How to report my result using REST slice viewer?

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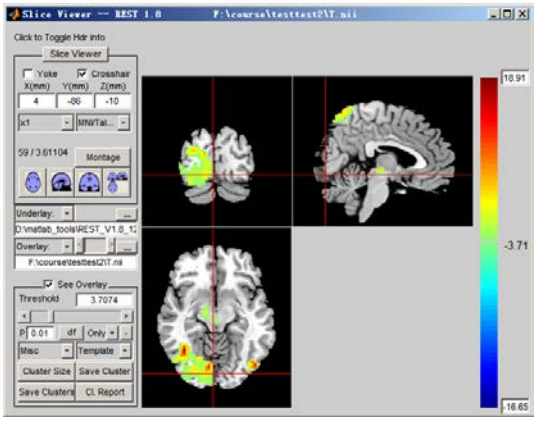
2013/12/30

Commonly, you got an activation for functional connectivity result based on either REST or SPM or other software. As long as this resultant map is in the MNI standard space, you can review it using REST slice viewer.

After several settings such as underlay and overlay images, threshold p value, threshold cluster size and connectivity criterion (this value decides two neighboring voxels are within one cluster or not, typically is set to 5), you will get several activated or functionally connected clusters:



Pressing Cl. Report, you will find cluster information in Matlab command window like this:

```
Number of clusters found: 4
----------------------
Cluster 1
Number of voxels: 112
Peak MNI coordinate: -45 -78 -12
Peak MNI coordinate region:   // Left Cerebrum // Occipital Lobe // Middle Occipital Gyrus // Gray Matter // brodmann area 19 //
Occipital_Inf_L (aal)
Peak intensity: 17.5958
# voxelsstructure
   112   --TOTAL # VOXELS--
    91   Left Cerebrum
    75   Occipital Lobe
    68   Occipital_Inf_L (aal)
    54   White Matter
    40   Middle Occipital Gyrus
    34   Gray Matter
    27   brodmann area 19
    21   Inferior Occipital Gyrus
    20   Cerebelum_Crus1_L (aal)
    16   Temporal Lobe
    13   Fusiform Gyrus
    12   Fusiform_L (aal)
    10   Inferior Temporal Gyrus
     9   Left Cerebellum
     9   Declive
     9   Cerebellum Posterior Lobe
     6   Sub-Gyral
     5   brodmann area 18
     2   Occipital_Mid_L (aal)
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Cluster 2
Number of voxels: 1301
Peak MNI coordinate: 36 -66 -15
Peak MNI coordinate region:    // Right Cerebrum // Occipital Lobe // Sub-Gyral // White Matter // undefined // Fusiform_R (aal)
Peak intensity: 18.9077
# voxelsstructure
  1301   --TOTAL # VOXELS--
  1203   Right Cerebrum
  1076   Occipital Lobe
   774   White Matter
   381   Gray Matter
```

```
   305  Middle Occipital Gyrus
   288  Lingual Gyrus
   229  Lingual_R (aal)
   203  Cuneus
   179  brodmann area 18
   153  Fusiform_R (aal)
   152  Occipital_Inf_R (aal)
   149  Sub-Gyral
   141  Calcarine_R (aal)
   138  Occipital_Mid_R (aal)
   127  Temporal Lobe
   113  brodmann area 19
   105  Occipital_Sup_R (aal)
    93  Inferior Occipital Gyrus
    88  Fusiform Gyrus
    83  Temporal_Inf_R (aal)
    58  Temporal_Mid_R (aal)
    57  Right Cerebellum
    51  Declive
    51  Cerebellum Posterior Lobe
    45  Cerebelum_6_R (aal)
    44  brodmann area 17
    43  Middle Temporal Gyrus
    38  Cuneus_R (aal)
    32  Cerebelum_Crus1_R (aal)
    30  brodmann area 37
    24  Inferior Temporal Gyrus
     6  Cerebellum Anterior Lobe
     6  Culmen
     4  Superior Occipital Gyrus
     1  brodmann area 39
     1  Vermis_6 (aal)
----------------------
Cluster 3
Number of voxels: 130
Peak MNI coordinate: 18 -30   0
Peak MNI coordinate region:   // Right Cerebrum // Sub-lobar // Thalamus // Gray Matter // undefined // Thalamus_R (aal)
Peak intensity: 9.7812
# voxelsstructure
   130  --TOTAL # VOXELS--
    73  Midbrain
    56  Right Cerebrum
    53  Right Brainstem
    46  Sub-lobar
    45  Gray Matter
    28  White Matter
    24  Extra-Nuclear
    19  Left Brainstem
    16  Red Nucleus
    15  Hippocampus_R (aal)
    15  Thalamus
     9  Limbic Lobe
     8  Thalamus_R (aal)
     6  Parahippocampa Gyrus
     6  Pulvinar
     4  brodmann area 27
     4  Cerebro-Spinal Fluid
     3  Substania Nigra
     3  Sub-Gyral
     2  Third Ventricle
     2  Subthalamic Nucleus
     2  Lateral Ventricle
     2  Lateral Geniculum Body
     1  Caudate Tail
     1  Lingual_R (aal)
     1  Medial Geniculum Body
     1  Caudate
     1  brodmann area 30
     1  Optic Tract
----------------------
Cluster 4
Number of voxels: 268
Peak MNI coordinate: 18 -66   66
Peak MNI coordinate region:   // undefined // undefined // undefined // undefined // undefined // Parietal_Sup_R (aal)
Peak intensity: 11.4539
# voxelsstructure
   268  --TOTAL # VOXELS--
   138  Parietal Lobe
   137  Right Cerebrum
    88  Precuneus_R (aal)
    86  Parietal_Sup_R (aal)
    75  White Matter
    66  Precuneus
    56  brodmann area 7
    56  Gray Matter
    45  Sub-Gyral
    27  Superior Parietal Lobule
    19  Inter-Hemispheric
    13  Precuneus_L (aal)
     8  Parietal_Inf_R (aal)
     5  Left Cerebrum
     1  Angular_R (aal)
```

