorlobe, the largest cerebellar lobe, is caudal to the primary fissure.
- The flocculonodular lobe is composed of the small nodulus ,which is part of the midline vermis,and the left and right flocculi, which are small lobules of the hemispheres.

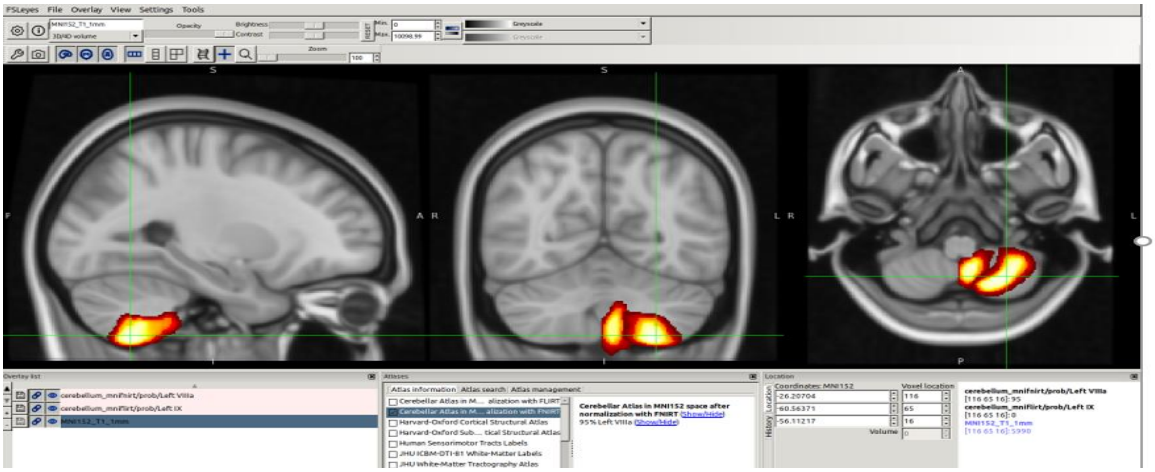
Cerebellum:



Left VI:



Leftville:



3)Brainstem:

What is the brainstem?

The brainstem is the stalklike part of your brain that connects your brain to your spinal cord It sits toward the bottom of your brain and is part of theCNS.

Function

What does the brainstem do?

Your brainstem sends messages between your brain and other parts of your body. Your brainstem helps coordinate the messages that regulate:

- Balance.
- Blood pressure.
- Breathing.
- Facial sensations.
- Hearing.
- Heart rhythms.
- Swallowing.

the brainstem also contains 10 of the 12 cranial nerves (nerves that start in your brain). These nerves control your facial movements, sensations and taste.

How does your brainstem perform with your brain?

the brain has three parts that work together. Each part does specific jobs to help you process information, move and function.

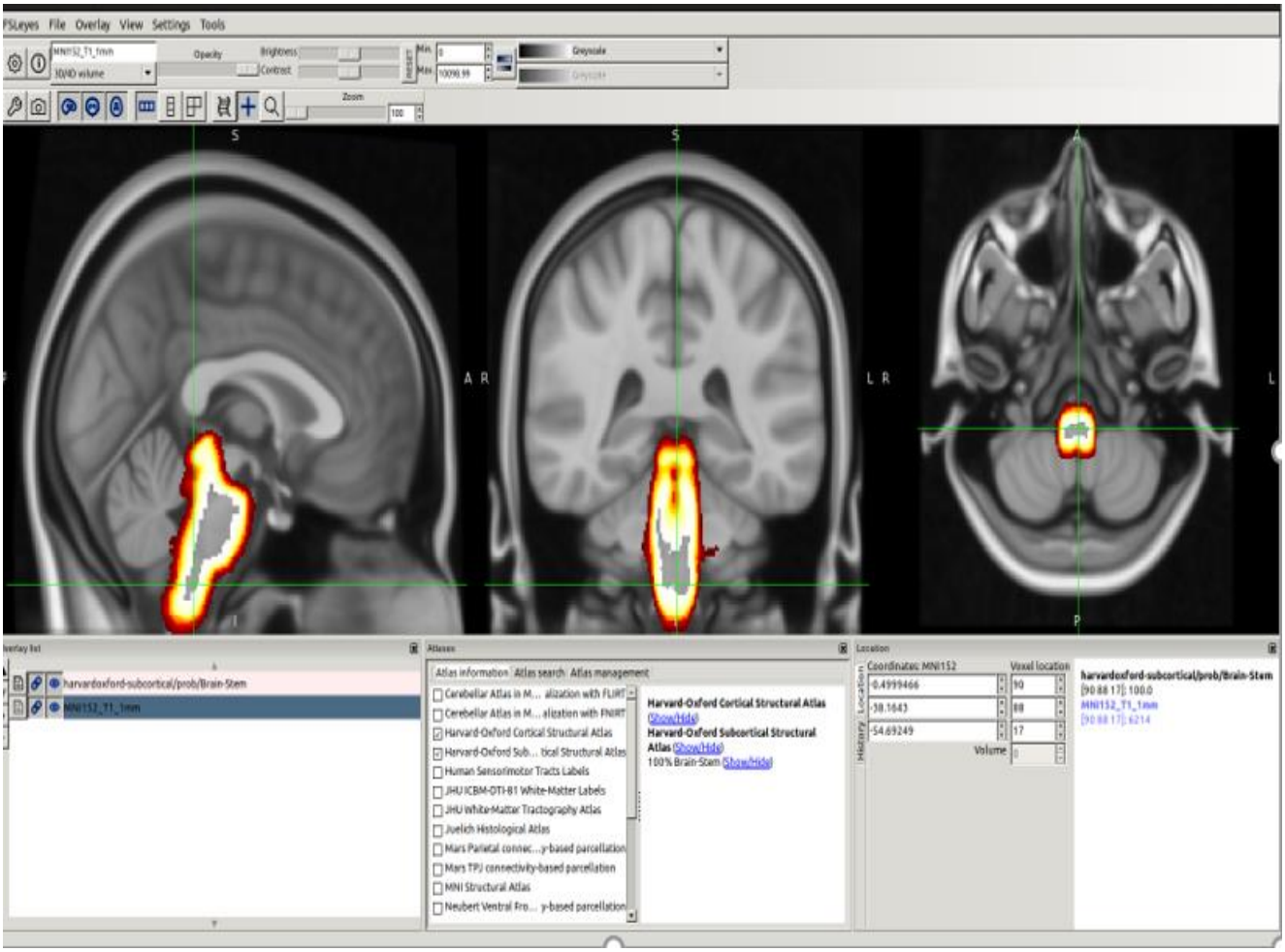
Your brainstem is one of these three parts. It regulates many of the body functions that feel “automatic,” like breathing or swallowing

Anatomy

It consists of three parts:

- **Midbrain:** The top part of the brainstem is crucial for regulating eye movements.
- **Pons:** The middle portion of the brainstem coordinates facial movements, hearing and balance.
- **Medulla oblongata:** The bottom part of the brainstem helps regulate your breathing, heart rhythms, blood pressure and swallowing.

brainstem also contains your reticular activating system (RAS). The RAS is a network of neurons . RAS controls your sleep and wake cycles. It also helps you stay alert and attentive to your surroundings.



