

## **Assignment-2(COL786)**

(Entry No:-2020CSY7576, Shivansh Chandra Tripathi)

### **Preprocessing and registration**

- a)Brain Extraction** using the Brain Extraction Tool.
- b)Spatial smoothing** using 4mm FWHM.
- c)Temporal Filtering** using 100s high pass filter cutoff.
- d)Motion Correction** using the MCFLIRT motion correction tool.
- e)Linear Registration** using the standard 2mm MNI brain template.

### **Generating Contrasts**

The 8 Explanatory Variables are used:

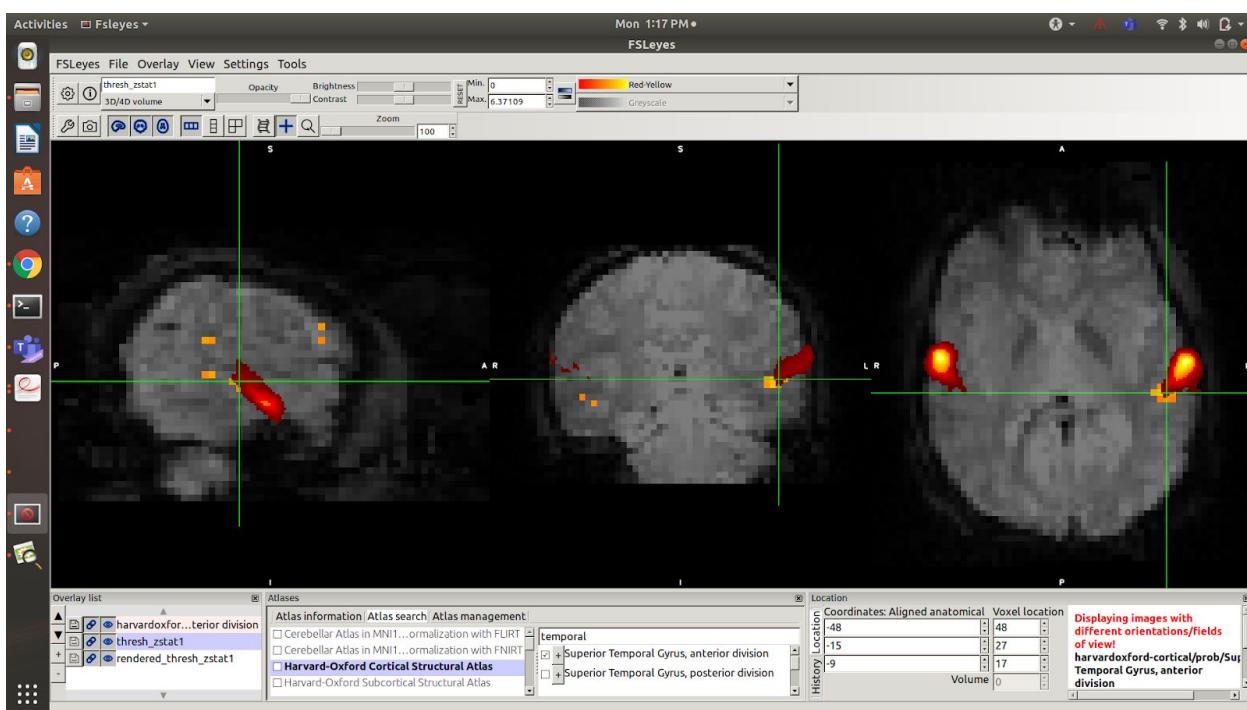
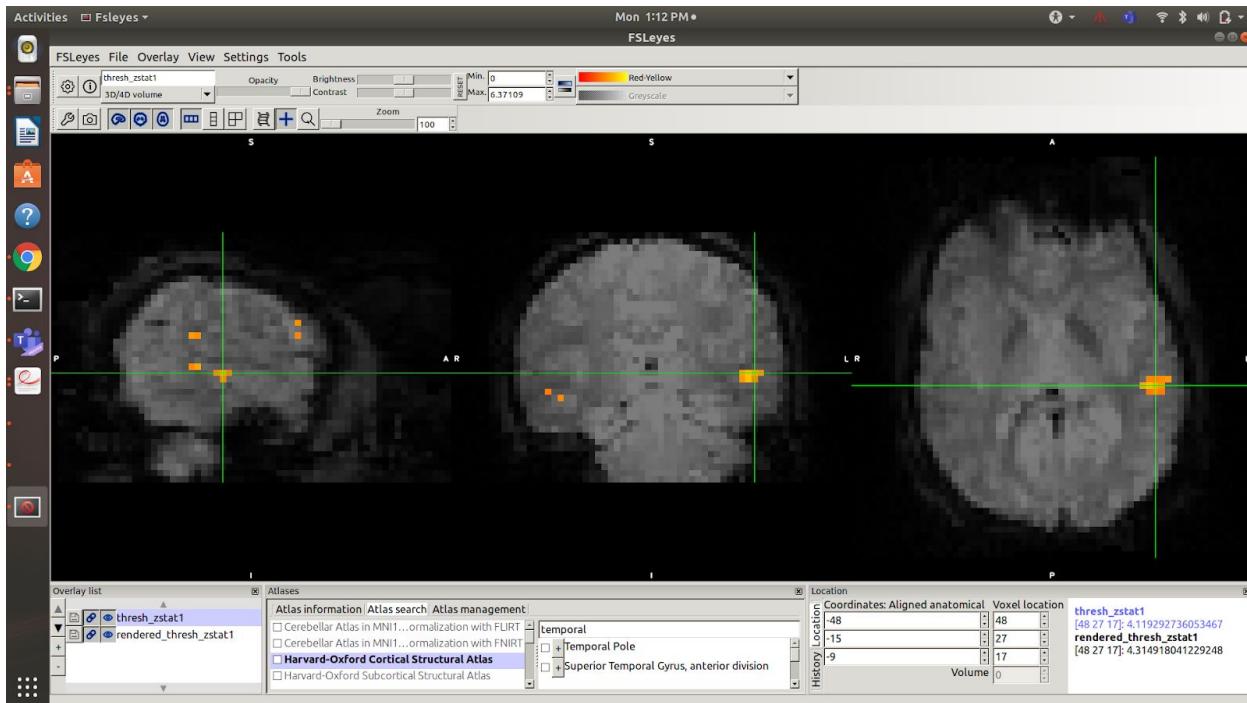
- EV1- audio left hand
- EV2- audio right hand
- EV3- audio sentence
- EV4- horizontal checkerboard
- EV5- vertical checkerboard
- EV6- video left hand
- EV7- video right hand
- EV8- video sentence

The following contrasts and their corresponding activated regions are as shown:

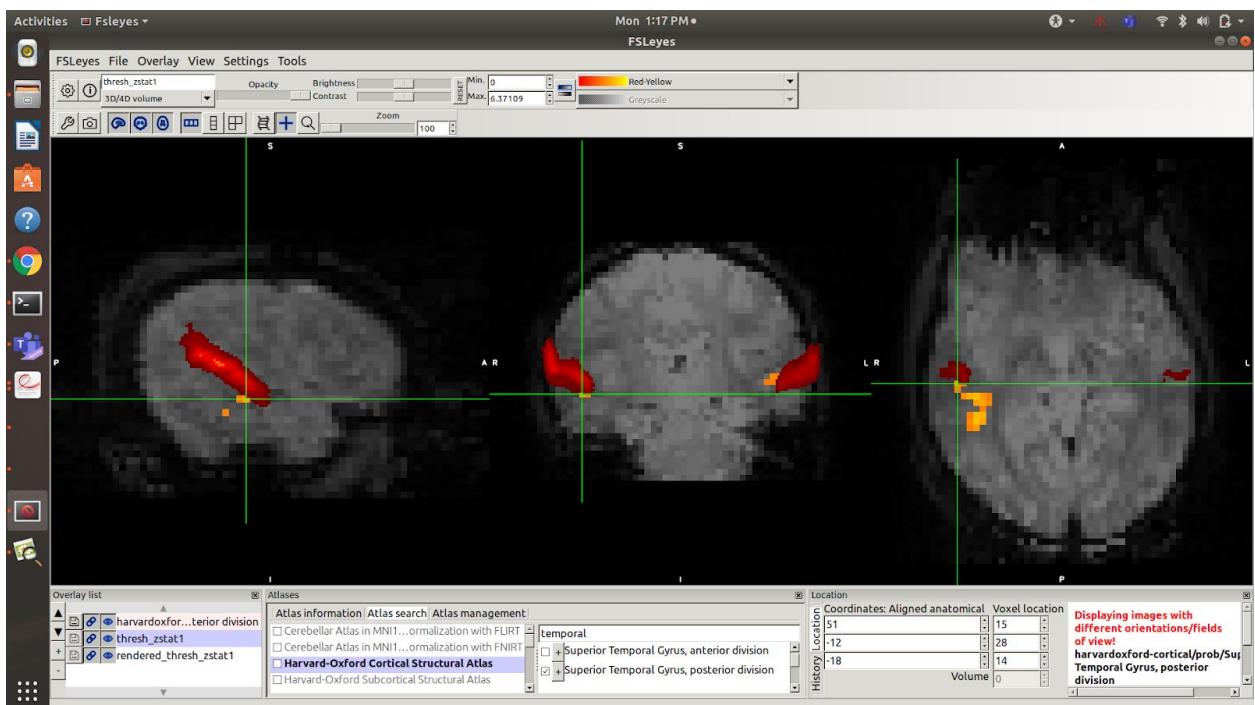
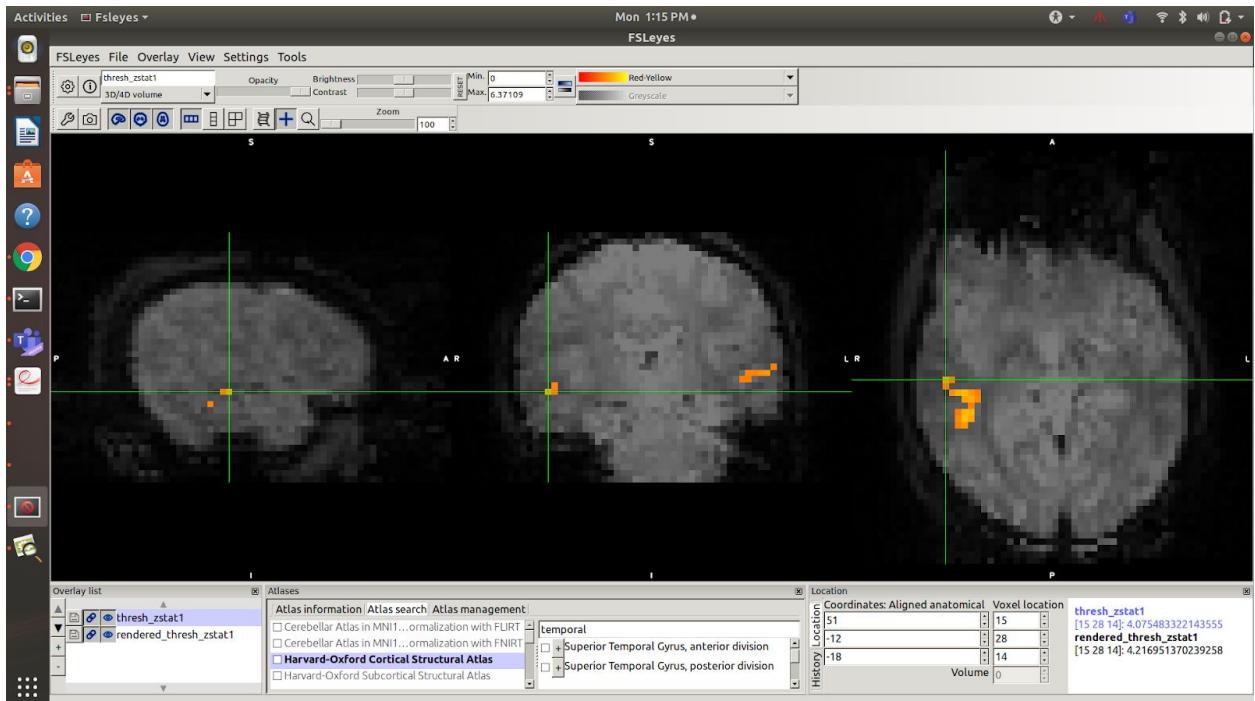
#### **a)video sentences- checkerboard (EV8 - EV4 - EV5)**

The following regions are activated:

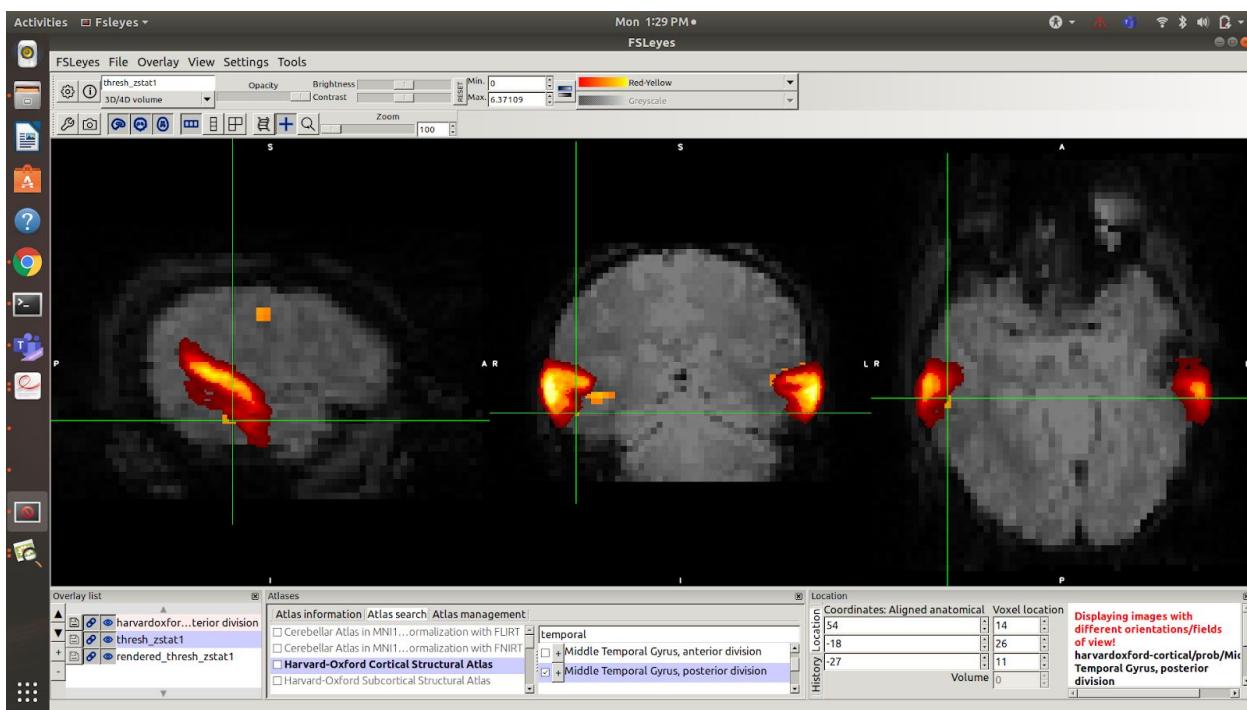
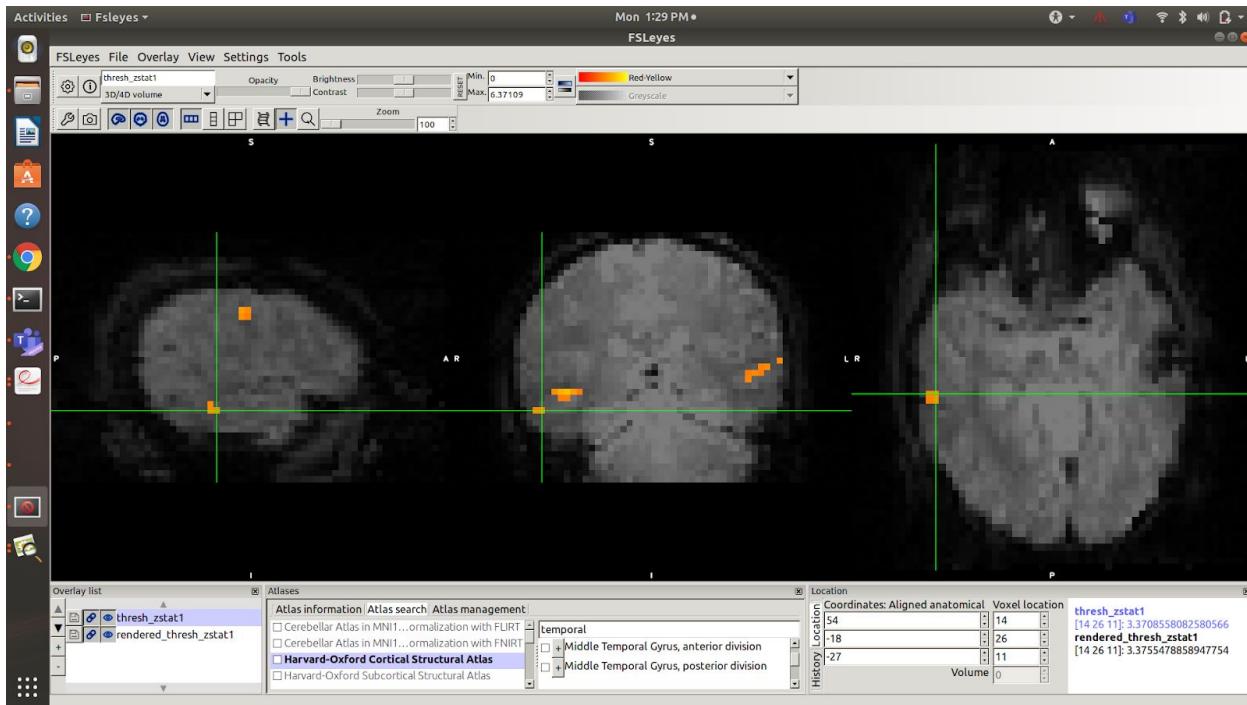
Superior temporal gyrus, anterior division



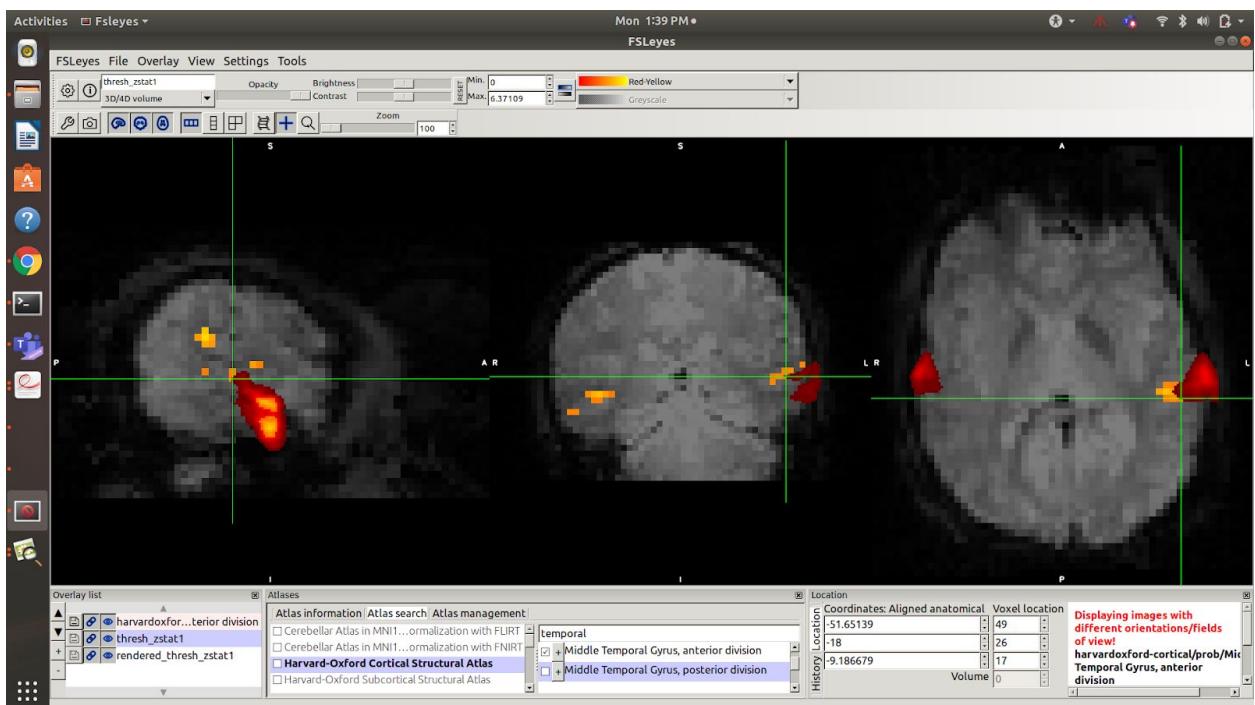
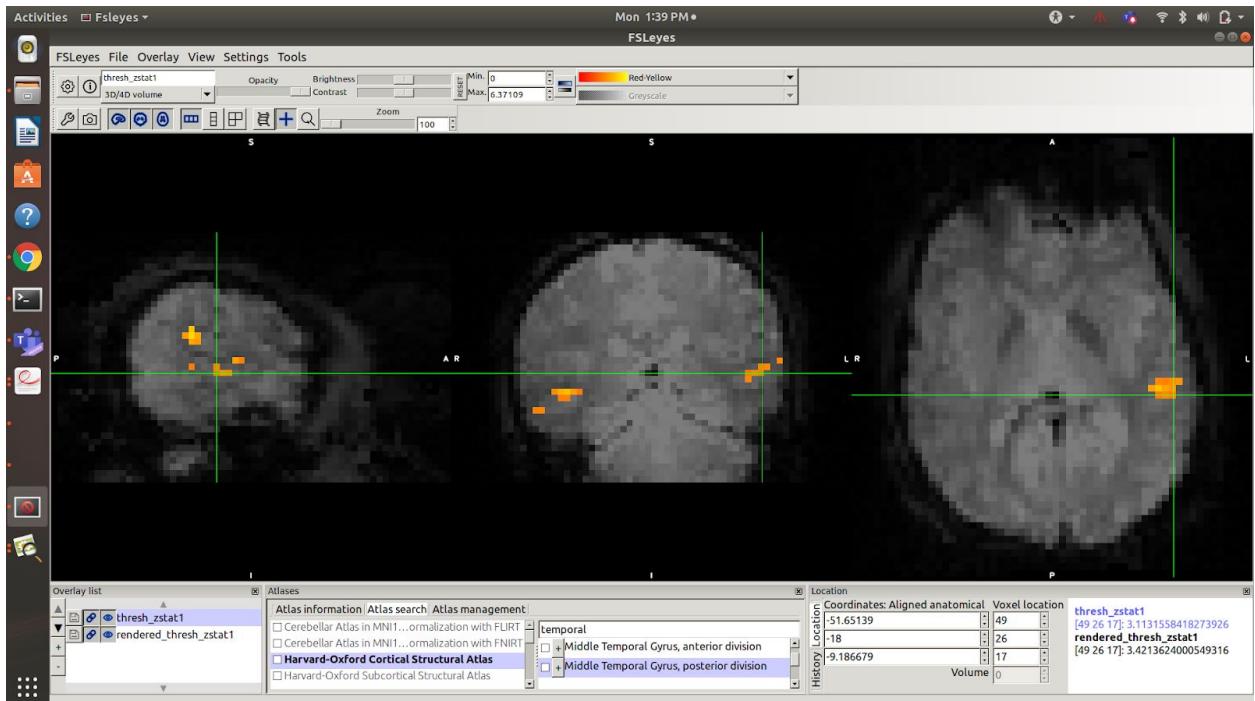
## Superior temporal gyrus, posterior division