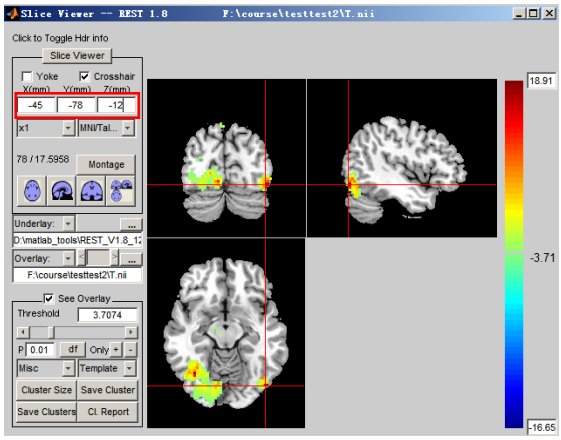
This indicates that you got 4 clusters supra-threhold. Taking cluster 1 as an example, I will show how to report this result:

Cluster 1 **%% This is the first cluster out of total 4 clusters %%**
Number of voxels: 112 **%% This cluster size is 112 voxels, or this cluster contains 112 connected voxels %%**
Peak MNI coordinate: -45 -78 -12 **%% The MNI coordinates of the peak voxel in the cluster %%**
Peak MNI coordinate region: // Left Cerebrum // Occipital Lobe // Middle Occipital Gyrus // Gray Matter // brodmann area 19 // Occipital_Inf_L (aal) **%% Approximated location of the peak voxel (This is just for reference! Not the location of the whole cluster!) %%**
Peak intensity: 17.5958 **%% The value of the peak voxel %%**
voxelsstructure
112 --TOTAL # VOXELS--
91 Left Cerebrum **%% How many voxels in which brain area (not an exclusively counting) %%**
75 Occipital Lobe
68 Occipital_Inf_L (aal)
54 White Matter
40 Middle Occipital Gyrus
34 Gray Matter
27 brodmann area 19
21 Inferior Occipital Gyrus
20 Cerebelum_Crus1_L (aal)
16 Temporal Lobe
13 Fusiform Gyrus
12 Fusiform_L (aal)
10 Inferior Temporal Gyrus
9 Left Cerebellum
9 Declive
9 Cerebellum Posterior Lobe
6 Sub-Gyral
5 brodmann area 18
2 Occipital_Mid_L (aal)