GML model

Statistics and Modeling:

In this part I will discuss the results of Statistics which exist in fsl report.

Steps for generate reports:

Choose data:

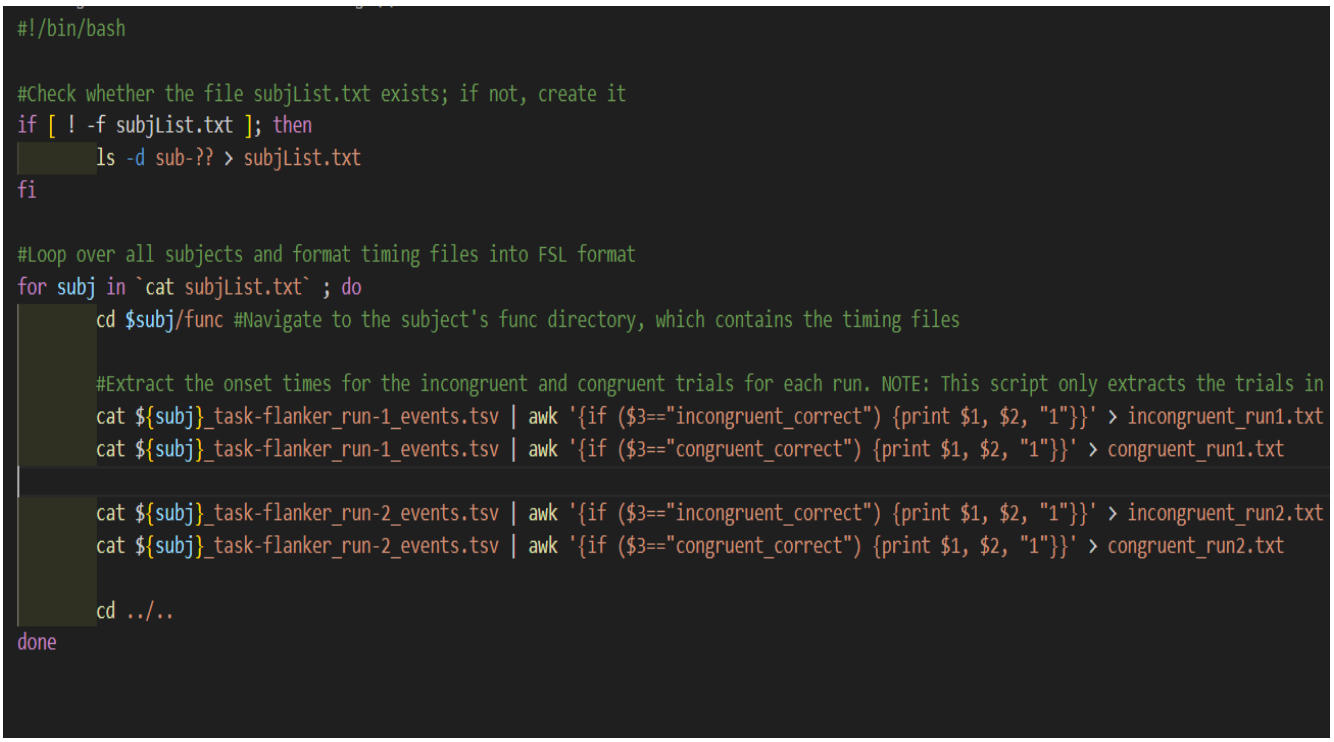
I choose preprocessing subject ,I choose sub09.feat

Stats:

I have 2 EVS which is congruent and incongruent .

I have 3 contrast vector c1=[1,0] and c2=[0,1] and c1-c2 =[1,-1]

Here is the script for timing fsl from whci I used for data set:



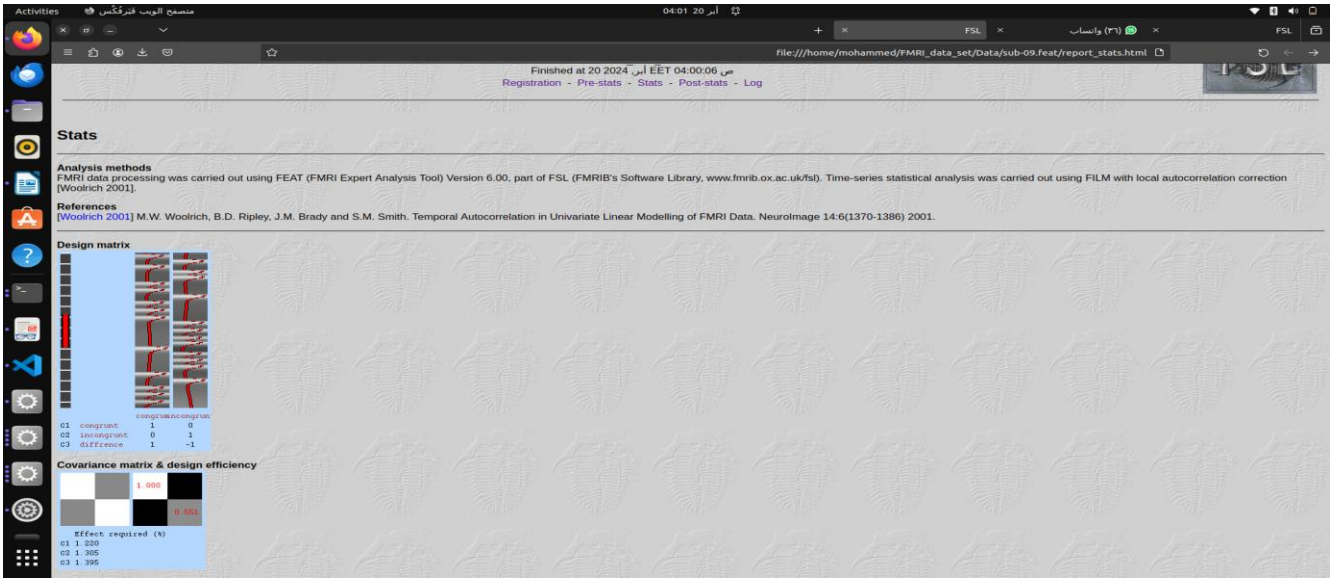
```
#!/bin/bash

#Check whether the file subjList.txt exists; if not, create it
if [ ! -f subjList.txt ]; then
	ls -d sub-?? > subjList.txt
fi

#Loop over all subjects and format timing files into FSL format
for subj in `cat subjList.txt` ; do
	cd $subj/func #Navigate to the subject's func directory, which contains the timing files

	#Extract the onset times for the incongruent and congruent trials for each run. NOTE: This script only extracts the trials in
	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
```

Post_stats:

I have number of voxel = 64*64*40 which is a large number so may voxel act as congruent and incongruent so we use Z_threshold which is 3.1

results as report :