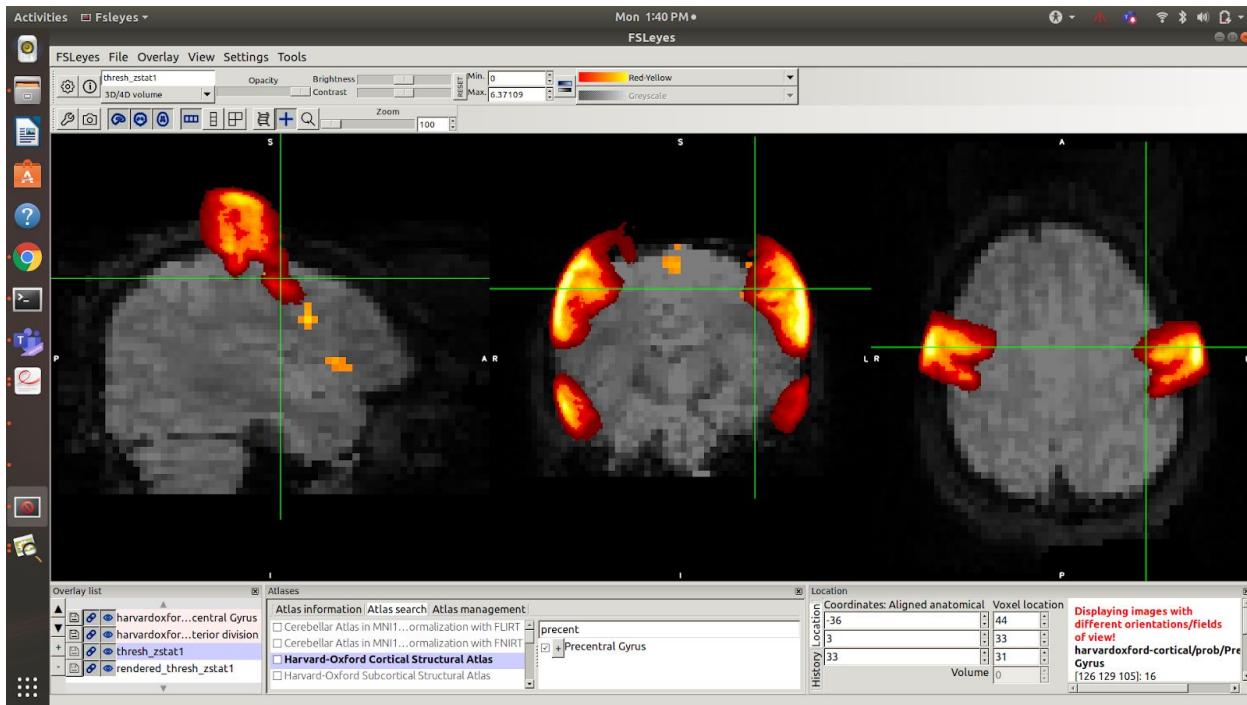
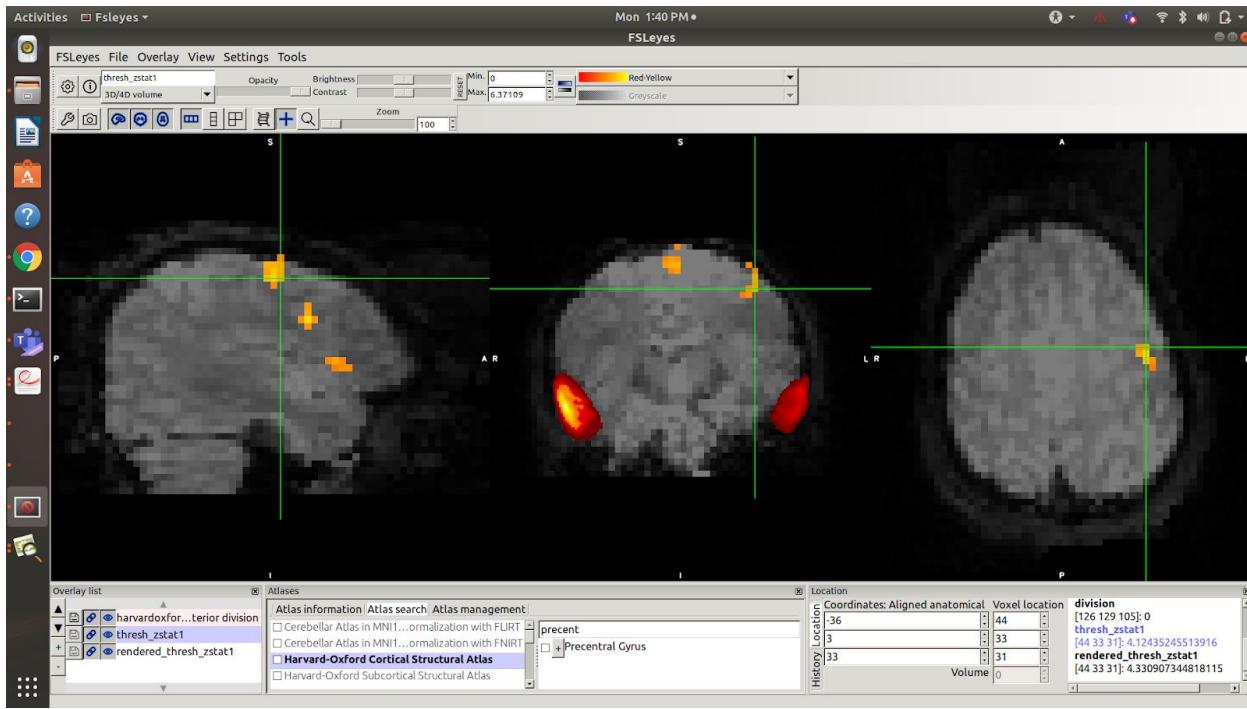
## Middle temporal gyrus, posterior division



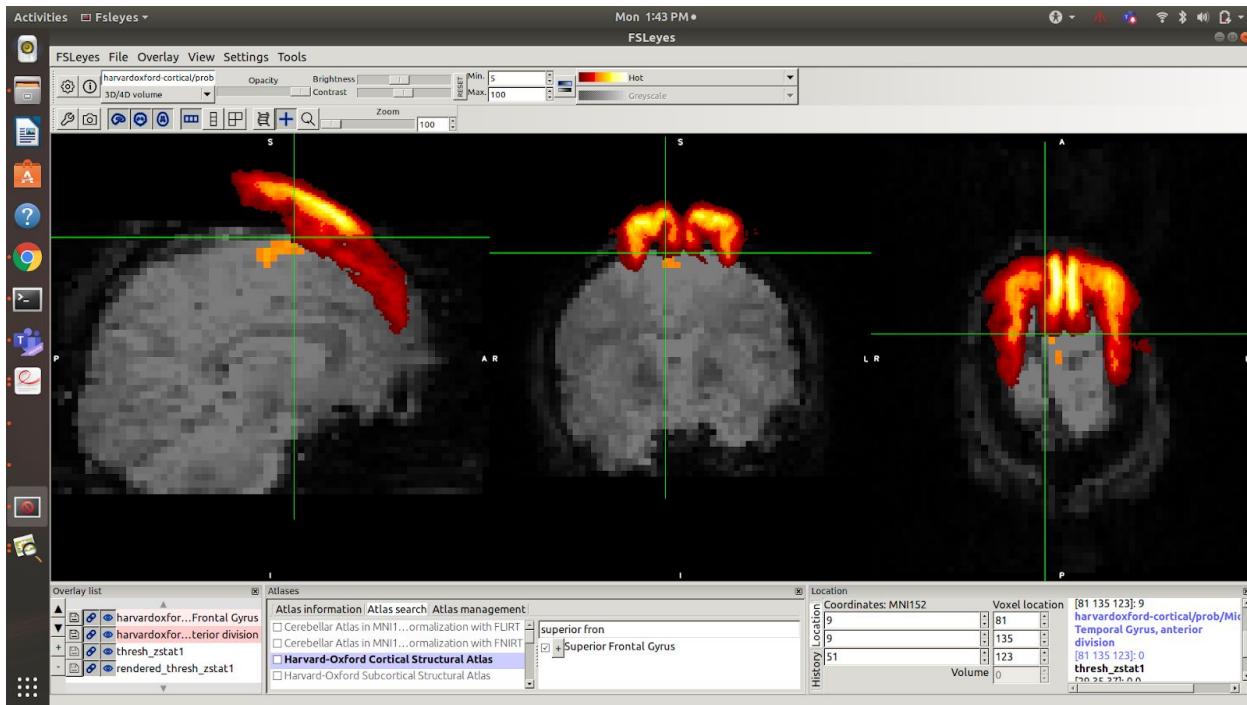
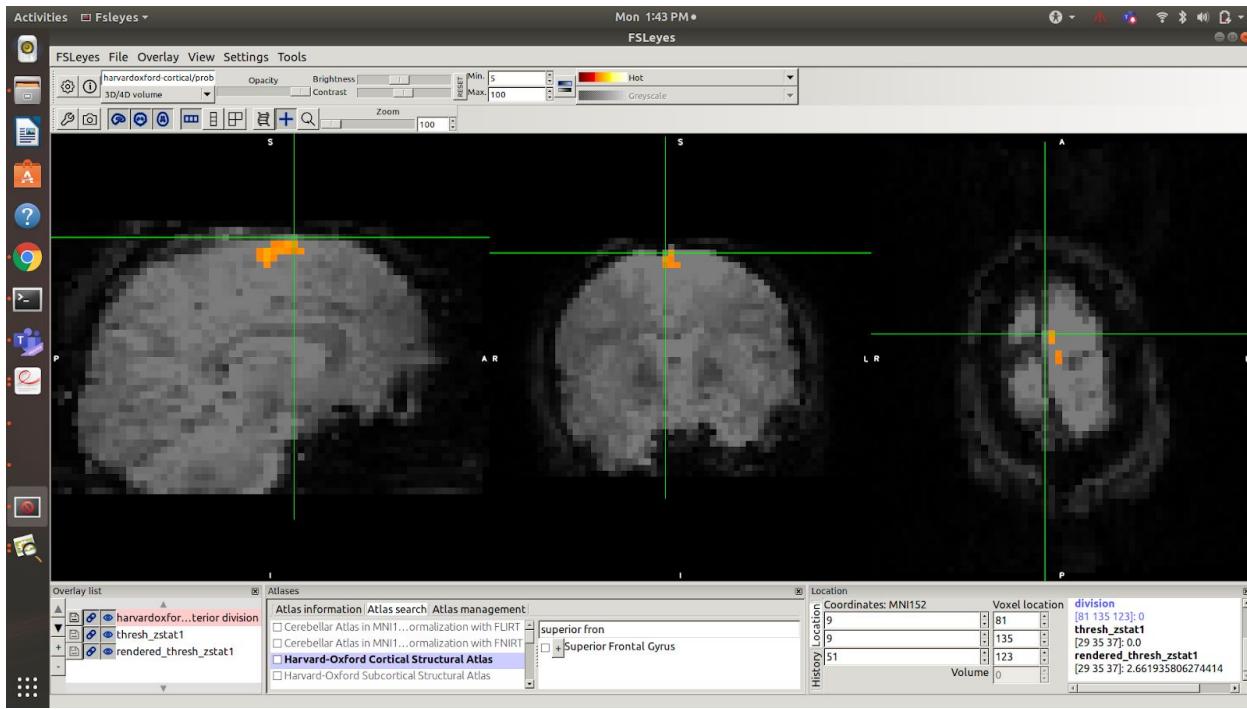
## Middle temporal gyrus, anterior division



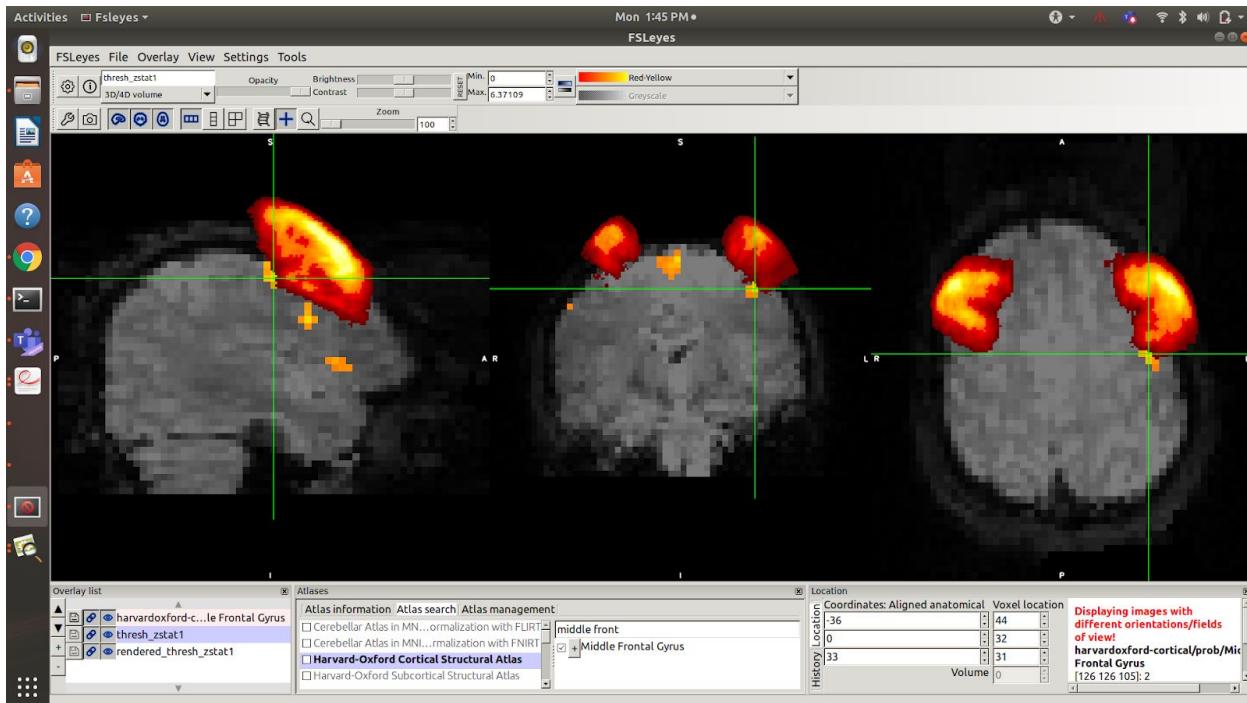
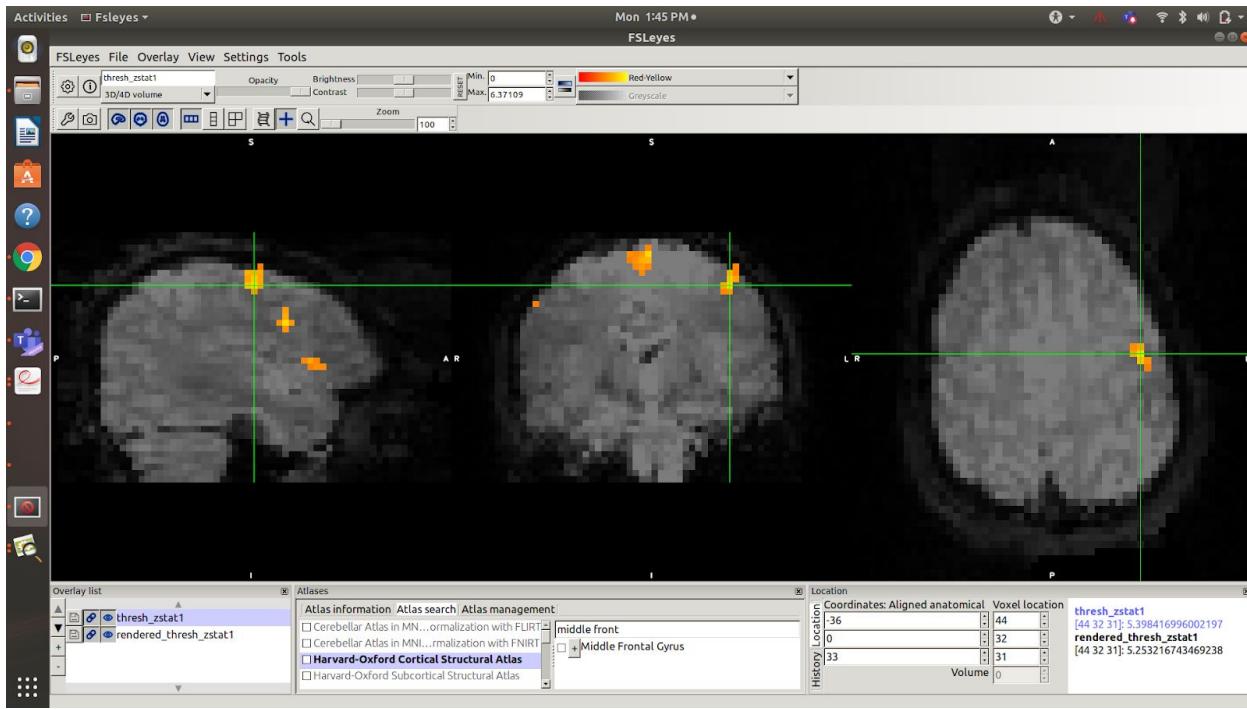
## Precentral Gyrus



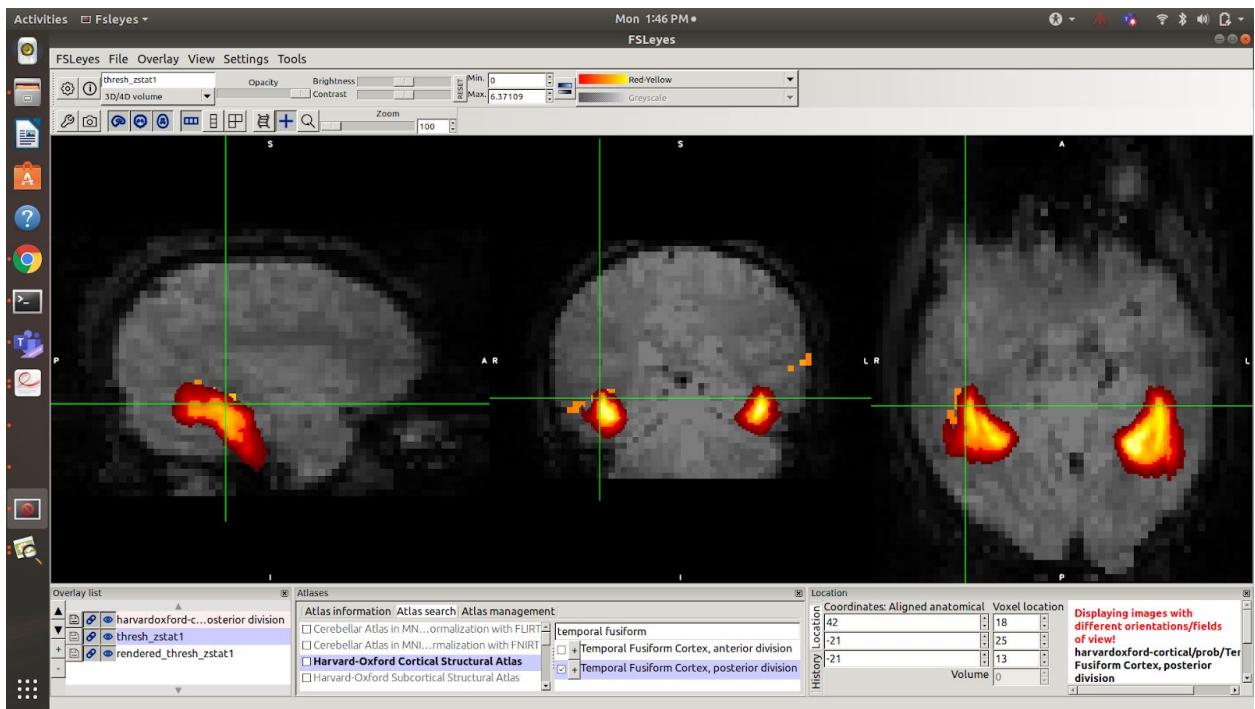
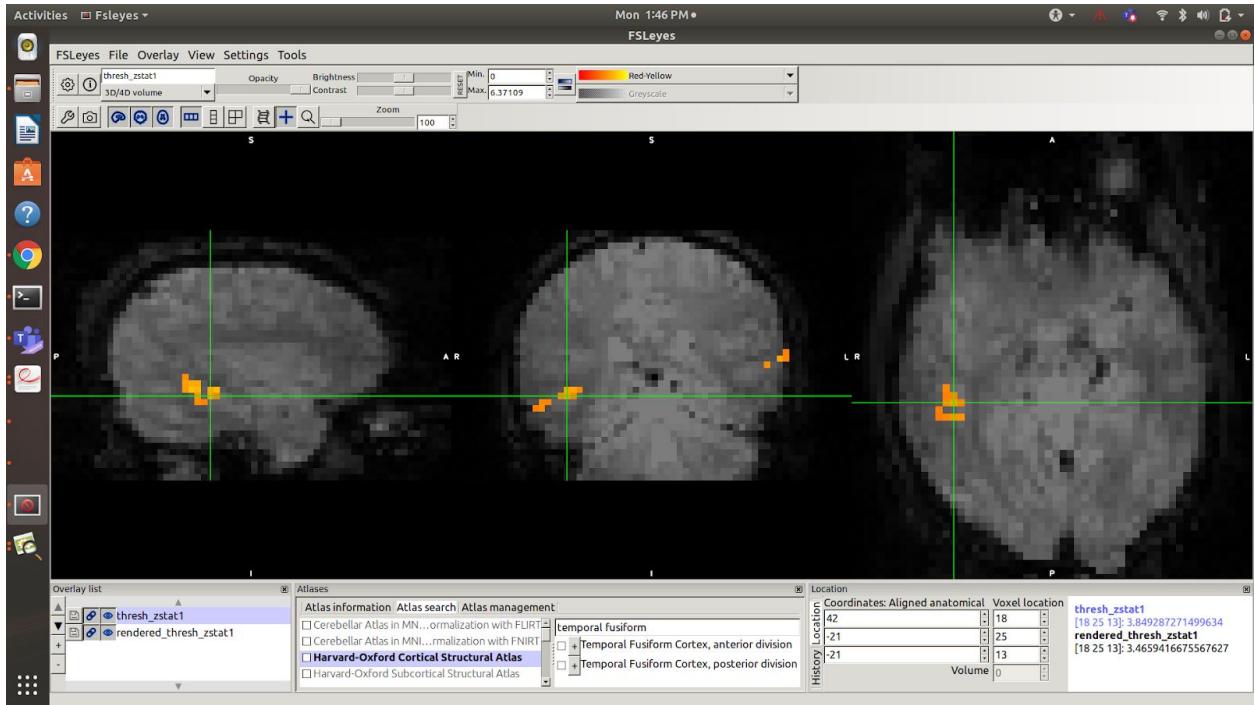
Superior frontal gyrus



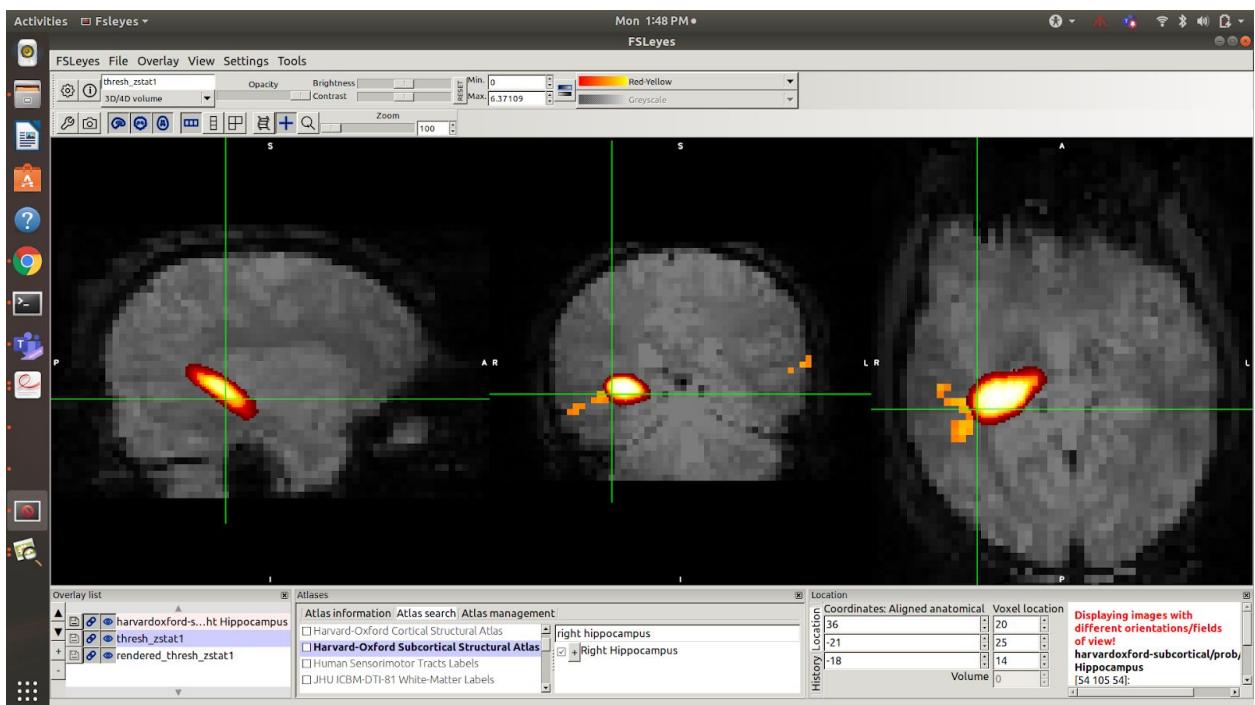
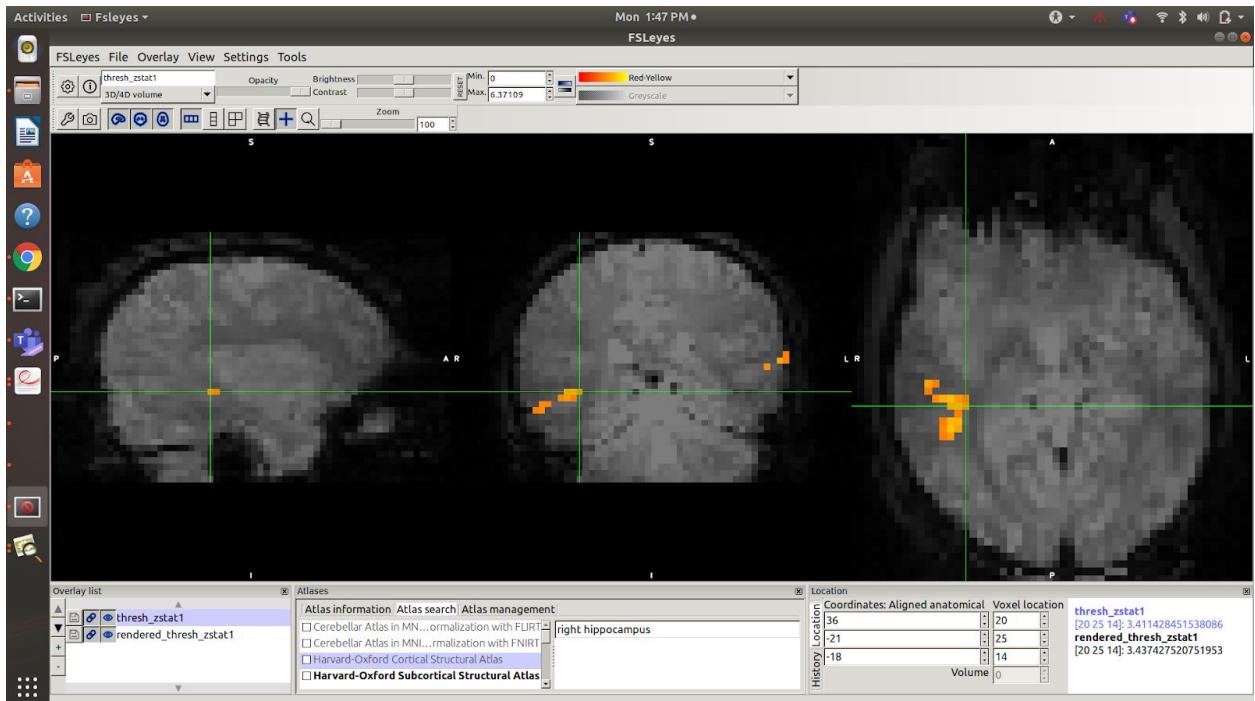
Middle frontal gyrus



Temporal fusiform cortex, posterior division

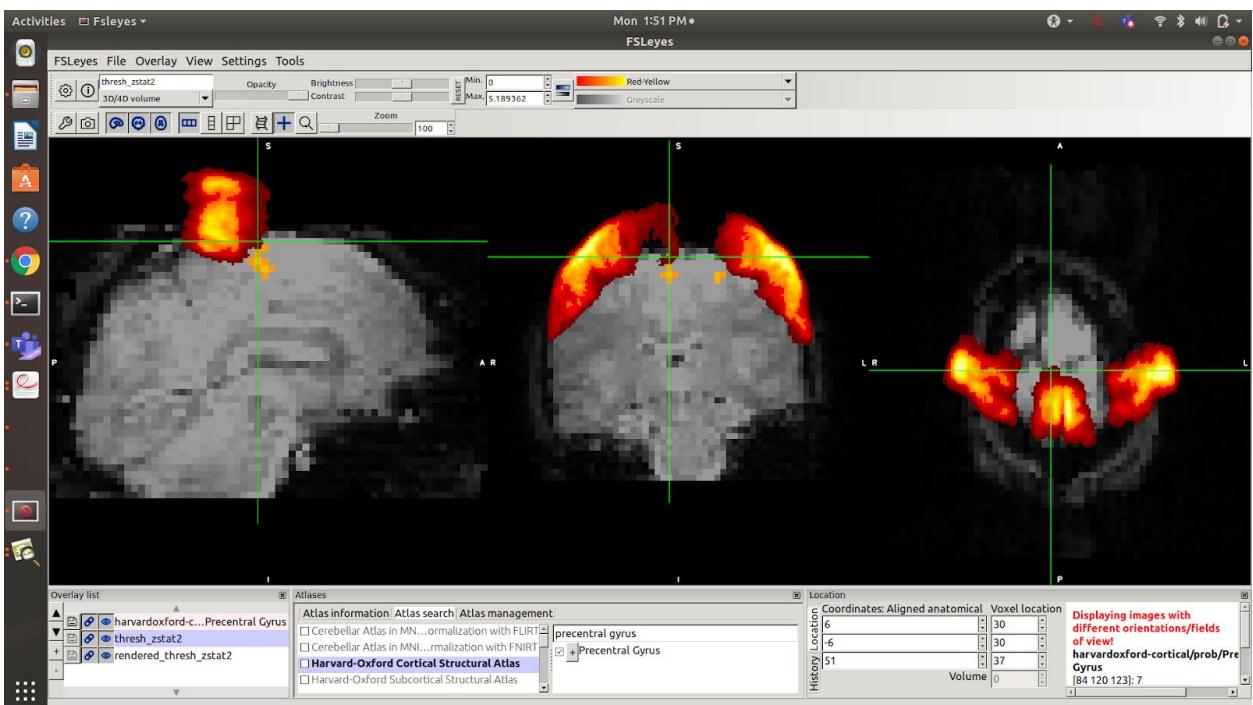
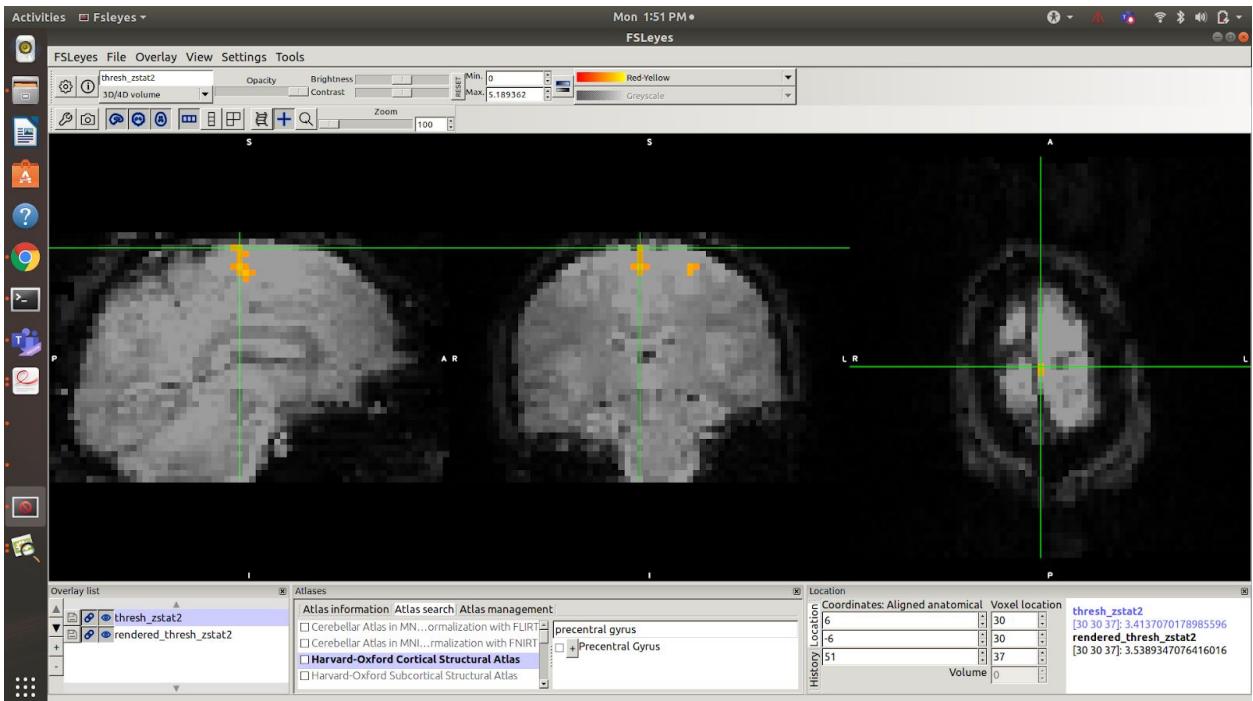


## Right hippocampus

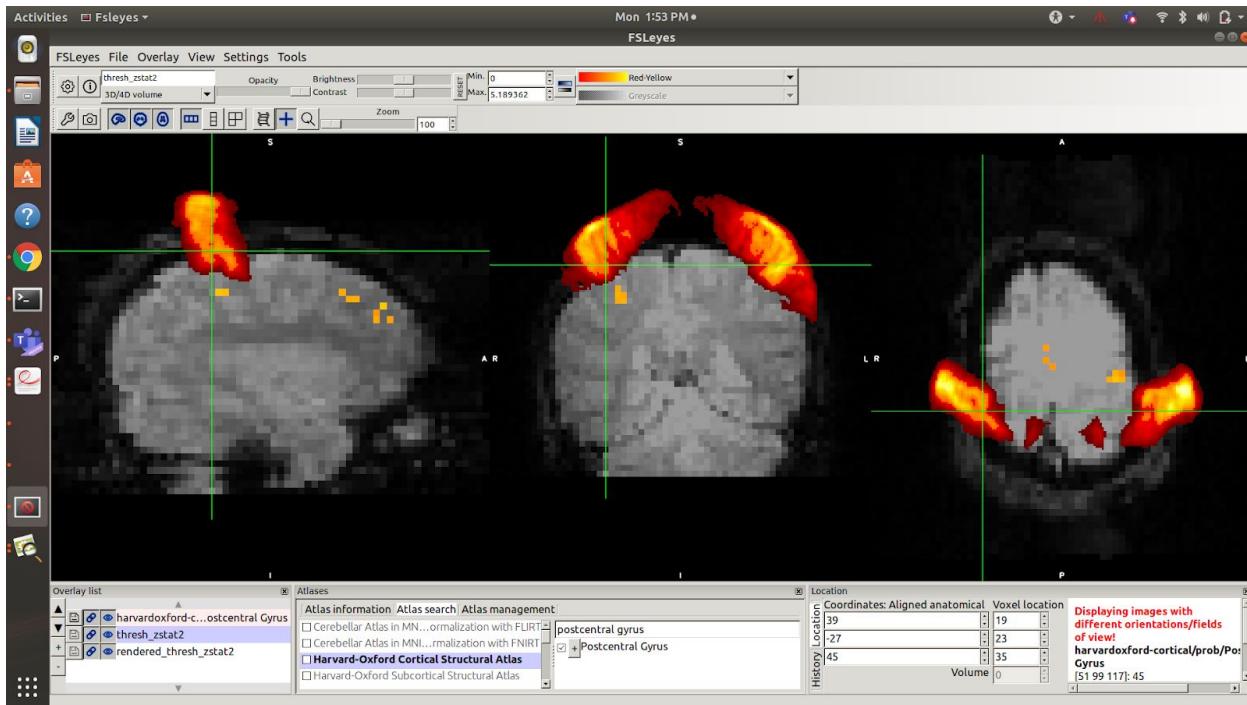
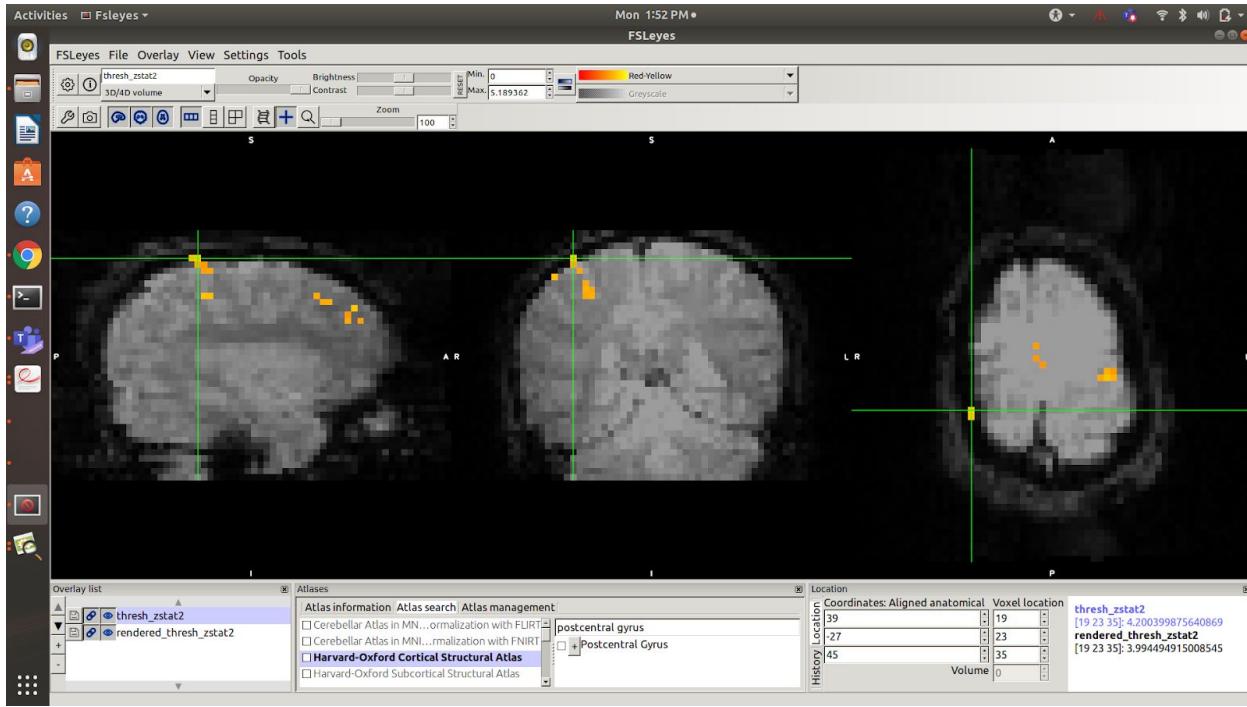


b)video left motor- checkerboard (EV6 - EV4 - EV5)