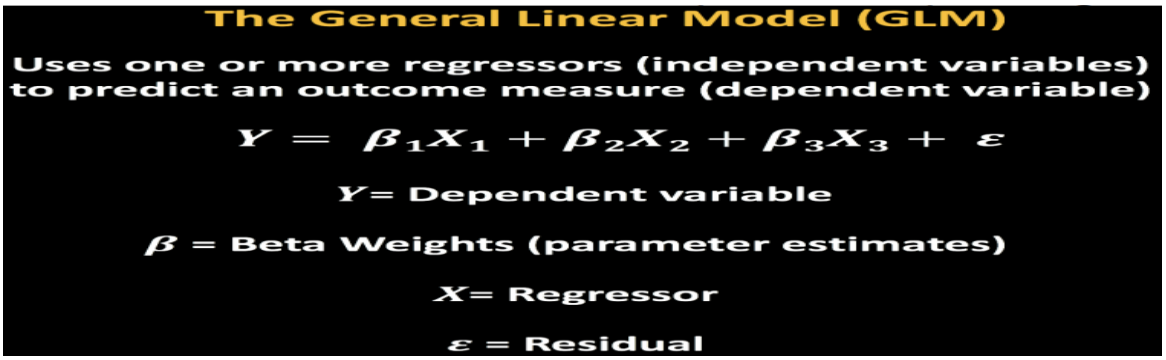
1)Design metrics:



2)Best estimate coff:

There are 2 file which contain the best coff for each pixel in function MRI which is

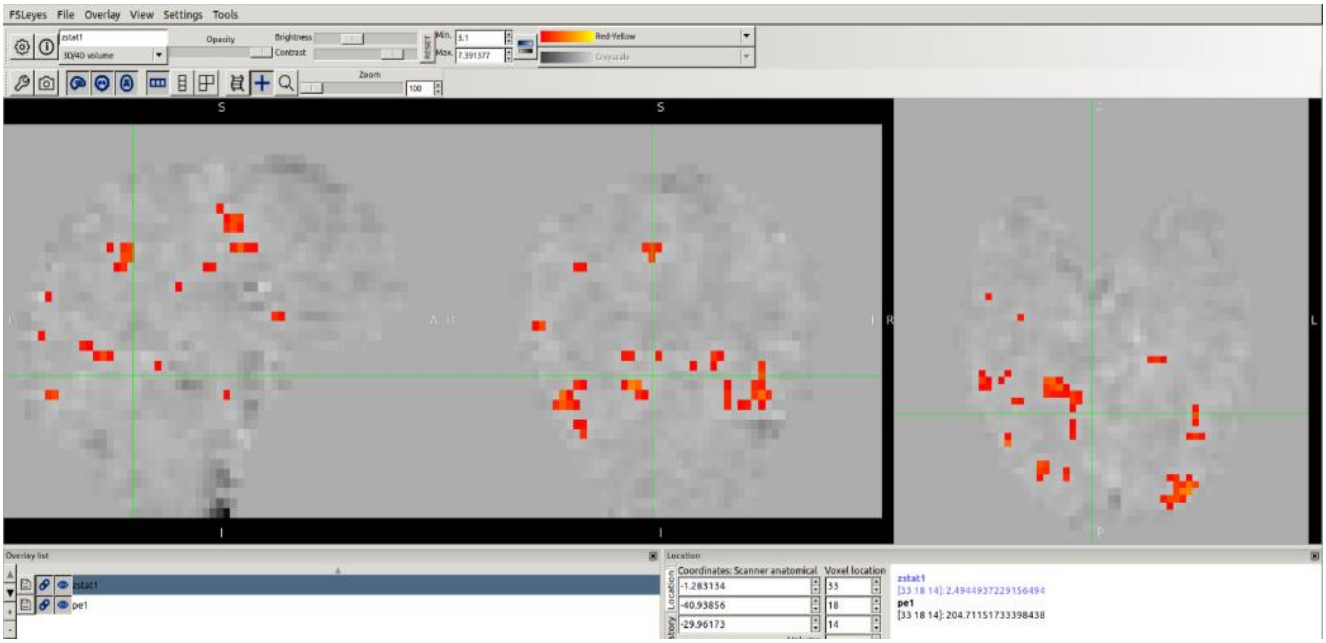
Is pe1 and pe2,error which is our target according to the equation of GML



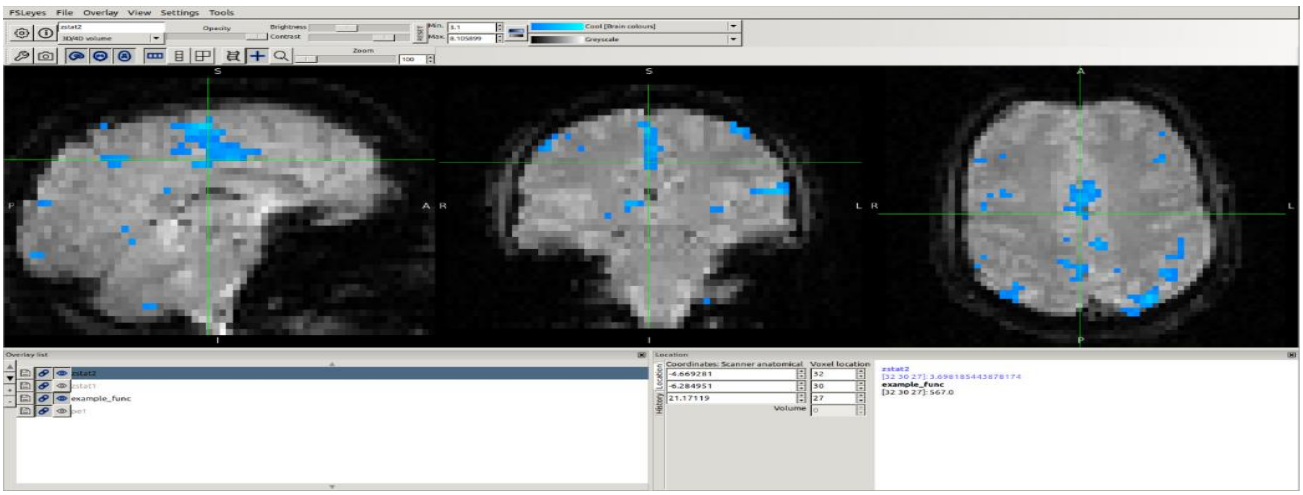
And also I found z_stat and t_stat which are similar in place but z_stat is high resultion in fsleyes.

Here is some image for the result on Example which exist in Fsl report.