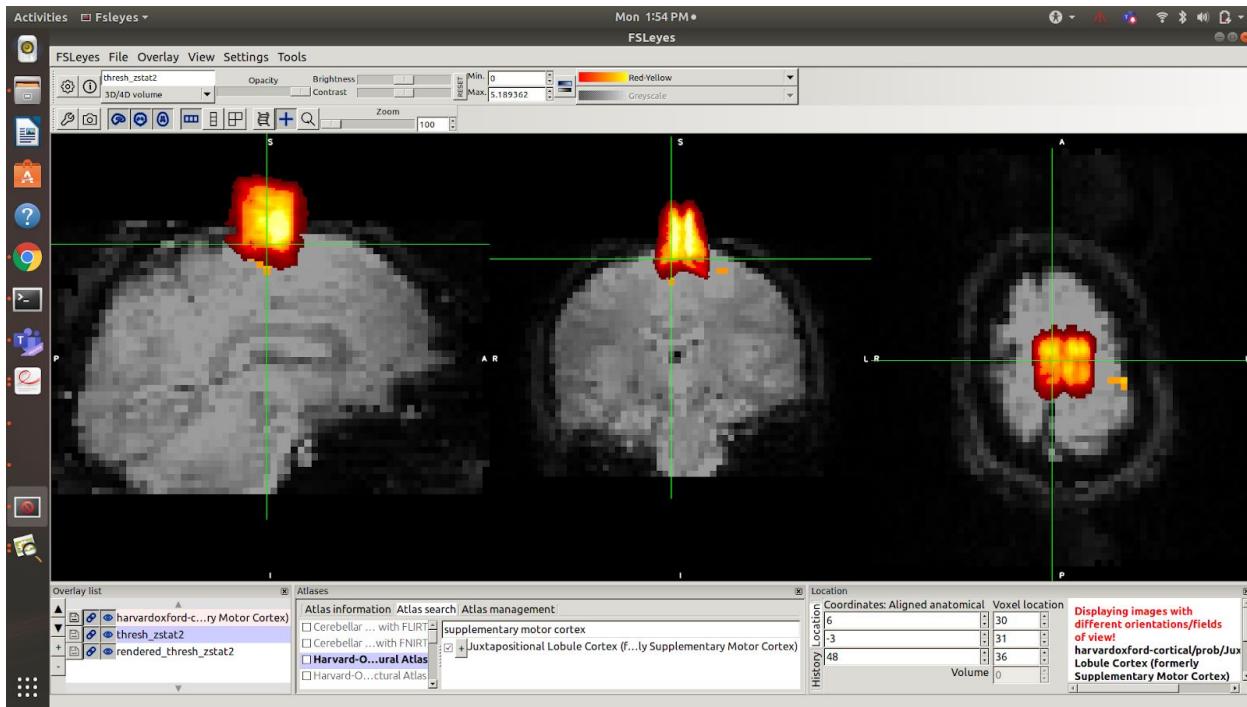
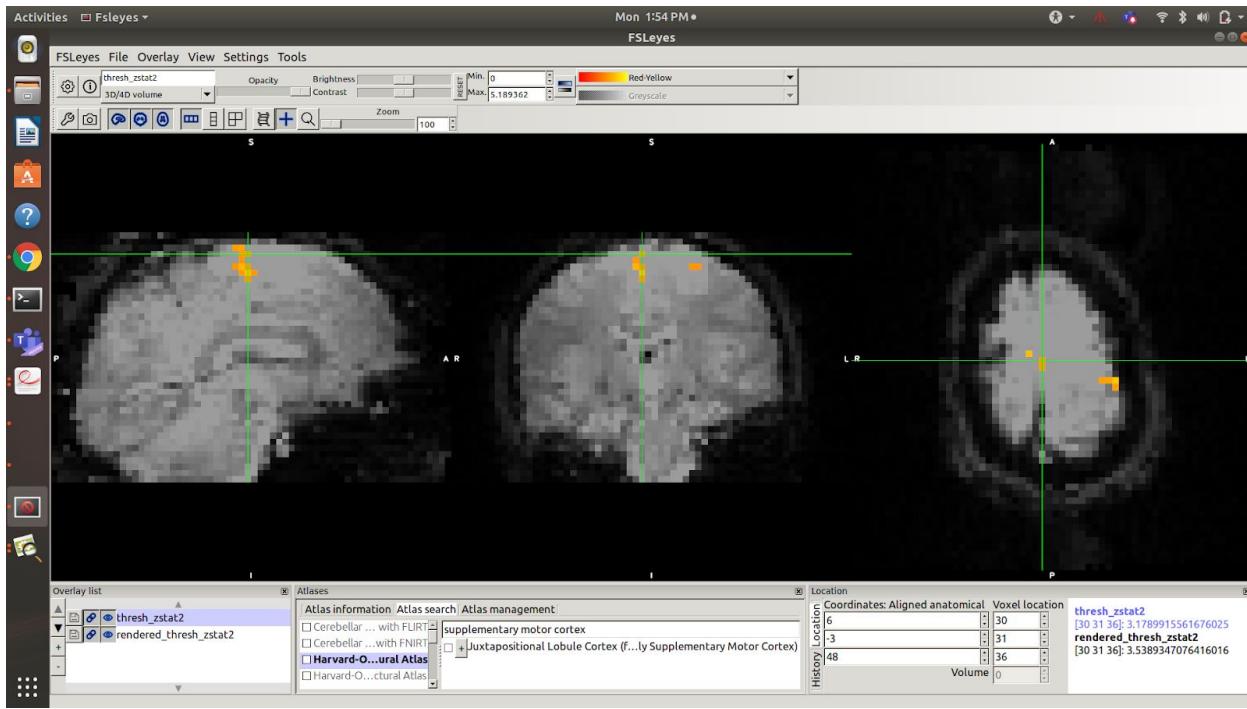
## Precentral gyrus



## Postcentral gyrus

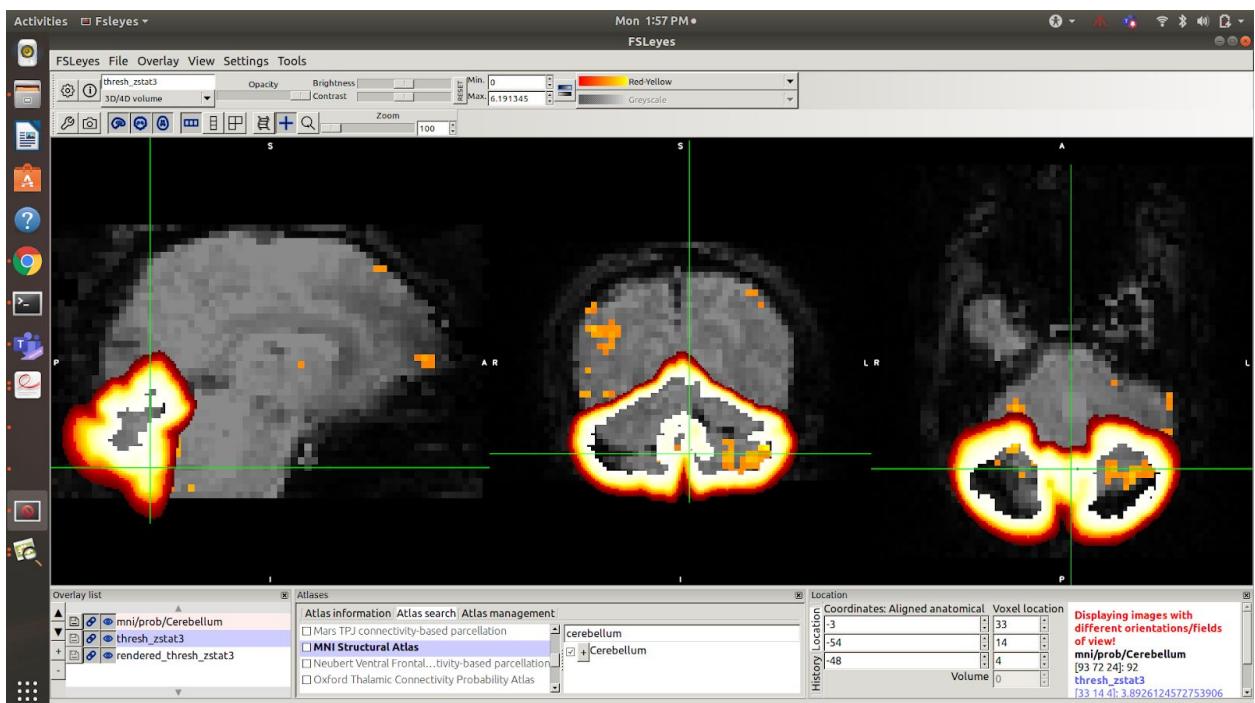
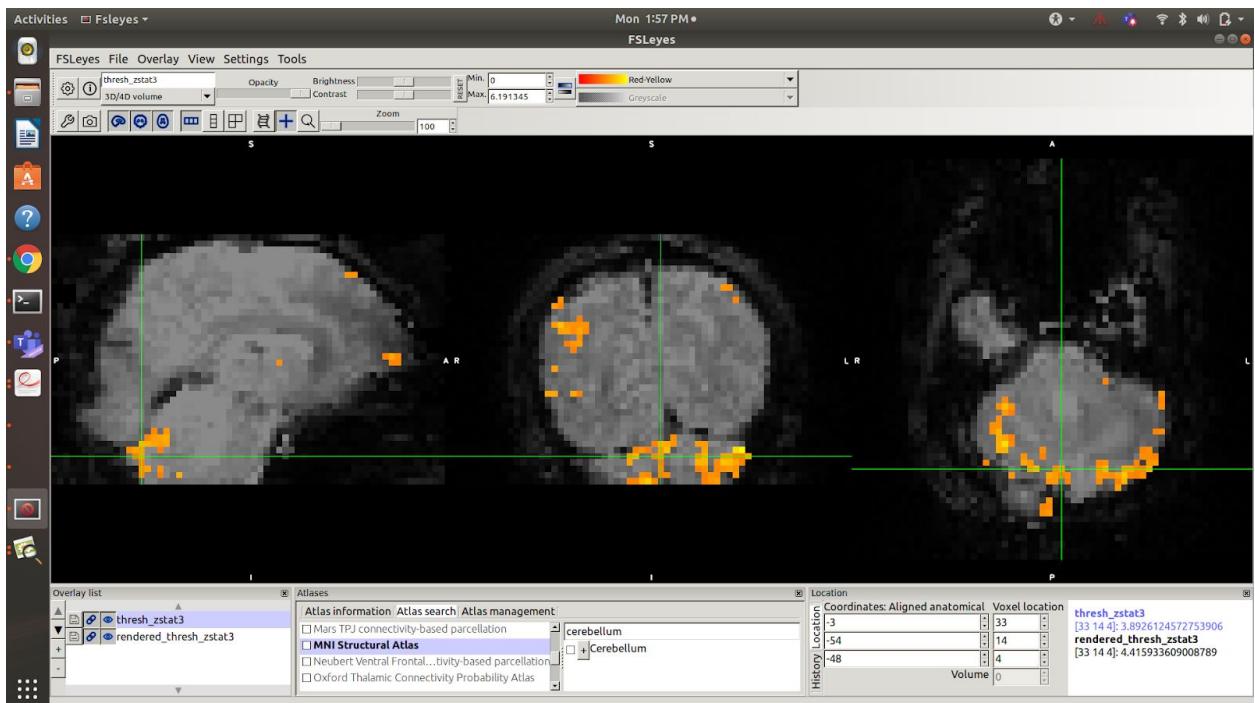


Supplementary motor cortex

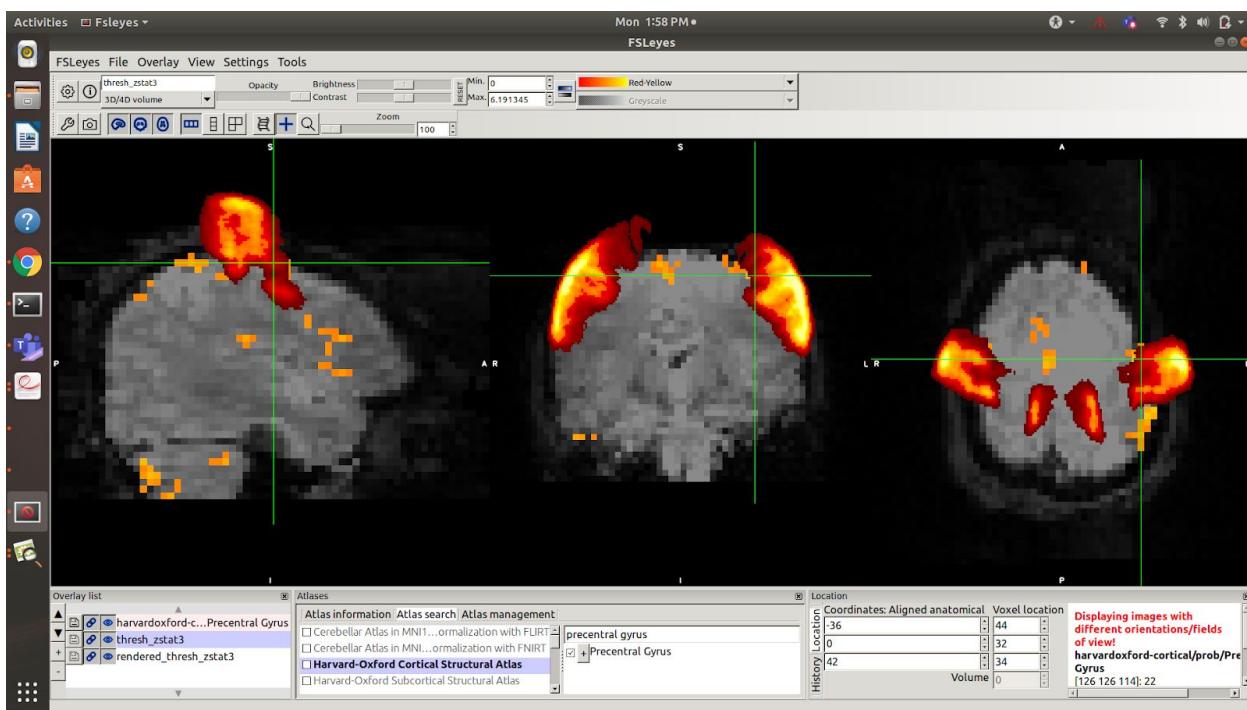
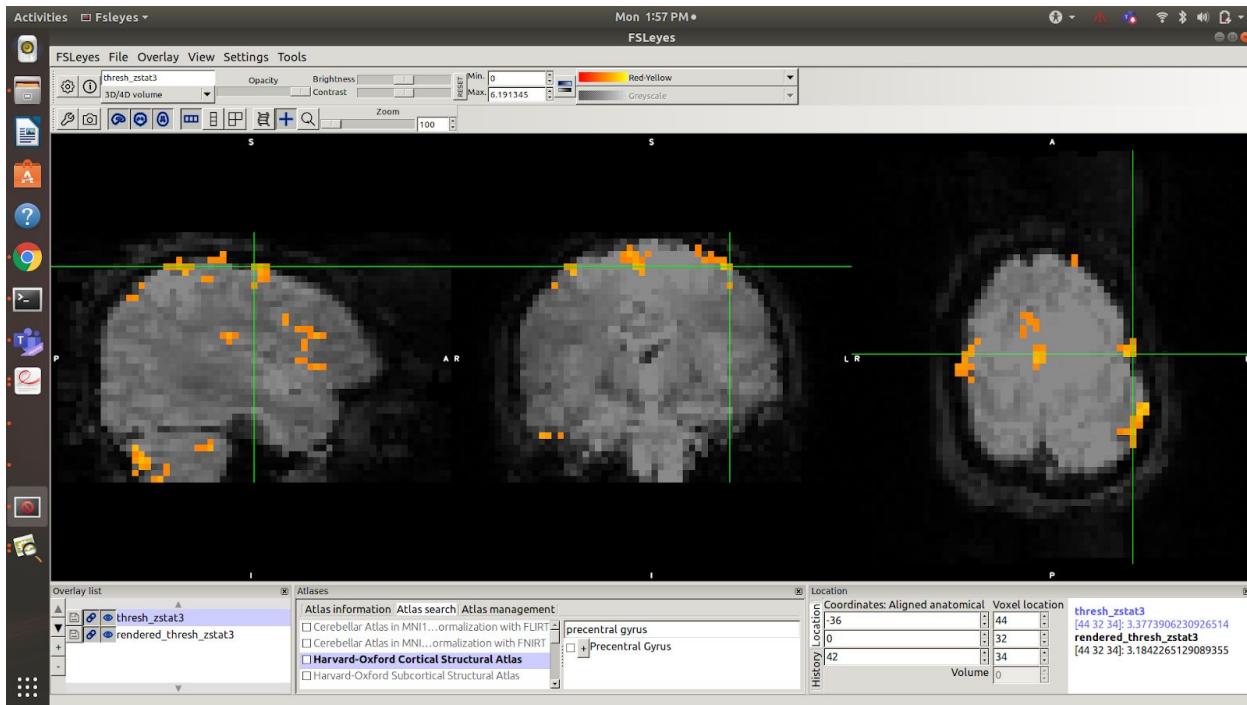


c)video right motor- checkerboard (EV7 - EV4 - EV5)

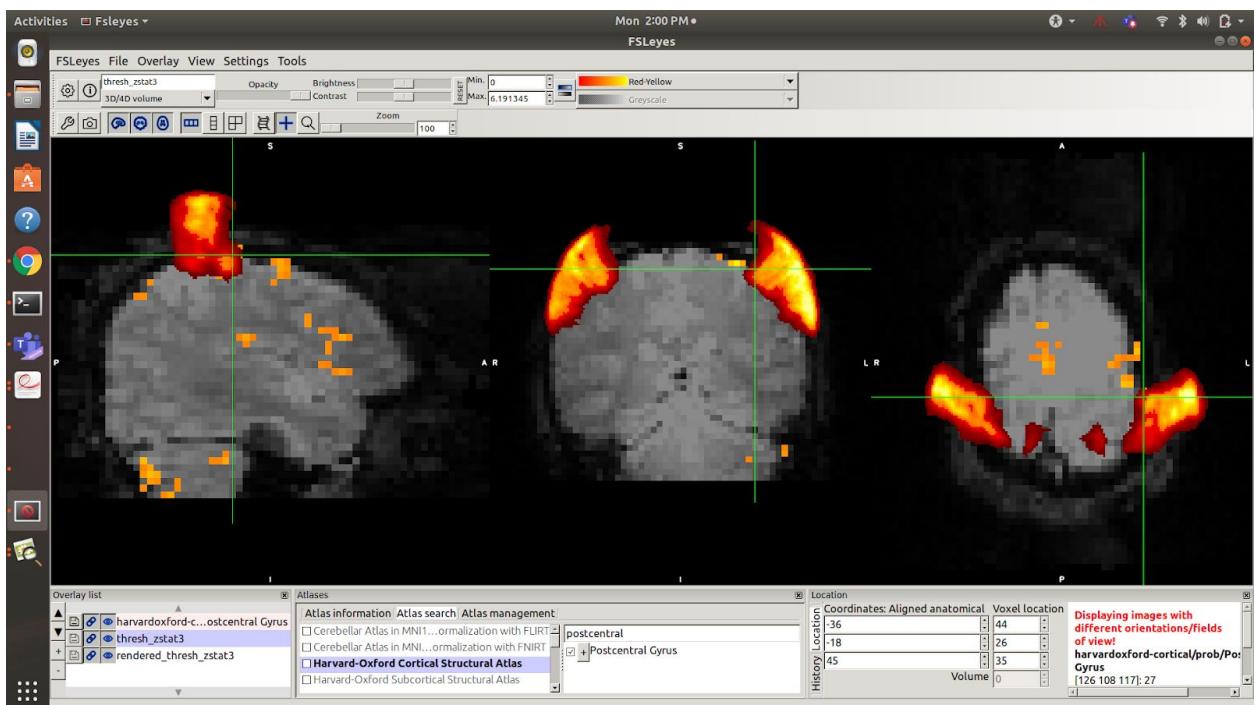
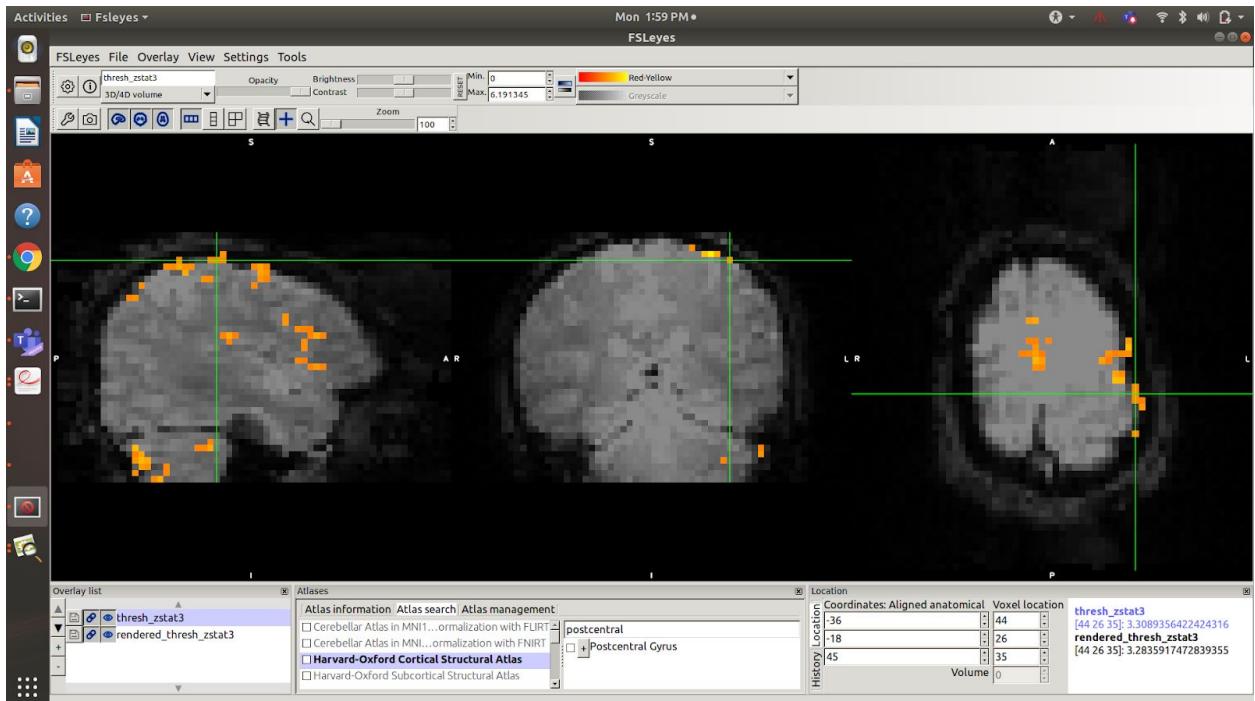
## Cerebellum