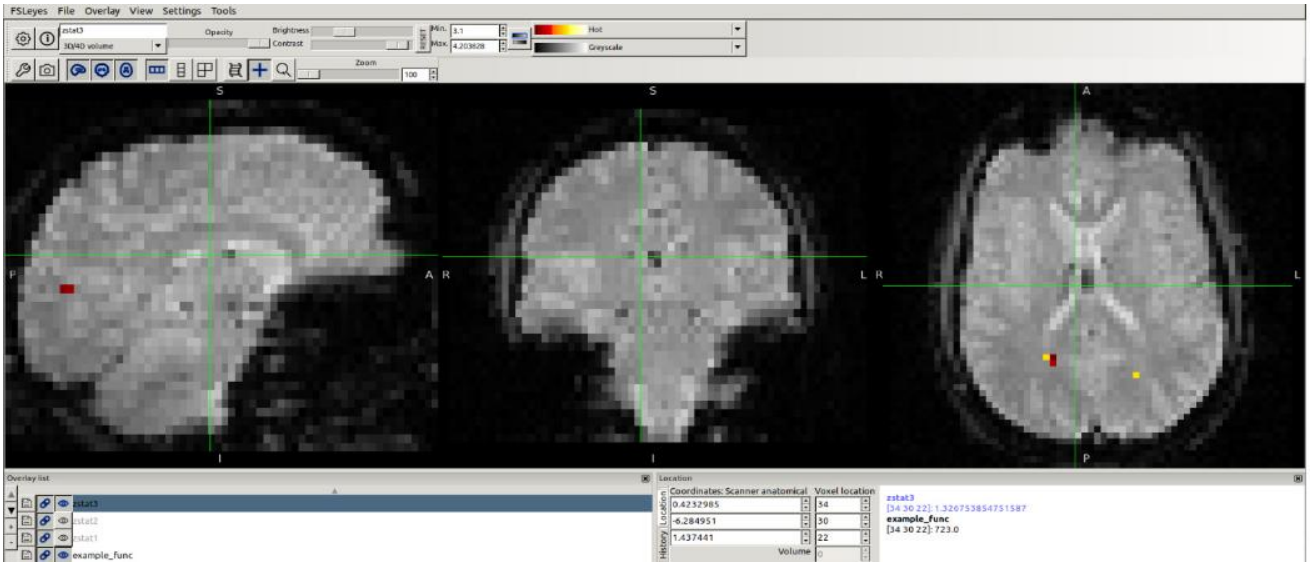
1)zstat1 which is threshold for pe1.



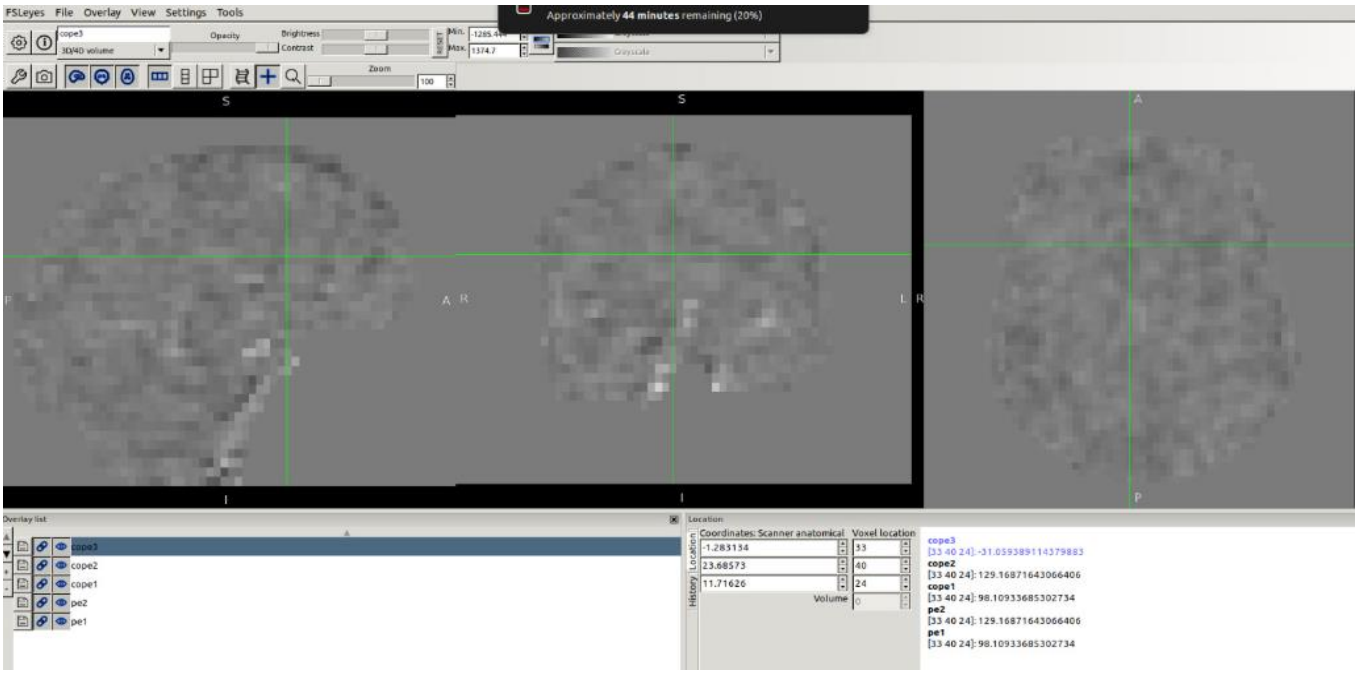
2) zstat2 on example function :



3) zstat3 on example function:

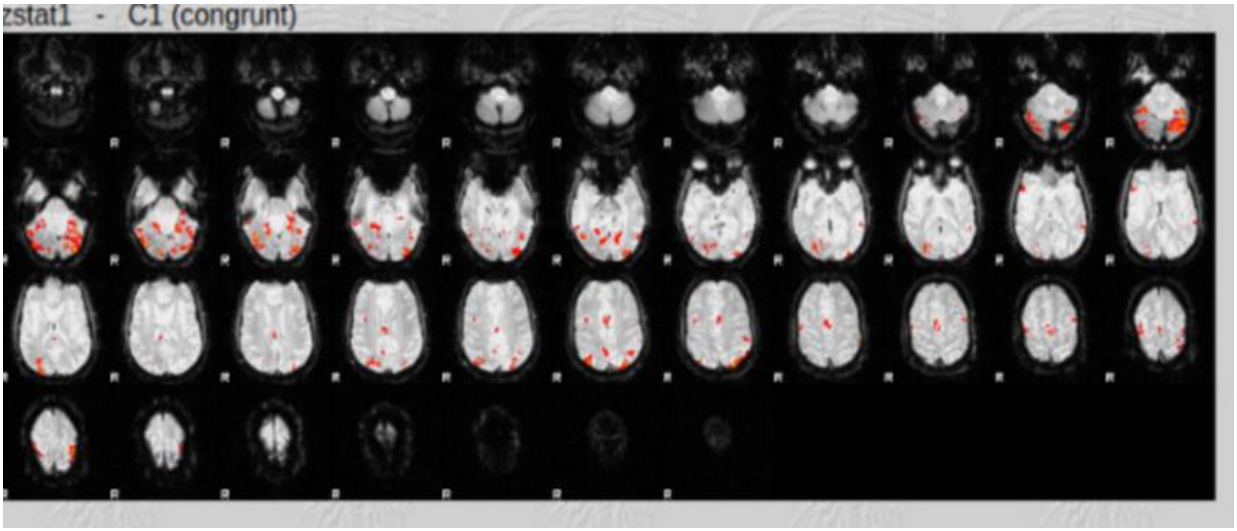


And the image for cop1,cop2andcop3

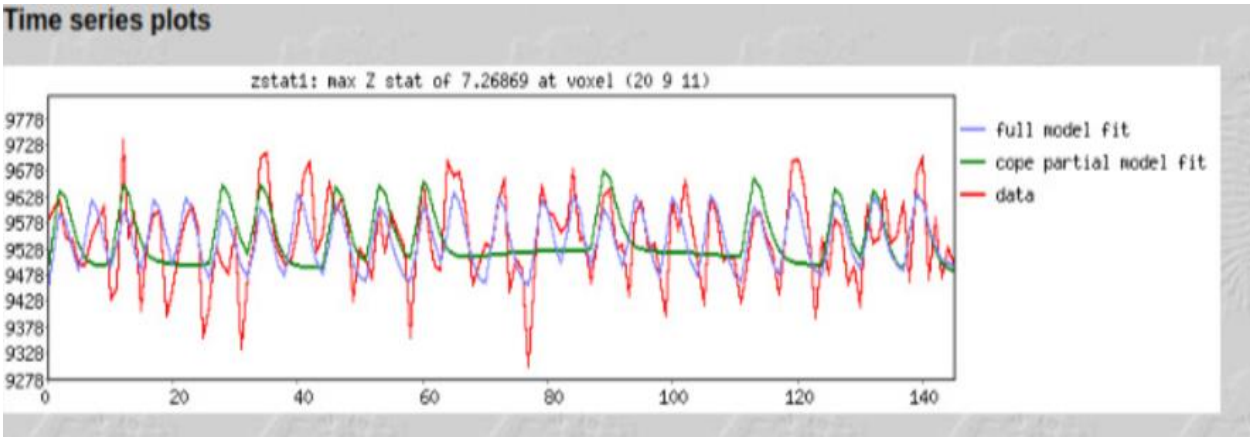


For image result from report:

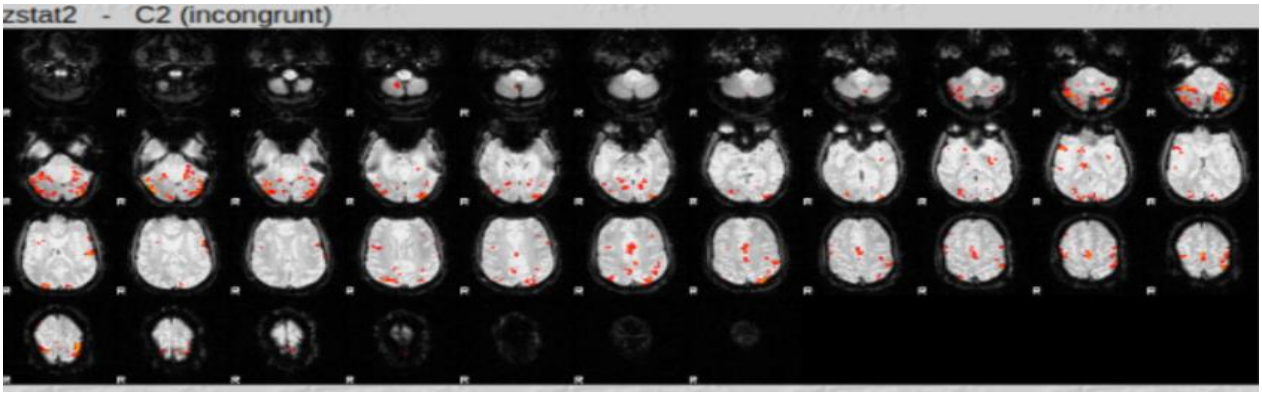
1)zstat1 for congruent task.



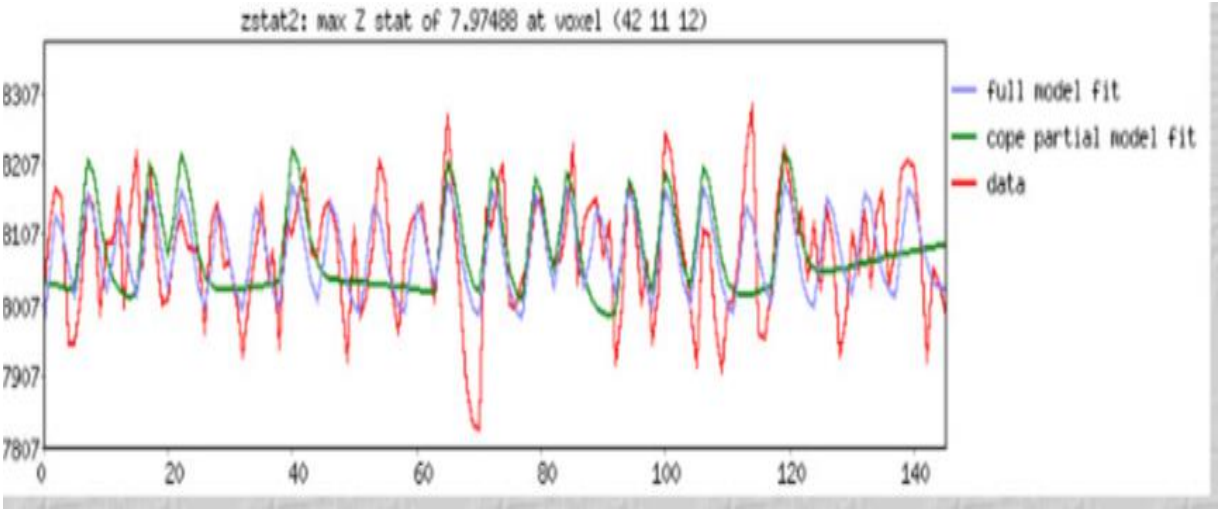
1)Time series of zstat1 for congruent task which is the output of Fmri.



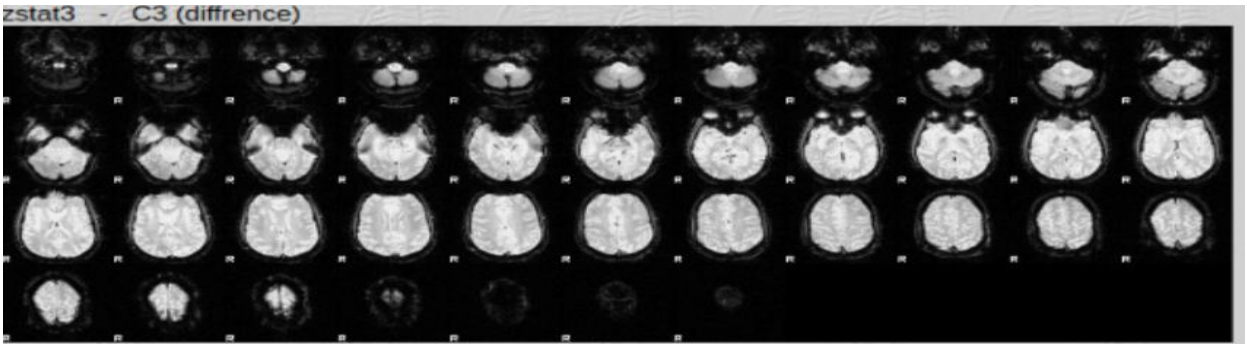
2)zstat2 for incongruent task.