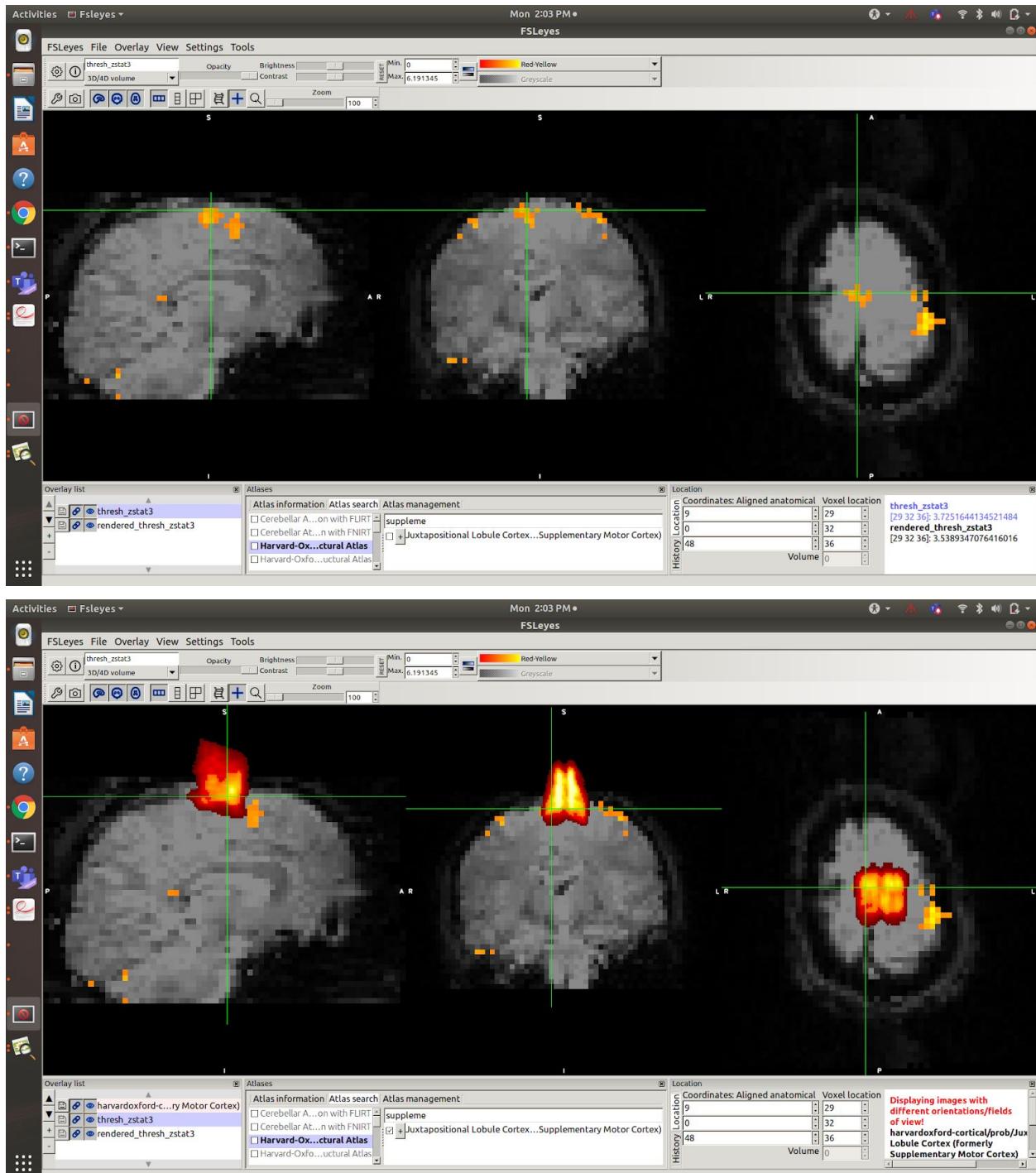
## Precentral gyrus



## Postcentral gyrus

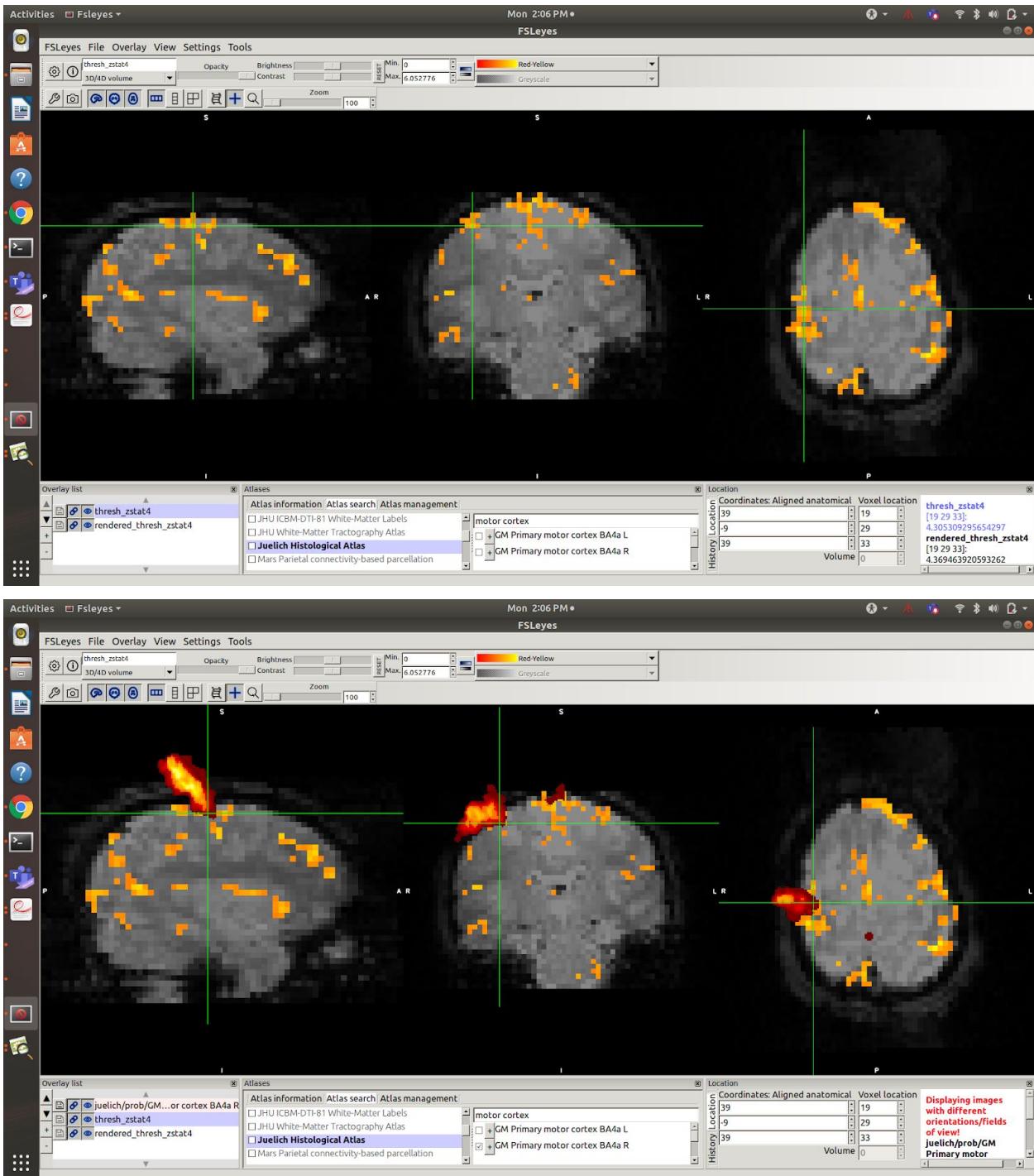


## Supplementary motor cortex

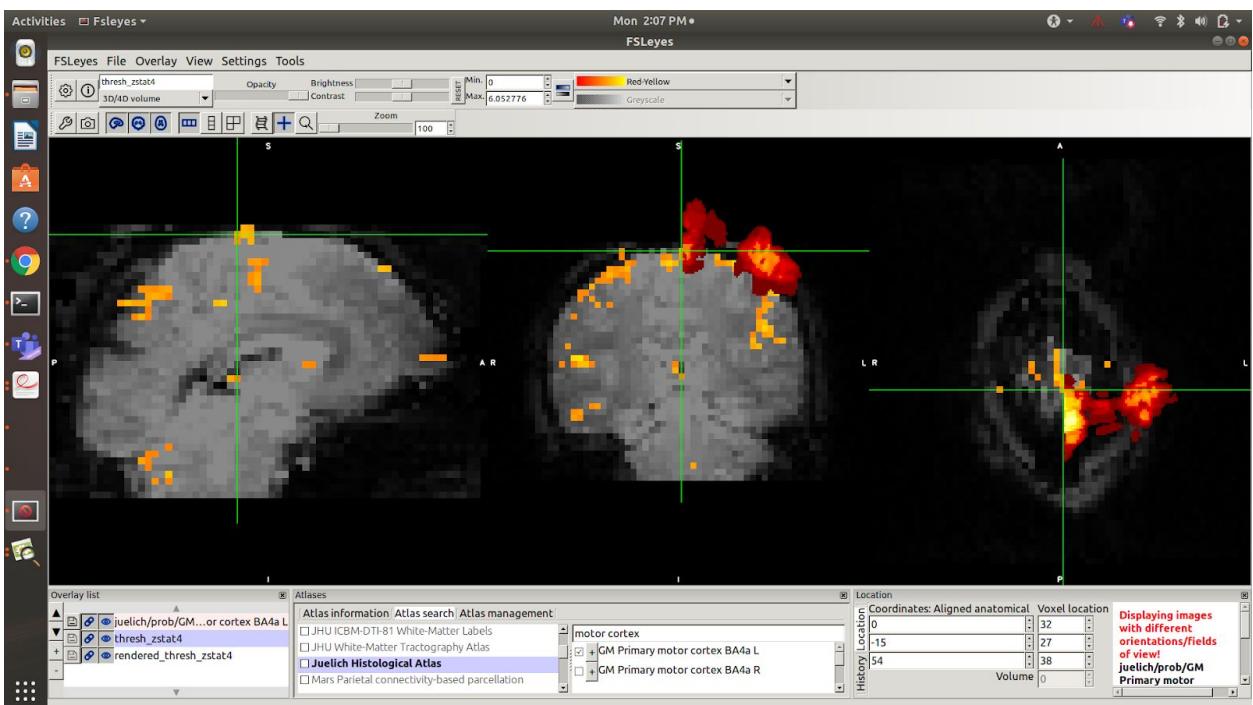
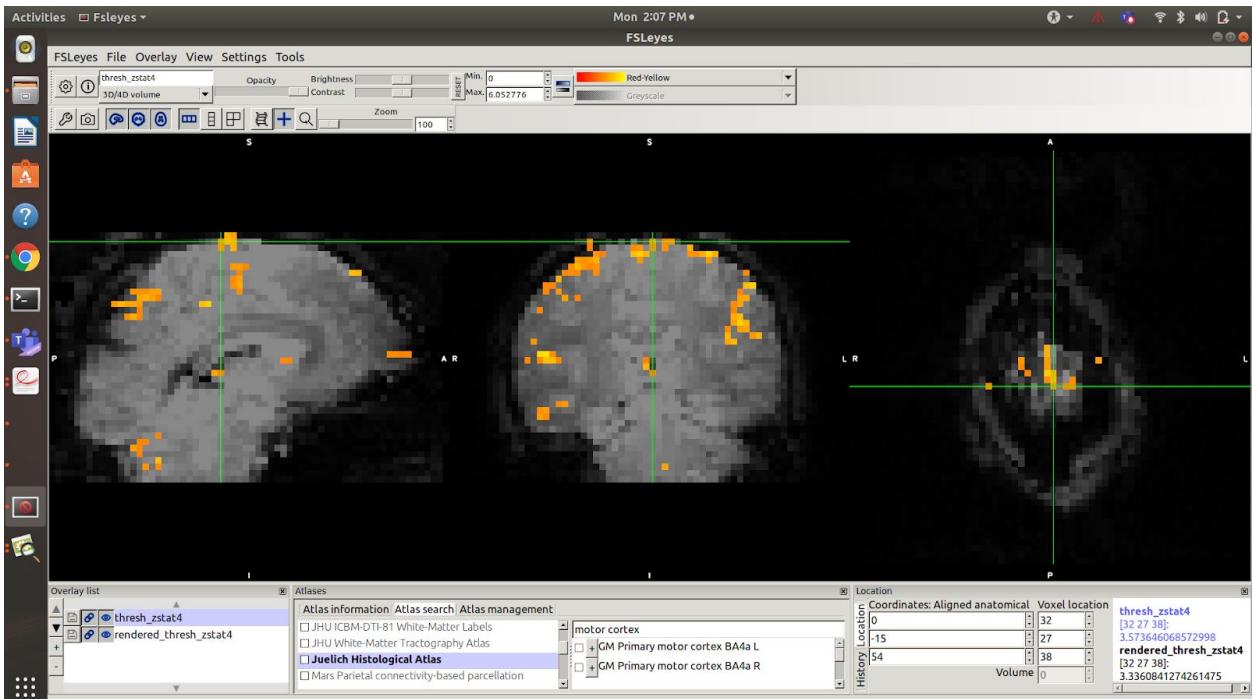


d)video motor- checkerboard (EV6 + EV7 - EV4 - EV5)

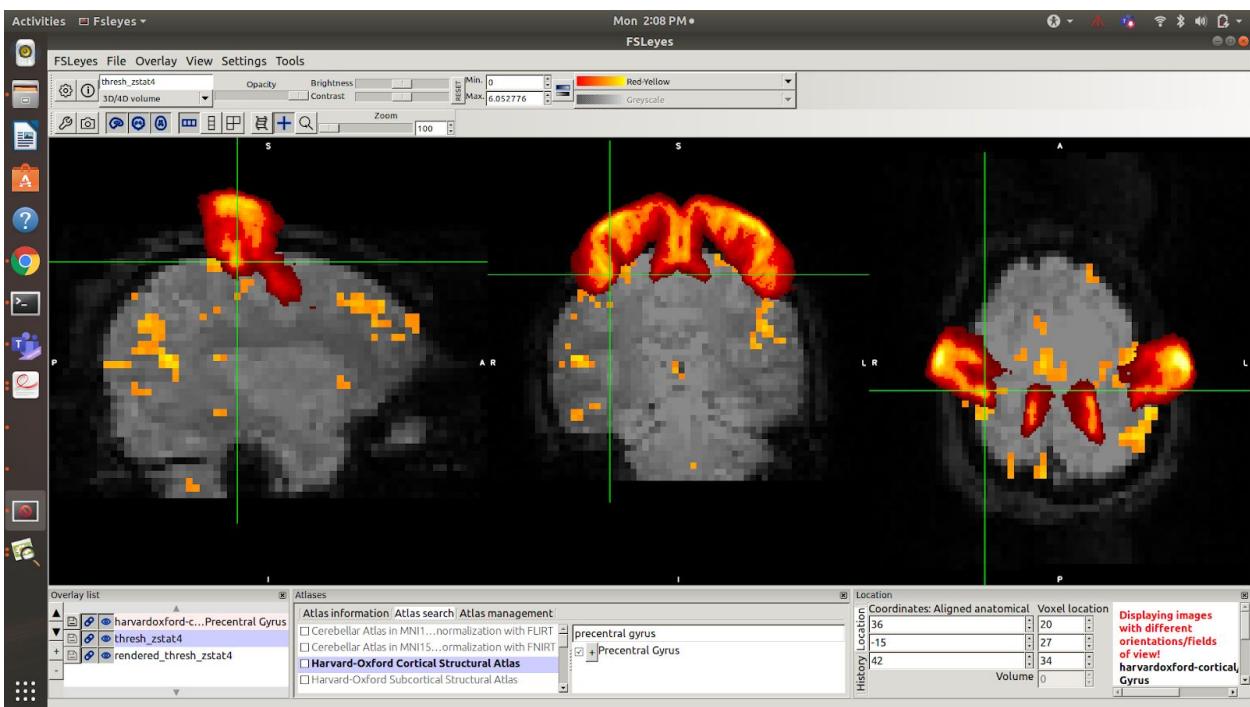
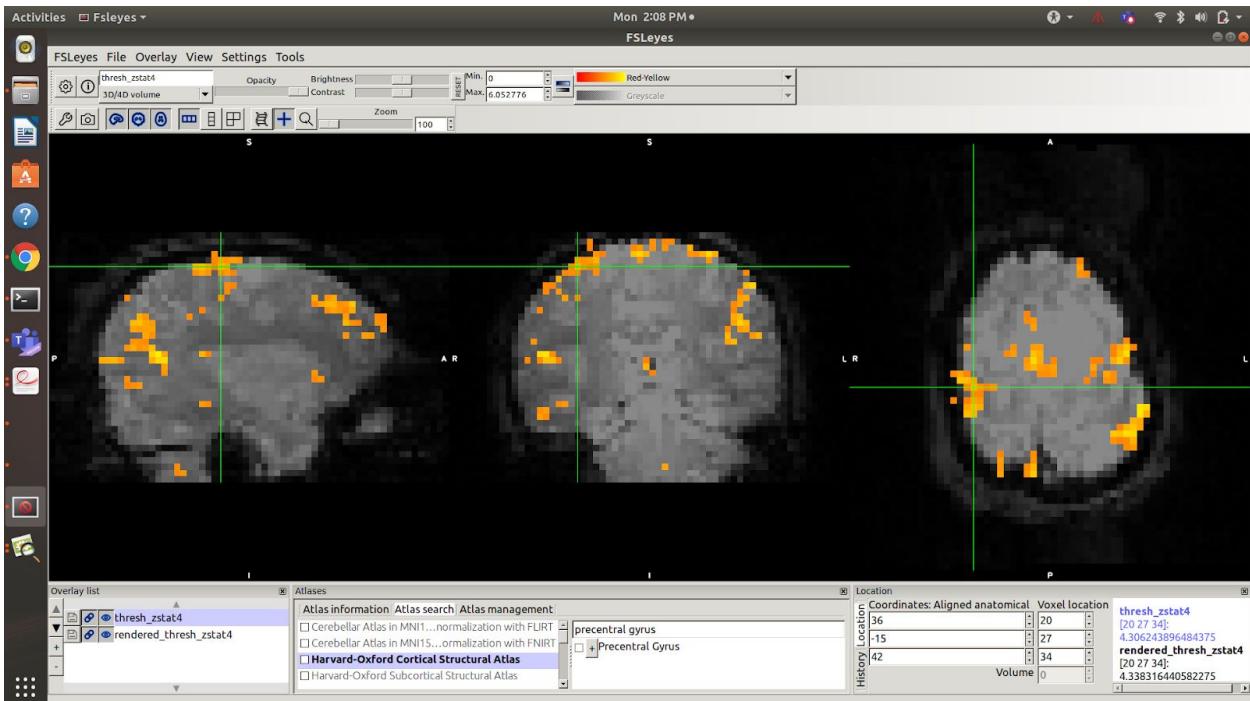
## GM primary motor cortex R