2)Time series of zstat2 for incongruent task which is the output FMRI.

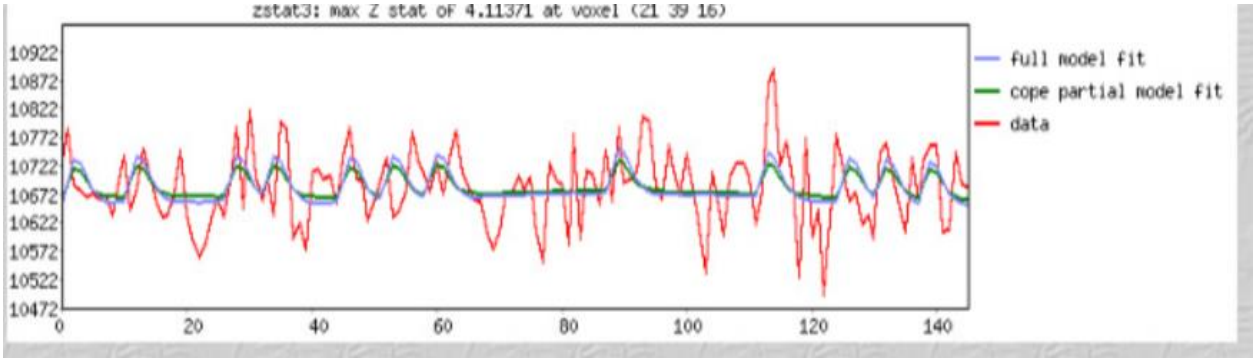


2)zstat3 for (congruent – incongruent)task.



But I don’t notice any function region

3)Time series of zstat3 for (congruent –incongruent) task which is the output FMRI



Higher Level Analysis:

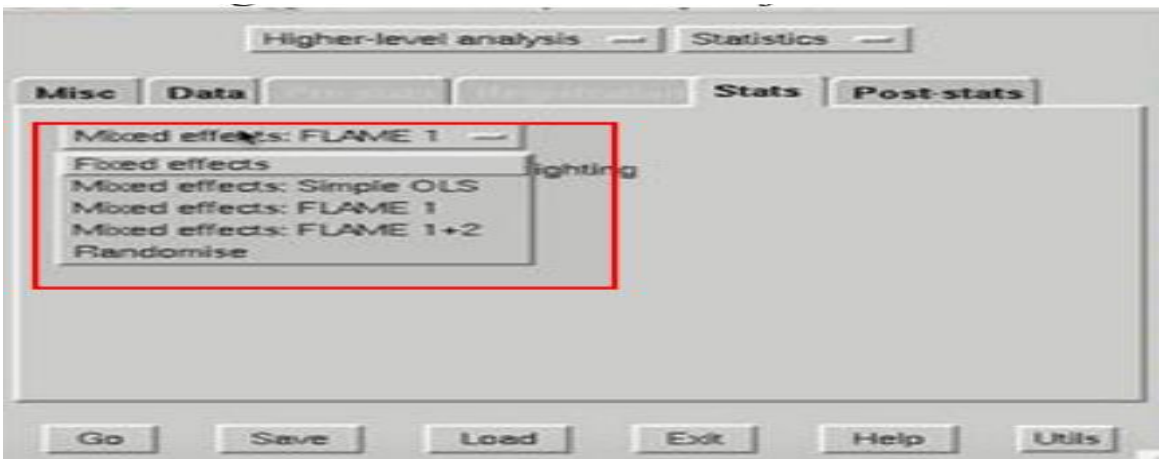
In this section , I used BASHSCRIPT to make 1st analysis for 26 subject .

```
for id in `seq -w 1 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}_brain.nii.gz -f 0.4
        fi


        cp ../design.fsf design1.fsf

        #change subject to current subject using "sed" command
        sed -i "s/sub-01/${subj}/g" design1.fsf

        cp design1.fsf design2.fsf

        #change run1,run-1 with run2,run-2 in design2.fsf using "sed" command
        sed -i 's/run1/run2/g; 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
```

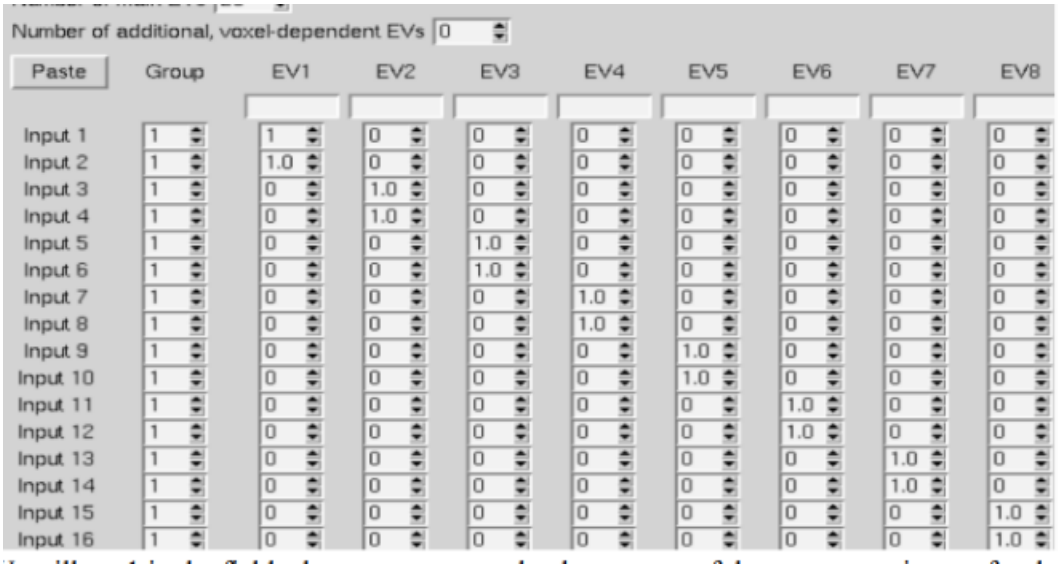
Second level analysis, It means calculating the average of the contrast estimates from the first level analysis to get a single second level cope image for each contrast for each subject

Steps:

- Load 52 run for 26 sub
- Different from the Stats tab in First level analysis here we will find this and which will make us able to choose between different types of inference or how you want the results to generalize to the population.