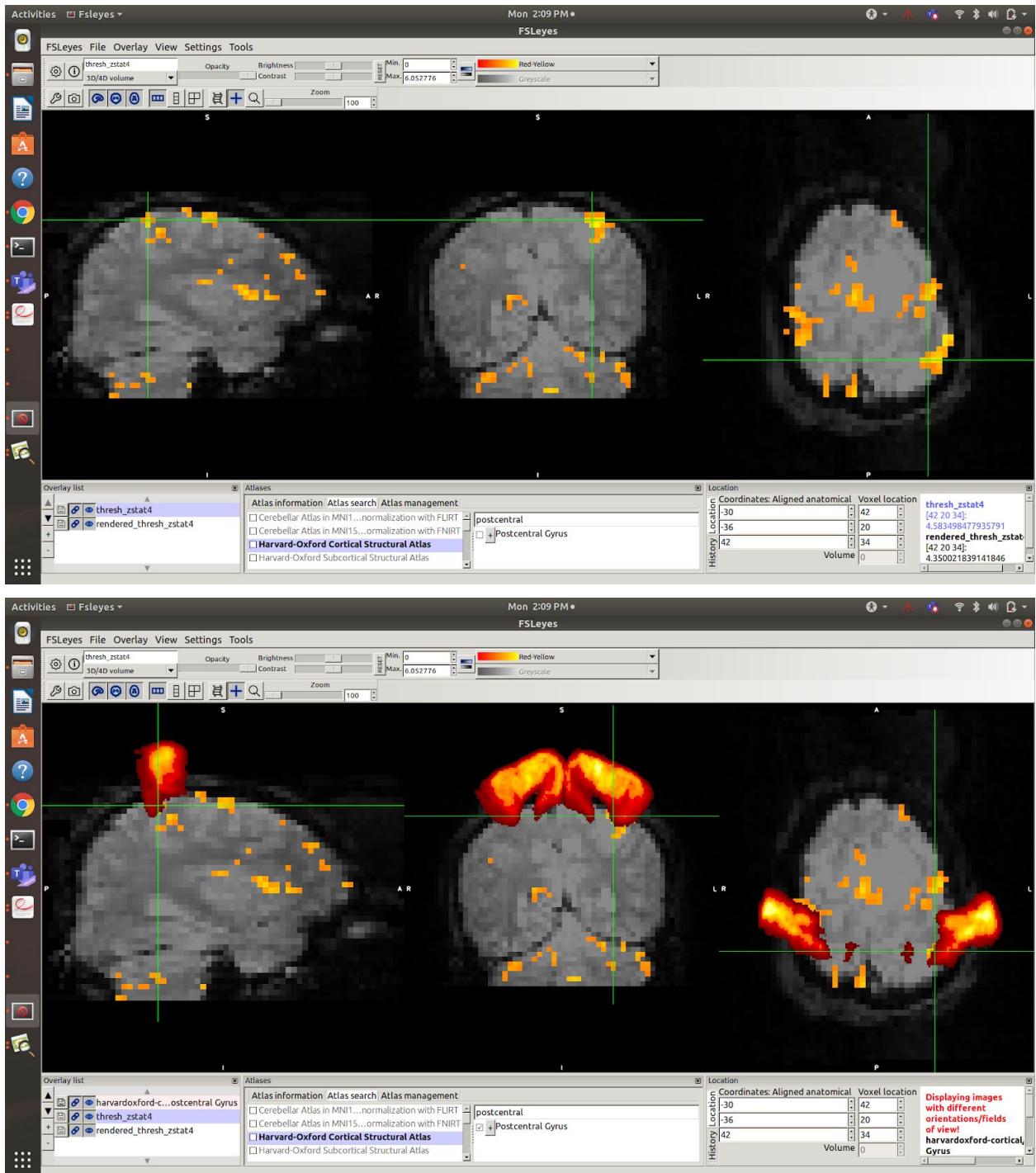
## GM primary motor cortex L



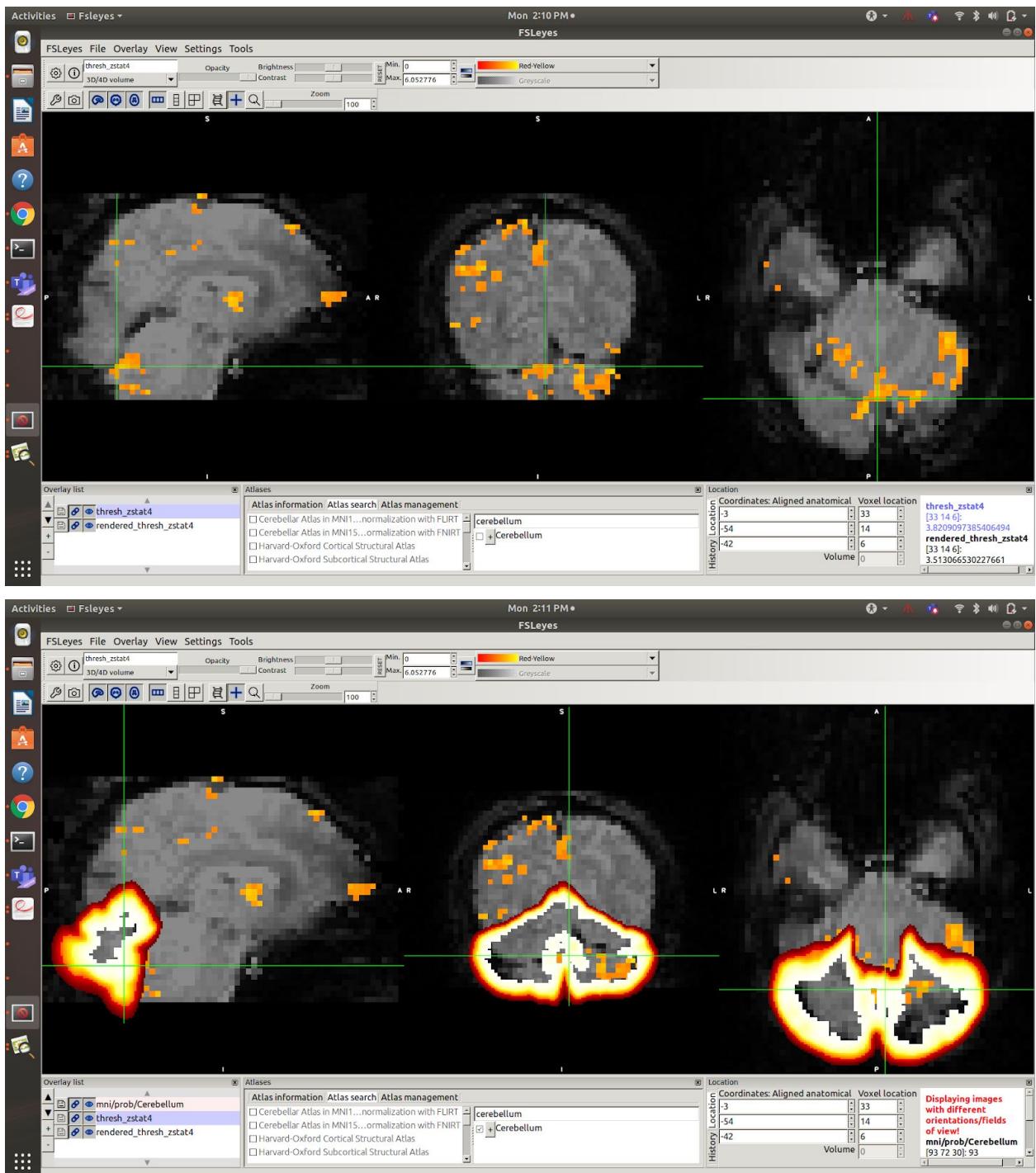
## Precentral gyrus



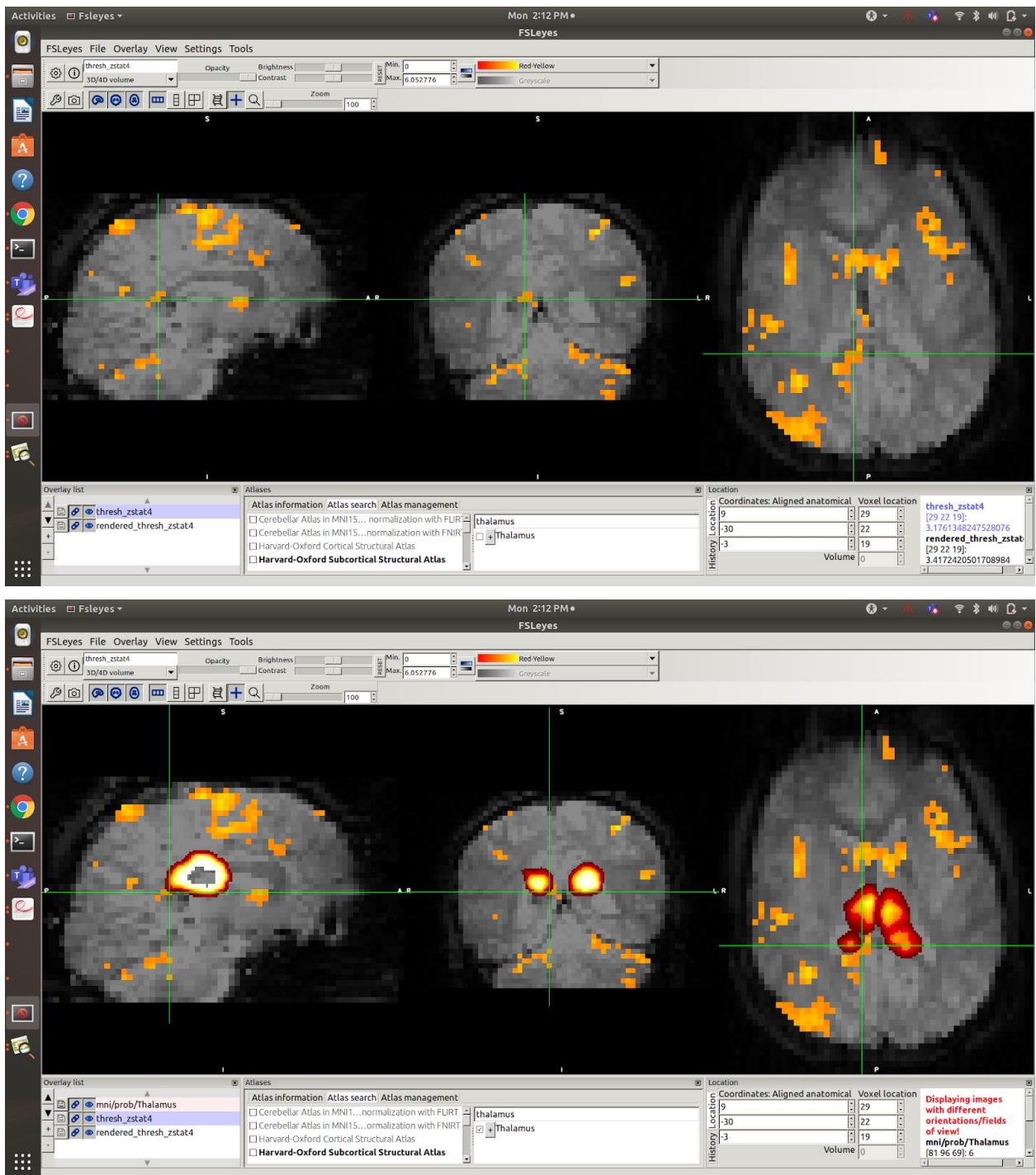
## Postcentral gyrus



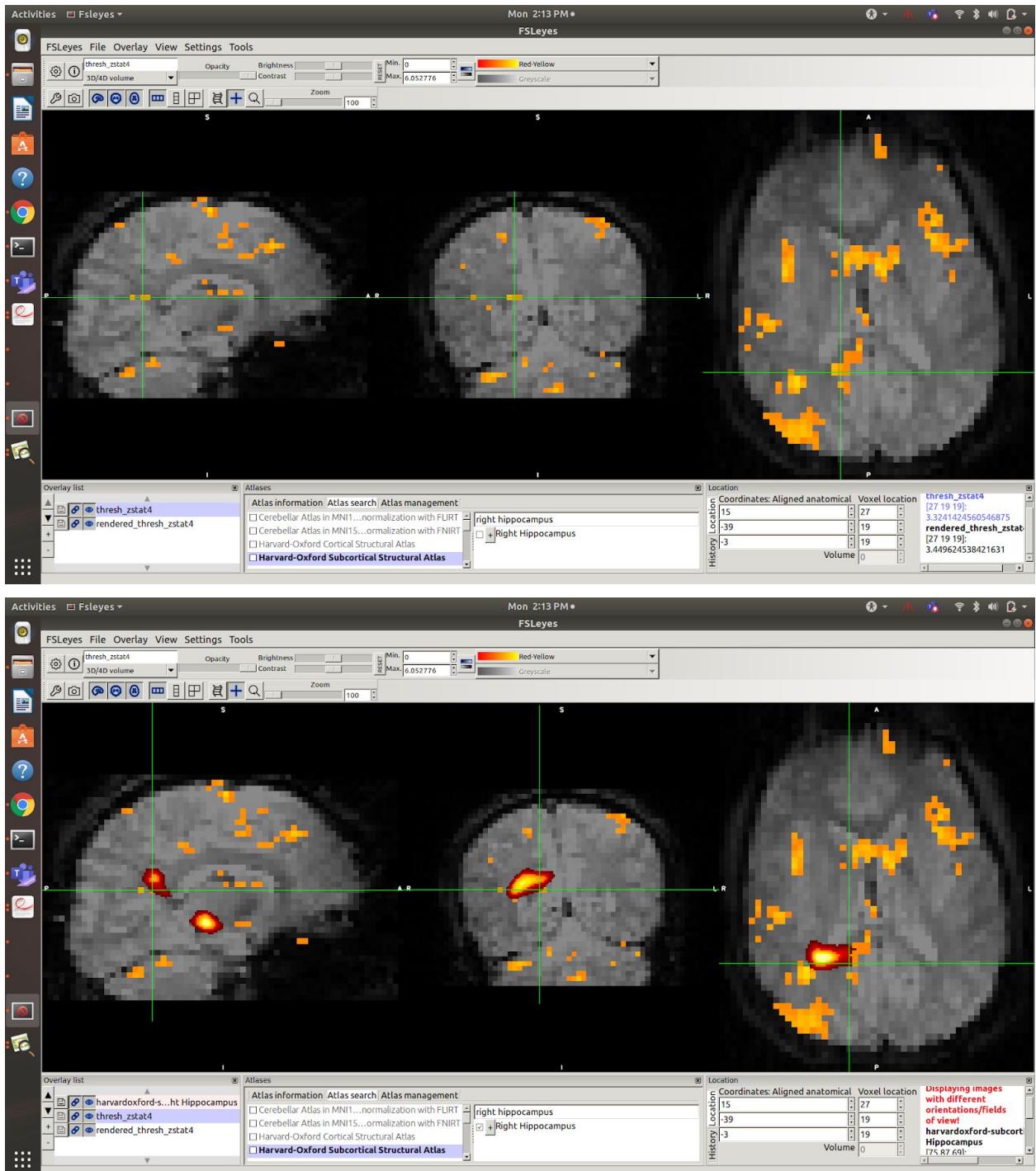
## Cerebellum



## Thalamus

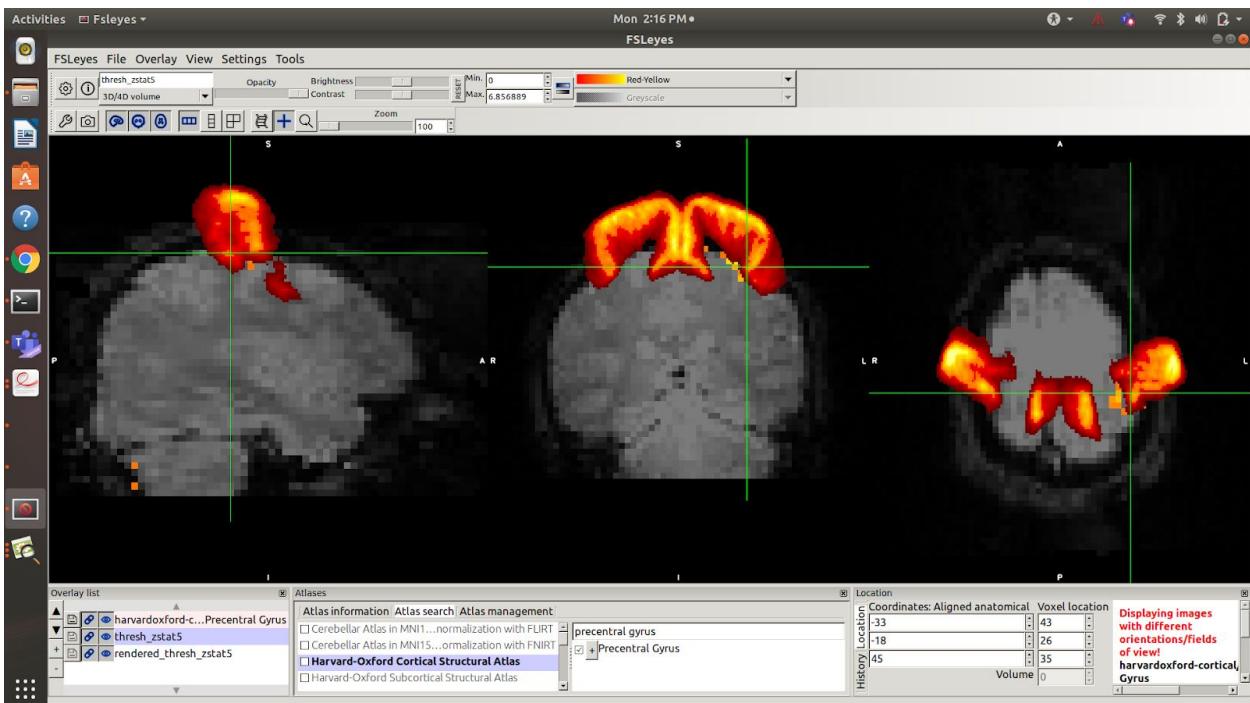


## Right hippocampus

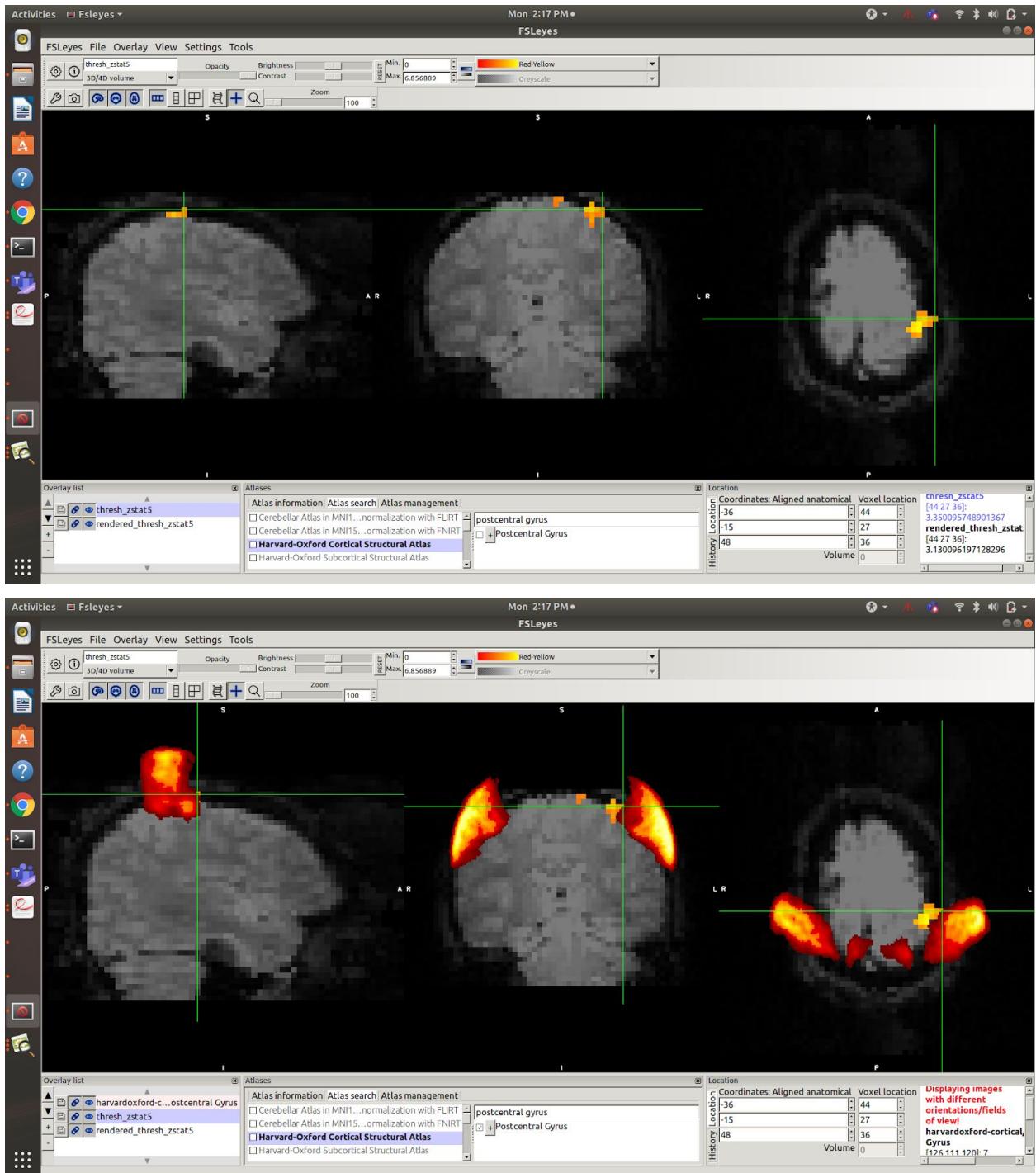


e)(video+audio)right motor- (video+audio)left motor  
(EV2+EV7 - EV1 - EV6)