- click on Full model setup, we will get a window with number of rows representing of individual contrast estimates in our cas52



- Click on Contrasts & F-tests tab

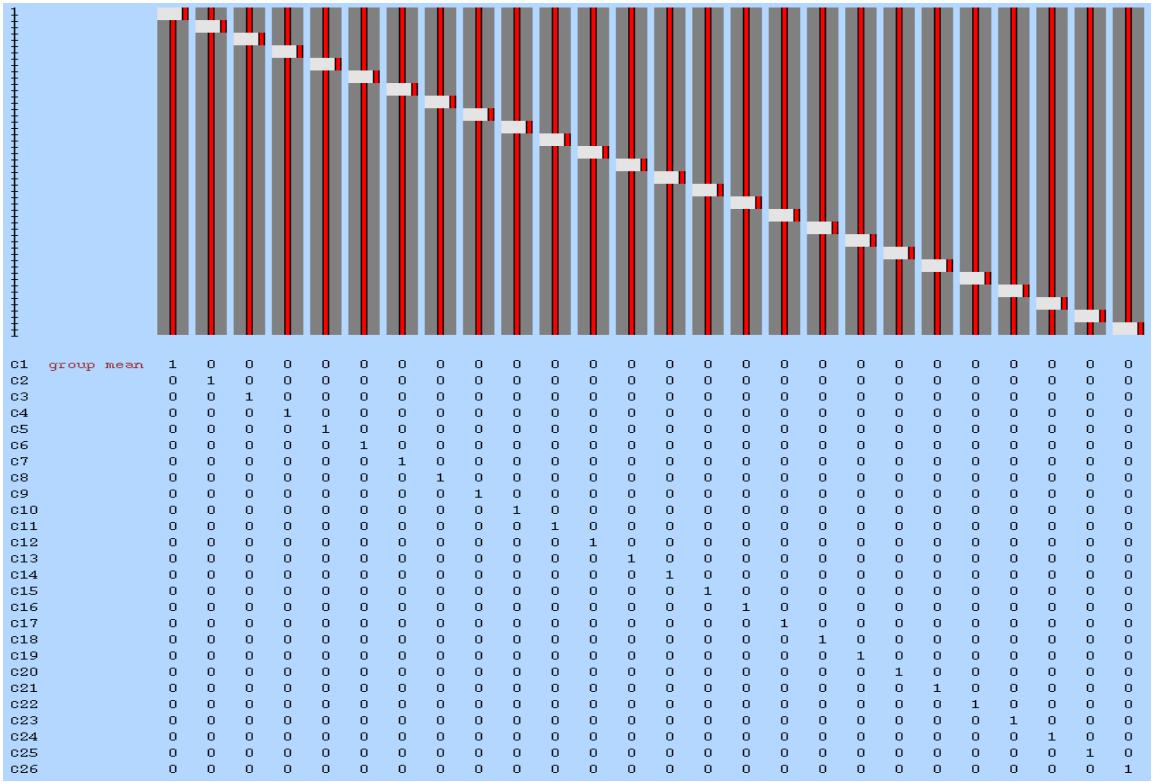
EVs | Contrasts & F-tests

Contrasts 26 F-tests 0

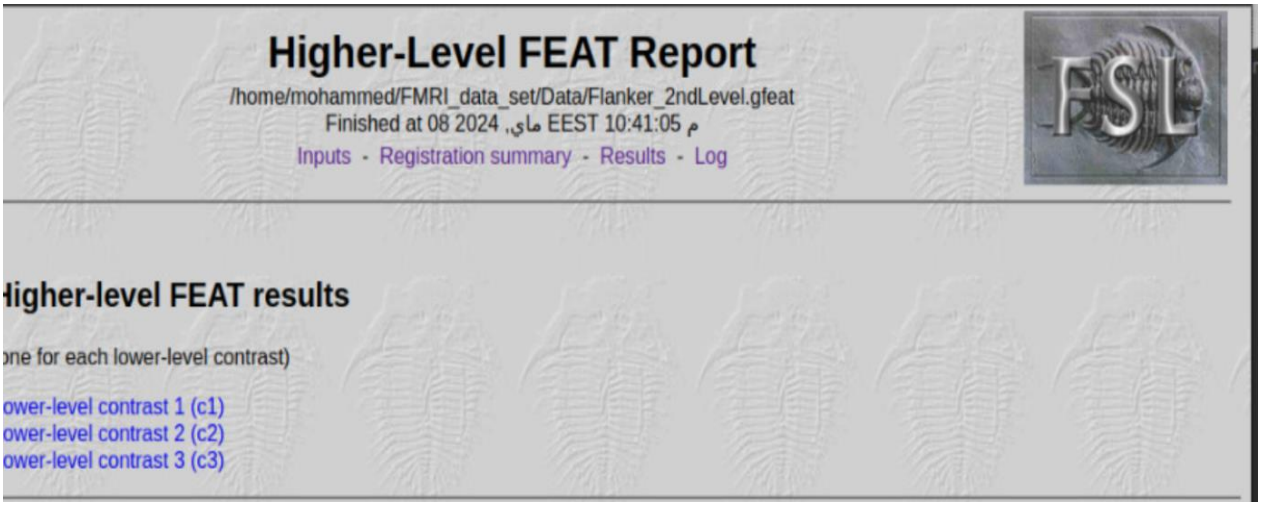
Paste	Title	EV1	EV2	EV3	EV4	EV5	EV6	EV7	EV8
C1		1	0	0	0	0	0	0	0
C2		0	1.0	0	0	0	0	0	0
C3		0	0	1.0	0	0	0	0	0
C4		0	0	0	1.0	0	0	0	0
C5		0	0	0	0	1.0	0	0	0
C6		0	0	0	0	0	1.0	0	0
C7		0	0	0	0	0	0	1.0	0
C8		0	0	0	0	0	0	0	1.0

- Change the numbers in the diagonal to 1 this tells FSL to calculate an average estimate for each that was specified in the data tab. Once finished hit Done then Go.

The resulted GLM:



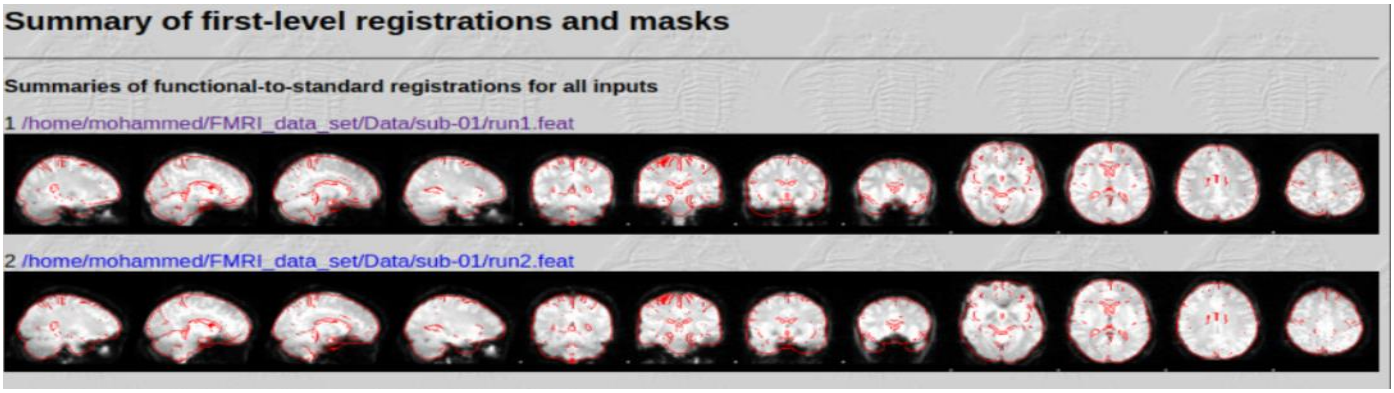
Here is the Higher-level FEAT Report

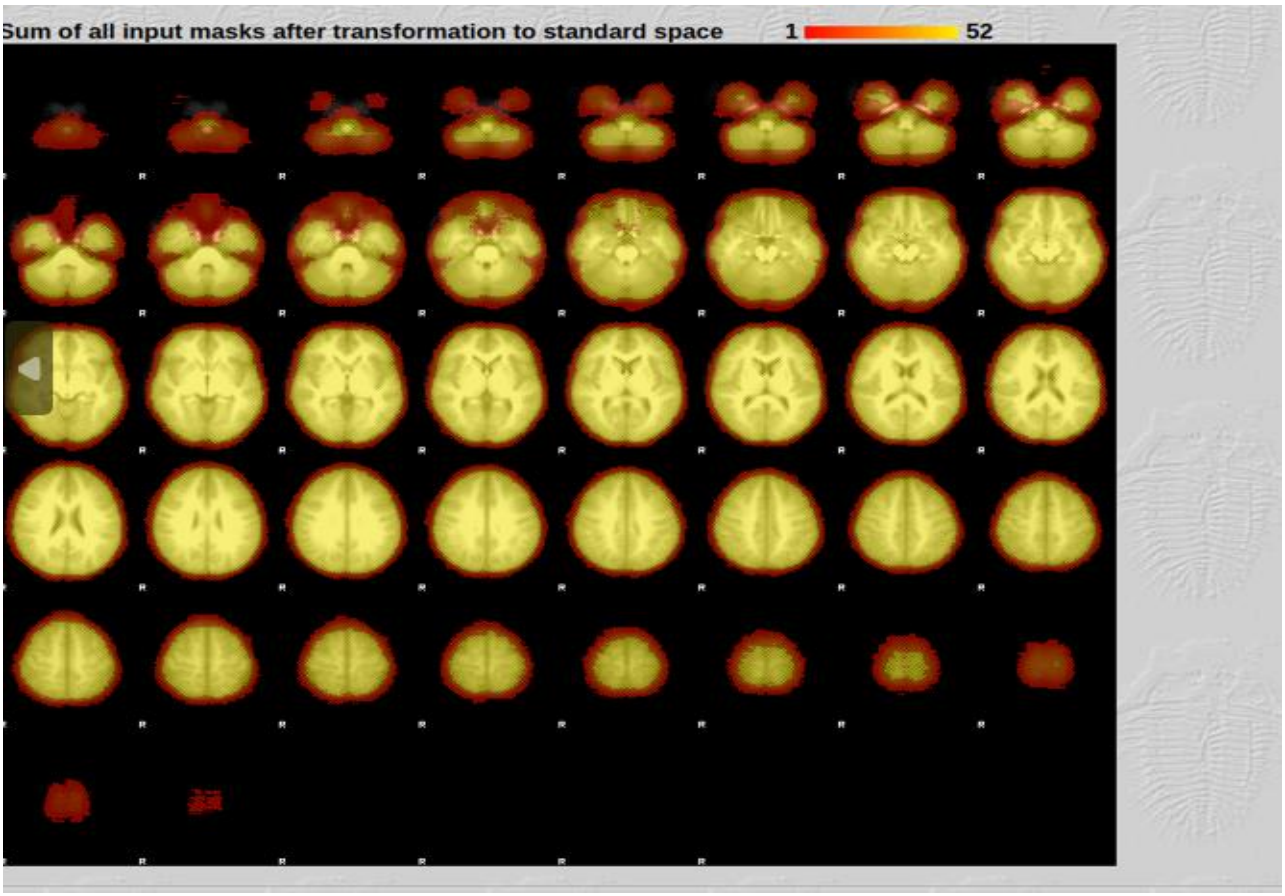


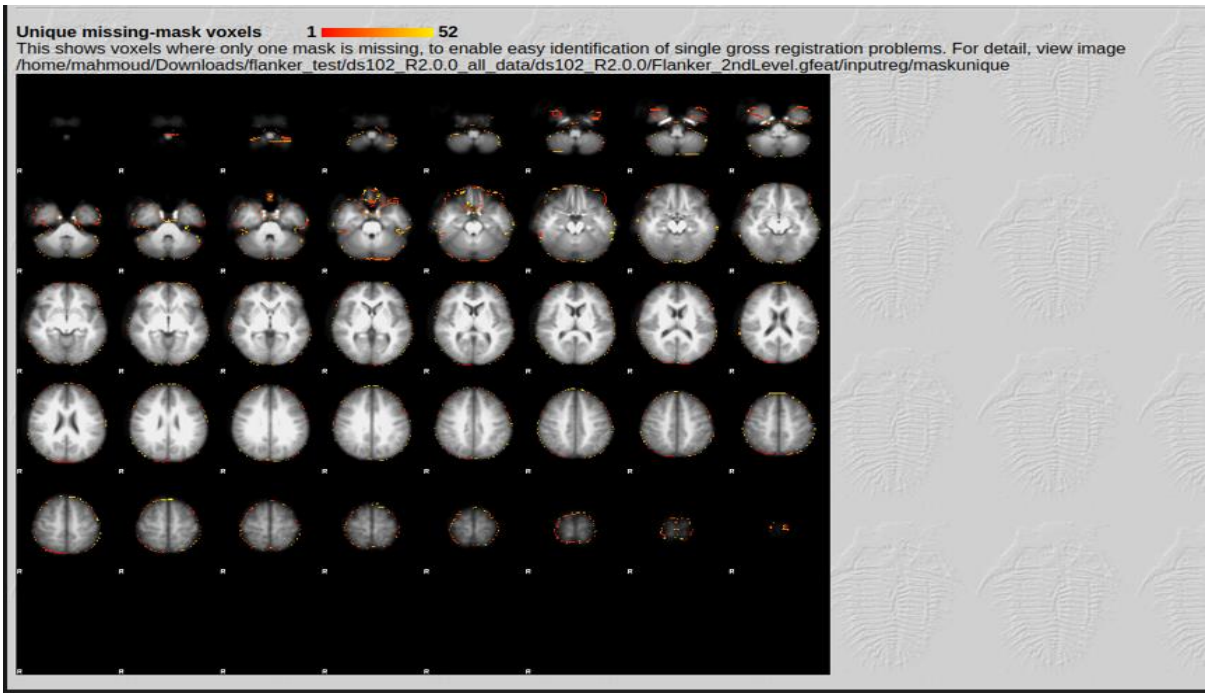
In inputs tab it contains the results of 1st level analysis for each feat directory.

Registration Summary: shows how the functional data have been normalized to a template. As we already checked the normalization during the preprocessing so no problem should appear here.

Results tab will show us the GLM for second level analysis along with the results for each of the contrasts. As first level we are not interested in post stats but I found that just we can check them for any activation in the ventricles or strong activation at the edges of the brain which tell us there is the movement.




Sum of all input masks after transformation to standard space
1
52


Unique missing-mask voxels
1
52
This shows voxels where only one mask is missing, to enable easy identification of single gross registration problems. For detail, view image
/home/mahmoud/Downloads/flanker_test/ds102_R2.0.0_all_data/ds102_R2.0.0/Flanker_2ndLevel.gfeat/inputreg/maskunique