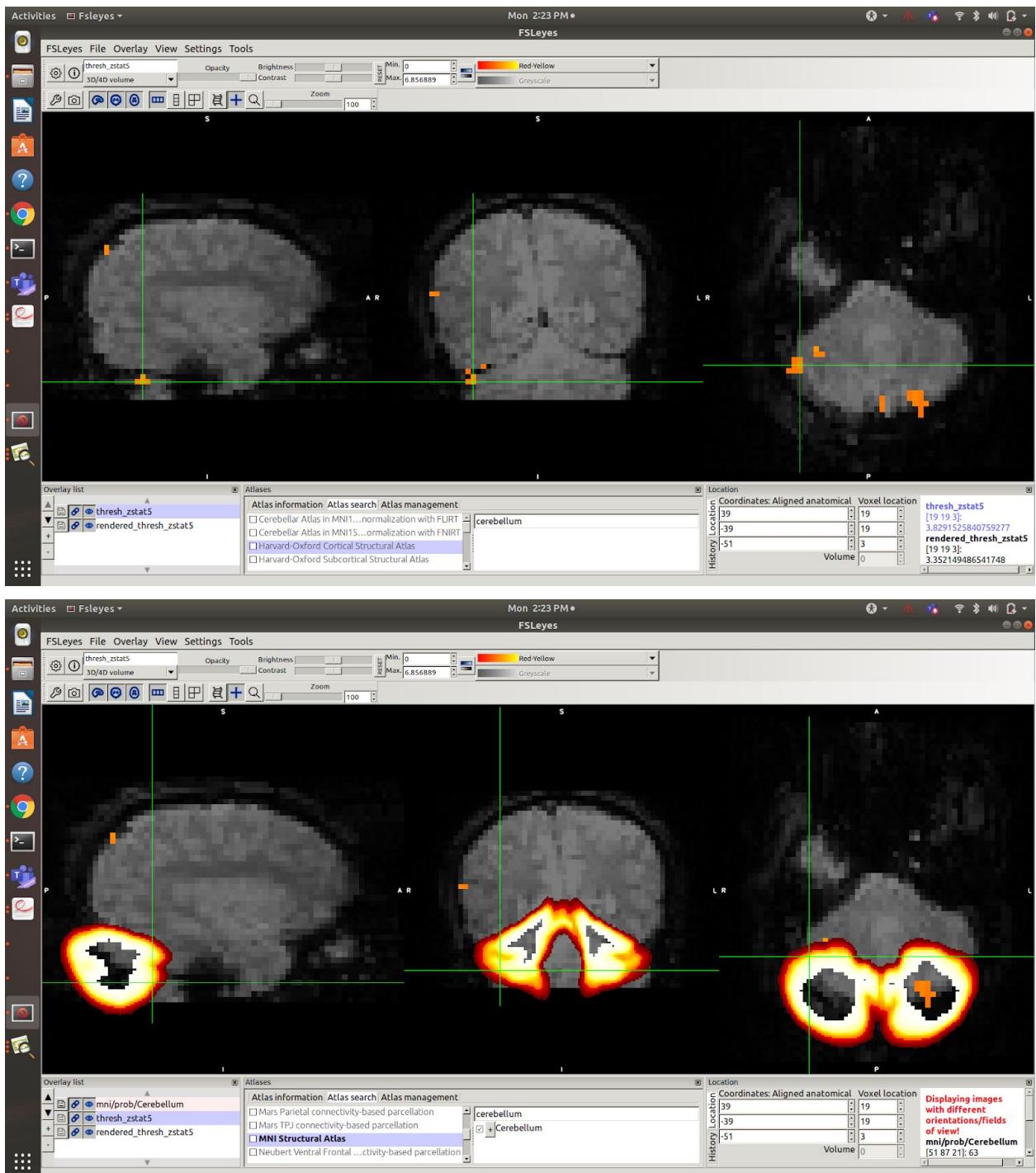
## Precentral gyrus



## Postcentral gyrus

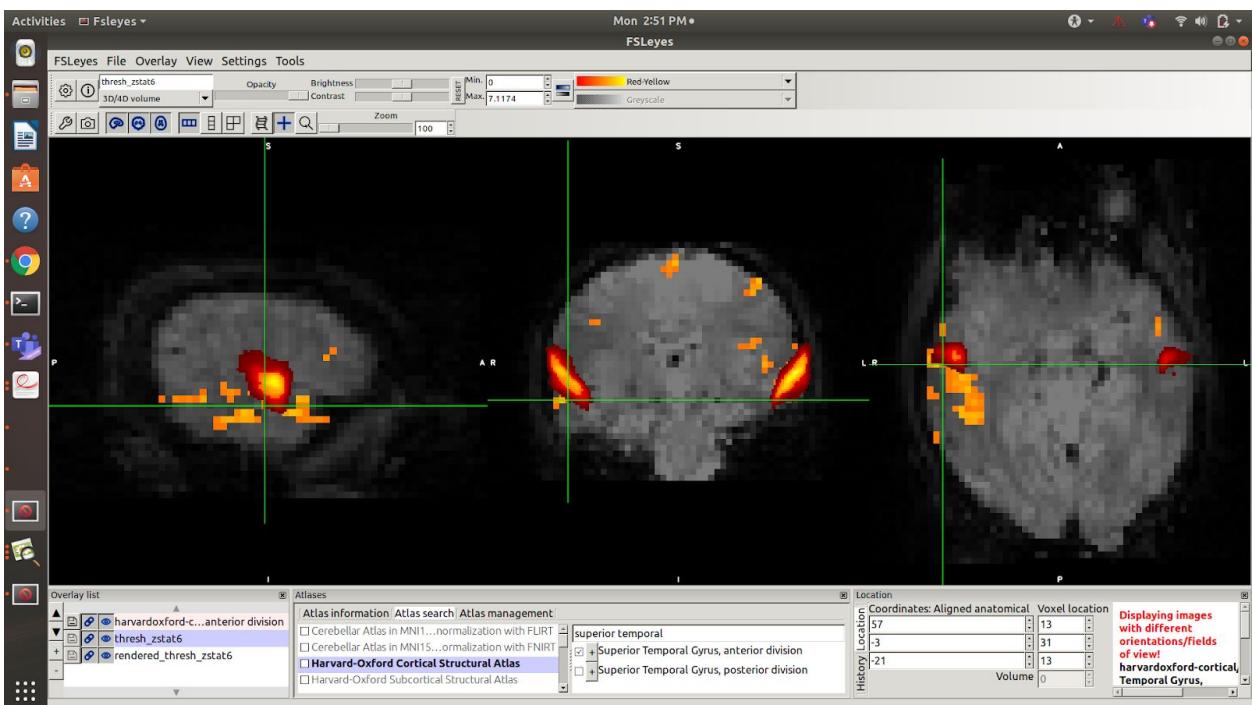
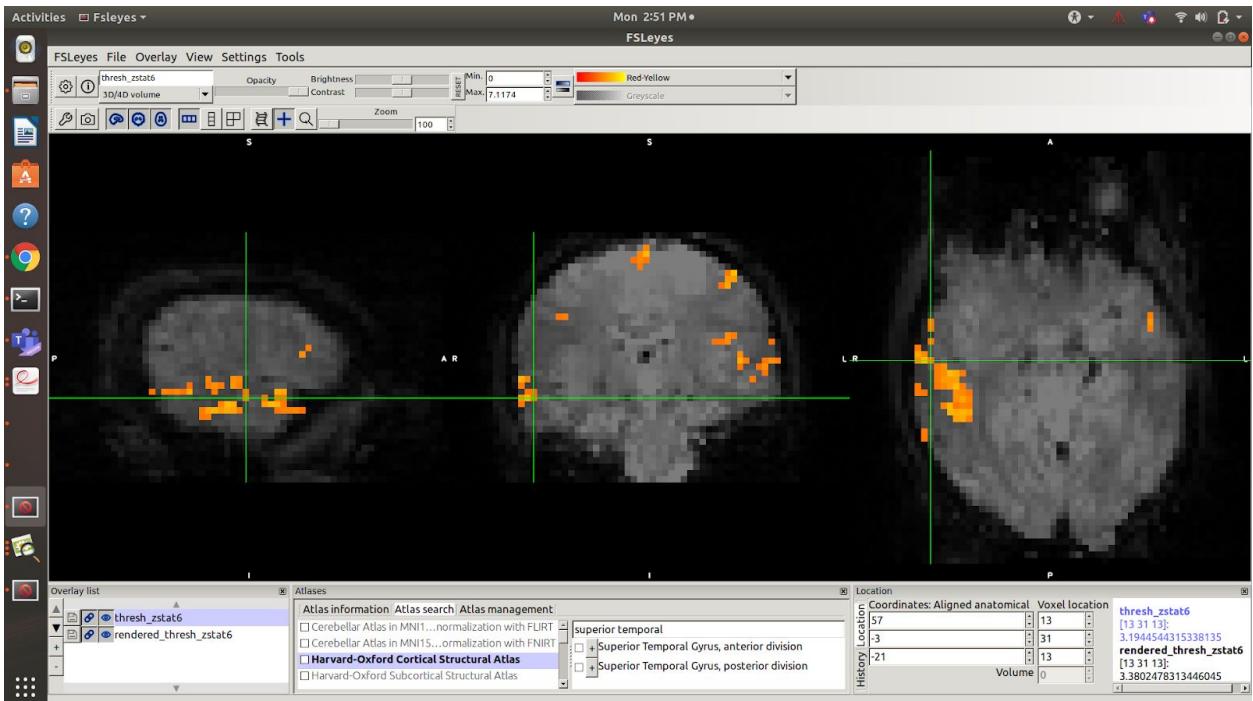


## cerebellum

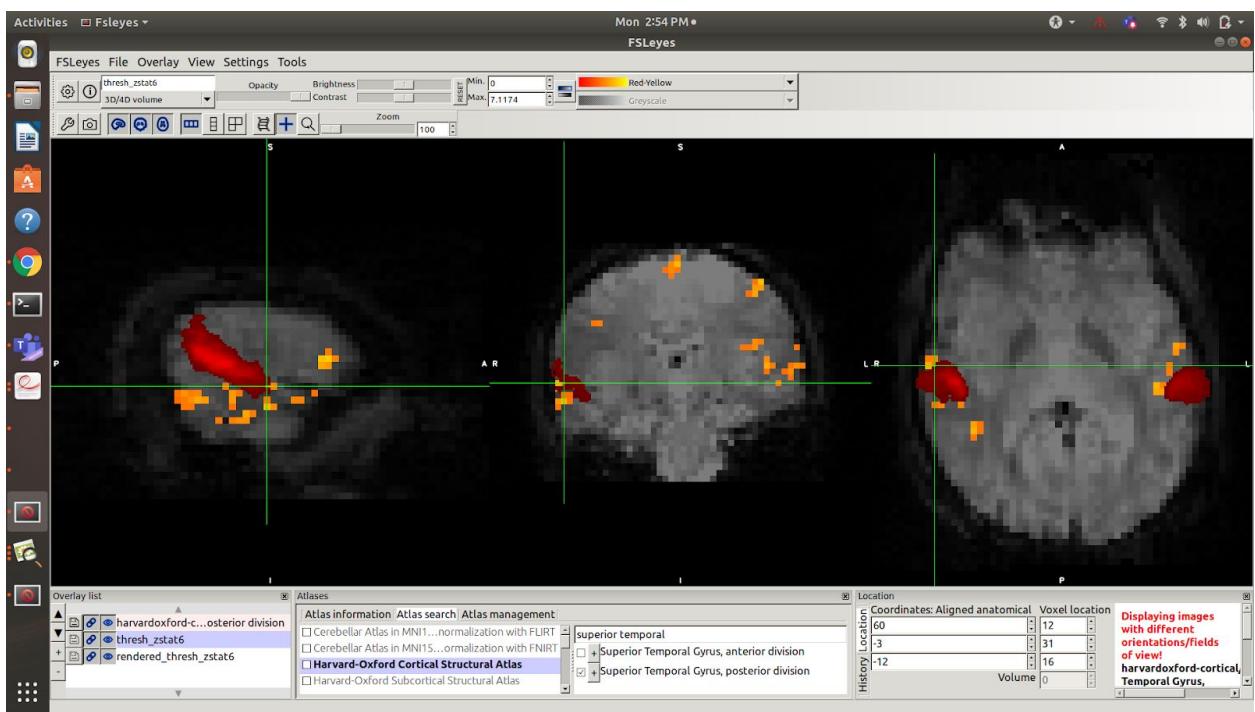
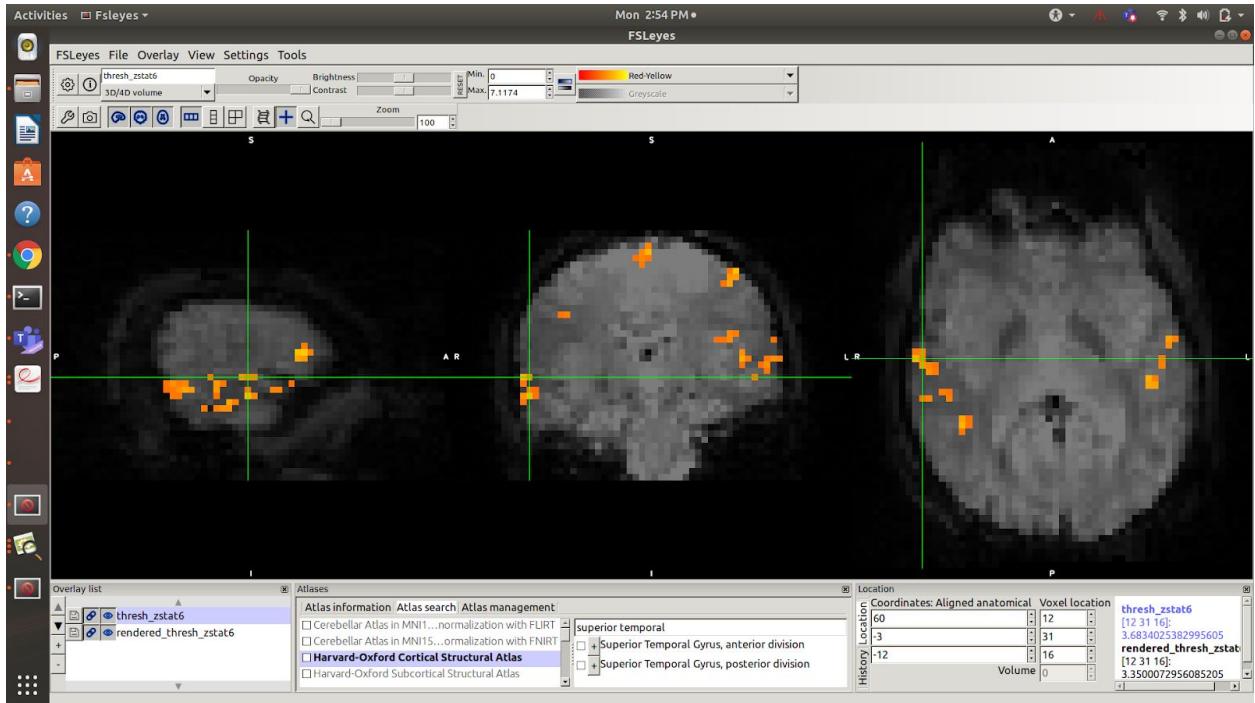


f)(video+audio)sentences- checkerboard (EV3+EV8 - EV4 - EV5)

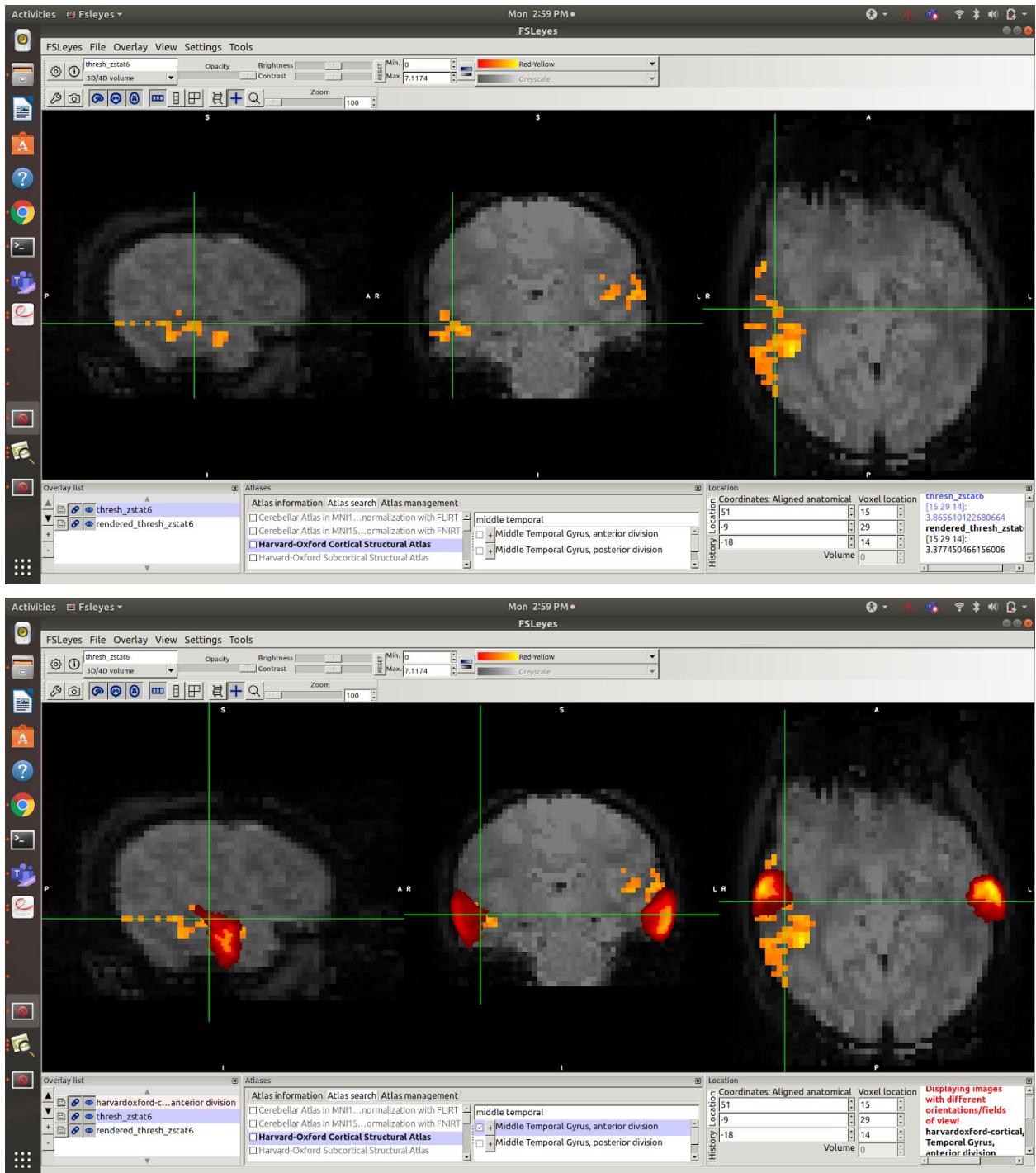
## Superior temporal gyrus, anterior division



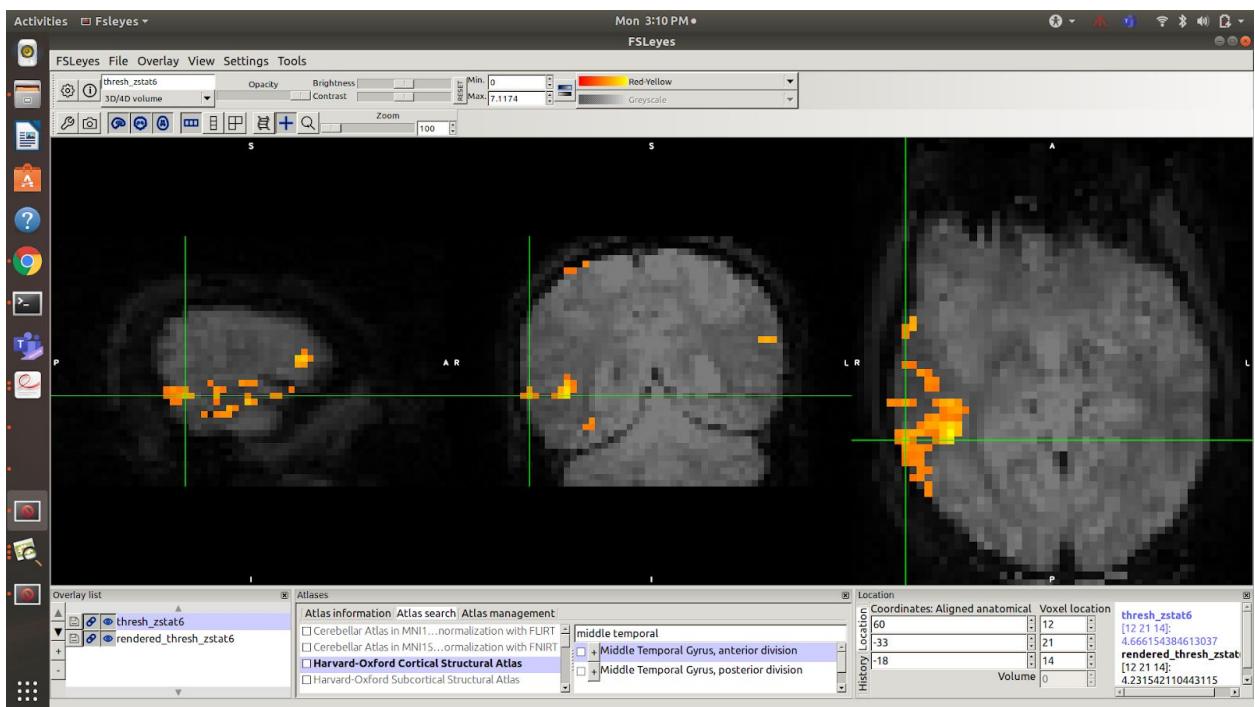
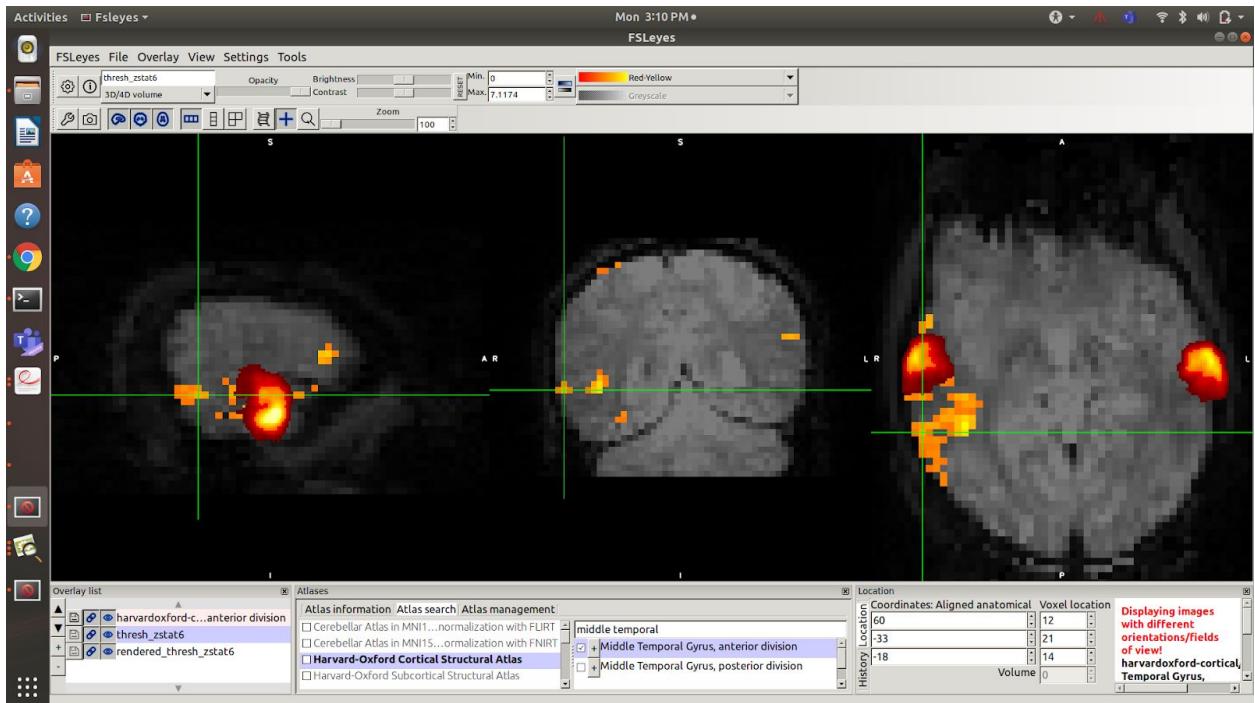
## Superior temporal gyrus, posterior division



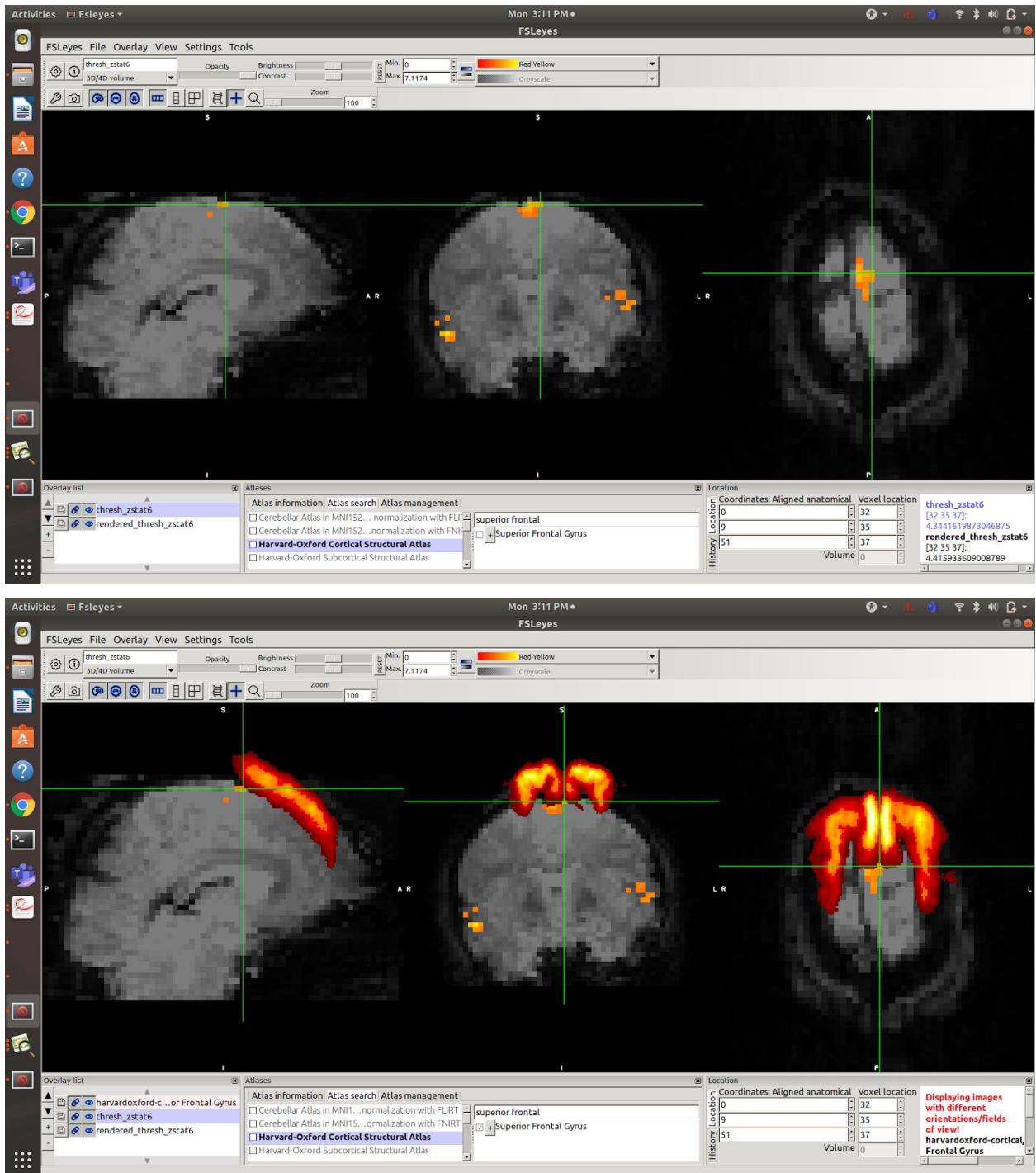
## Middle temporal gyrus, anterior division



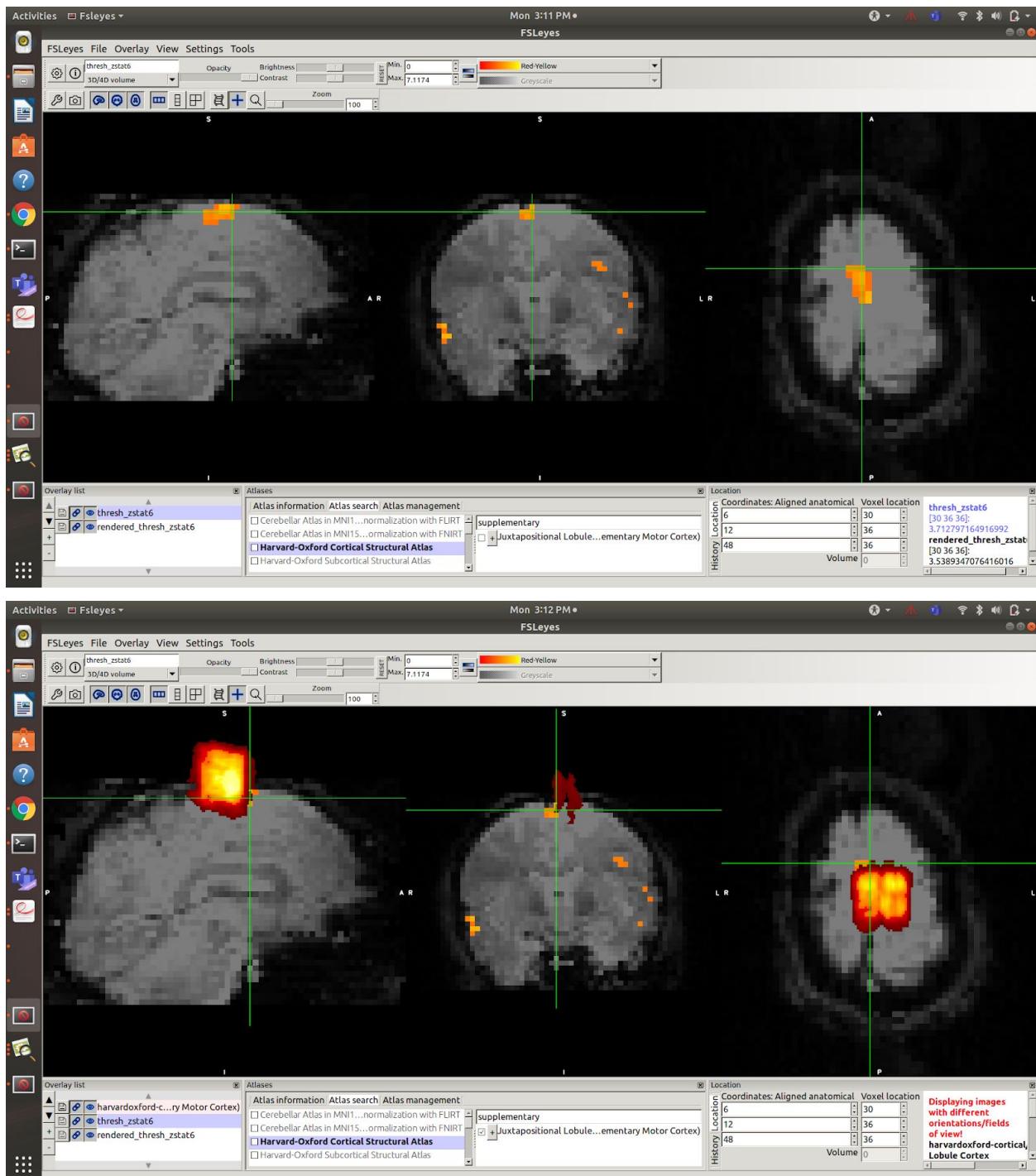
## Middle temporal gyrus, posterior division



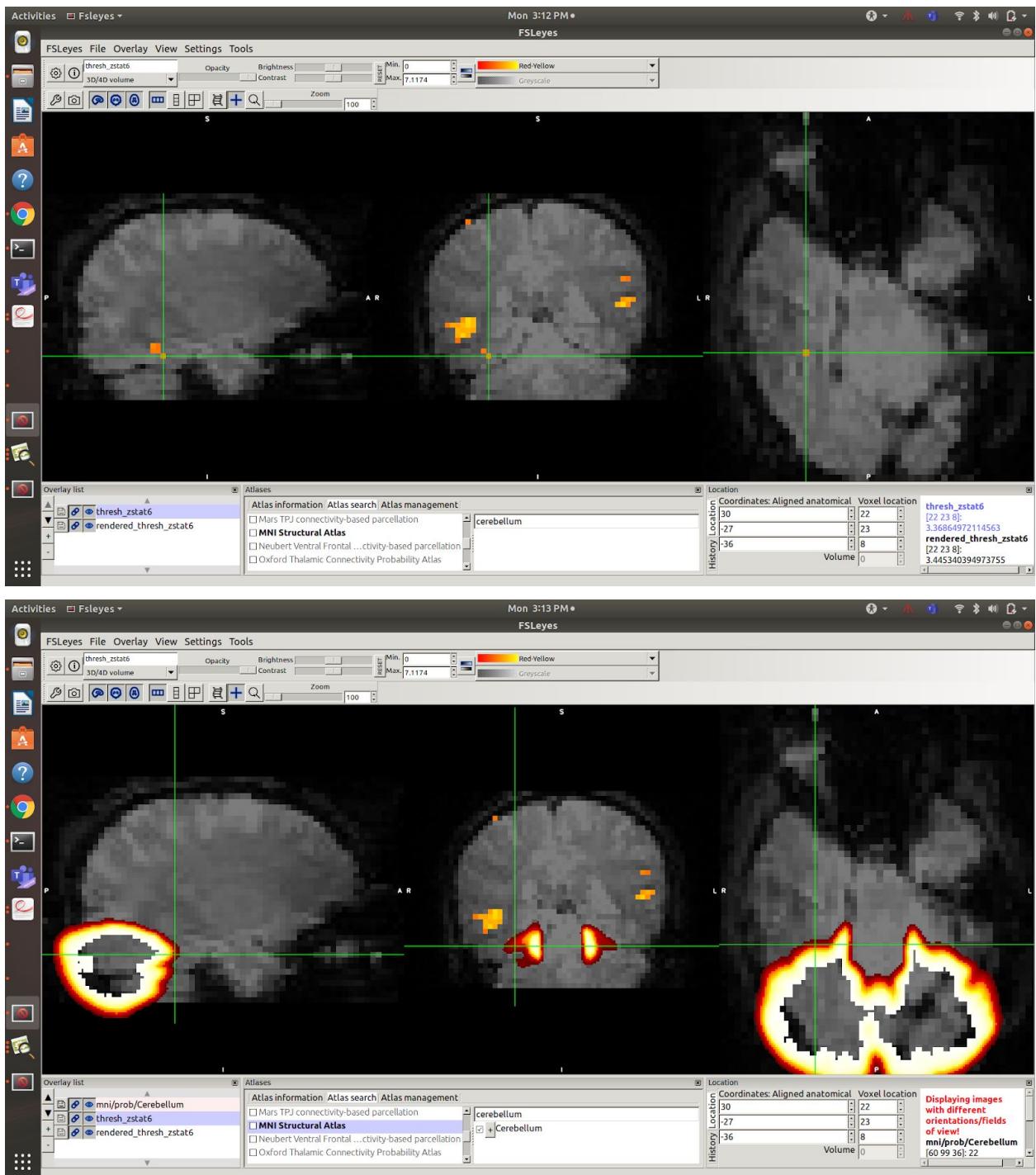
## Superior frontal gyrus



## Supplementary motor cortex



## cerebellum



Brain area	x-coordinate	y-coordinate	z-coordinate	T value
<b>Sentences reading-checker boards</b>				
Superior temporal gyrus, anterior division	-48	-15	-9	4.29
Superior temporal gyrus, posterior gyrus	51	-12	-18	4.24
Middle temporal gyrus, posterior division	54	-18	-27	3.47
Precentral Gyrus	-36	3	33	4.30
Superior frontal gyrus	9	9	51	2.18
Middle frontal gyrus	-36	0	33	5.79
Temporal fusiform cortex, posterior division	42	-21	-21	4.00
Right hippocampus	36	-21	-18	3.51
<b>Video left motor-checker board</b>				
Precentral gyrus	6	-6	51	3.51
Postcentral gyrus	39	-27	45	4.39

Supplementary motor cortex	6	-3	48	3.26
<b>Video right motor-checker board</b>				
cerebellum	-3	-54	-48	4.04
Precentral gyrus	-36	0	42	3.47
Postcentral gyrus	-36	-18	45	3.4
Supplementary motor cortex	9	0	48	3.85
<b>Video motor-checker board</b>				
GM primary motor cortex R	39	-9	39	4.5
GM Primary motor cortex L	0	-15	54	3.69
Precentral gyrus	36	-15	42	0.00
Postcentral gyrus	-30	-36	42	4.82
cerebellum	-3	-54	-42	3.96
thalamus	9	-30	-3	3.26
Right hippocampus	15	-39	-3	3.42
<b>(video+audio)right motor-(video+audio)left motor</b>				

Precentral gyrus	-33	-18	45	3.76
Postcentral gyrus	-36	-15	48	3.44
cerebellum	39	-39	-51	3.97
<b>(video+audio)s entences-check erboard</b>				
Superior temporal gyrus, anterior division	57	-3	-21	3.28
Superior temporal gyrus, posterior division	60	-3	-12	3.81
Middle temporal gyrus, anterior division	51	-9	-18	4.01
Middle temporal gyrus, posterior division	60	-33	-18	4.92
Superior frontal gyrus	0	9	51	4.55
Supplementary motor cortex	6	12	48	3.84
cerebellum	30	-27	-36	3.46

The above diagram and table show the activated regions in the 6 contrasts generated. Since, the contrasts given in [1] is not exactly the same as our generated contrasts (except for video sentence - checkerboard) but are more or less similar to them, hence most of the activated regions comply with the literature or are close to. E.g., for Sentence reading - checkerboards superior temporal gyrus(anterior), superior temporal gyrus(posterior), middle temporal gyrus(posterior), precentral gyrus, superior frontal gyrus, middle frontal gyrus, temporal fusiform cortex, posterior division, right hippocampus were found to be active for our setup as well as in [1], the regions which were not active in ours but active in [1] are left hippocampus, lingual gyrus, thalamus, cerebellum, precuneus gyrus. Activation of superior temporal gyrus (it has the

wernicke's area) indicates the comprehension of the sentence reading. The frontal gyrus and hippocampus responsible for long term memory, are activated indicating the sentences are being memorized by brain regions. Only higher level vision areas are active here, the ones not in occipital lobe since that was responsible for checkerboard and is excluded.

For contrast 2, motor cortex is active for visualizing the motor cortex actions in the video(through mirror neurons), although vision is active here but it is subtracted through the checkerboard excluding its activations.

For contrast 3, similar activations like 2, since it is a symmetric action, except that we found cerebellum also active in this case, since cerebellum is responsible for complex coordinated movements. In contrast 2 as well, cerebrum might be active but couldn't capture due to some inherent error.

For contrast 4, which is similar to contrast 2 and 3, hence similar regions are active plus we've thalamus, hippocampus and cerebellum activations indicating the motor movements being captured in long term memory.

For contrast 5, activations of precentral, postcentral gyrus and cerebellum responsible for complex motor actions are found to be active.

For contrast 6, superior temporal gyrus(anterior and posterior), middle temporal gyrus(anterior and posterior), superior frontal gyrus, supplementary motor cortex and cerebellum are active. Activations of different areas of temporal gyrus indicates the broca's and wernicke's area for sentence reading comprehension and regeneration of the language. Motor areas are active because ears have muscular actions such as vibrations of eardrum or cilia movements or fluid moving across the inside of ear.

#### **Drive Link to all folders:**

(Note that the linked folder is a full analysis method, hence it includes both the preprocessing and contrast generating step)

[https://drive.google.com/drive/folders/1aj0SEGXVZupDXSnDtbyW-aiKurqE\\_jC0?usp=sharing](https://drive.google.com/drive/folders/1aj0SEGXVZupDXSnDtbyW-aiKurqE_jC0?usp=sharing)

#### **References**

- 1)– Pinel, P., Thirion, B., Meriaux, S., Jobert, A., Serres, J., Le Bihan, D., ... Dehaene, S. (2007). Fast reproducible identification and large-scale databasing of individual functional cognitive networks. *BMC neuroscience*, 8(1), 1-18.

2)Orfanos, D. P., Michel, V., Schwartz, Y., Pinel, P., Moreno, A., Le Bihan, D., Frouin, V. (2017). The brainomics/localizer database. Neuroimage, 144, 309-314.