For cluster 1, we can see it contains 112 voxels, as fMRI data we usually have 3*3*3mm voxel, so the size of the cluster will be 112*27 mm^3. To report this cluster, following steps you should do:

Step 1. Glimpsing this cluster in REST Slice viewer for a roughly assessment of its location.

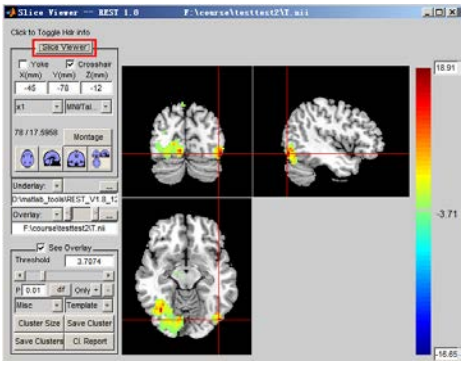
Enter "Peak MNI coordinate" in Slice viewer, you goes to the peak voxel of this cluster:



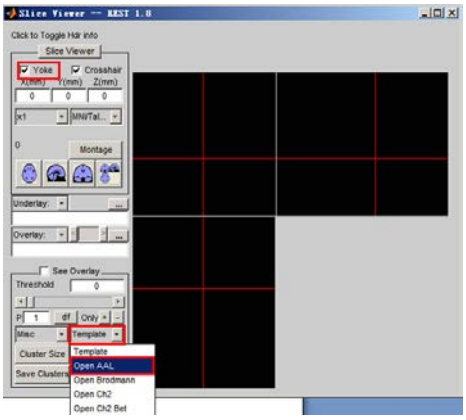
The red cross indicates the cluster (Cluster 1) you're currently interested with. This is a relatively small cluster which locates in the **left lateral occipital lobe** (left is right, right is left in REST slice viewer).

Step 2. Open two new Slice Viewer windows showing BA and AAL atlas to roughly define the location of this cluster in BA and AAL.

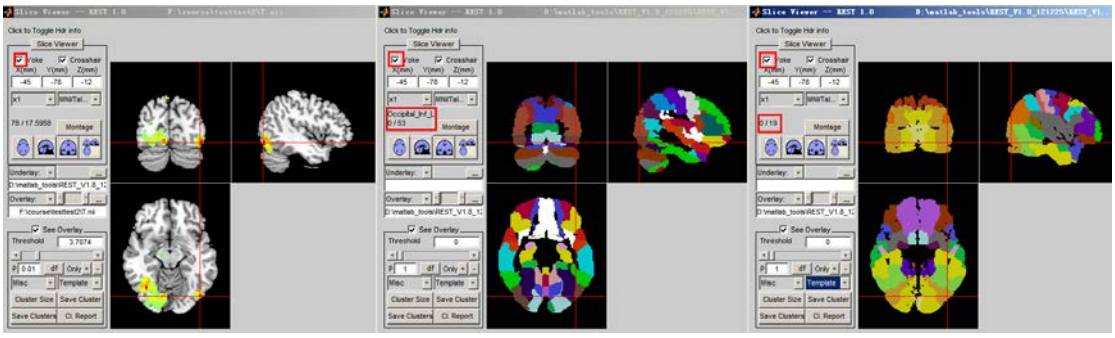
Click "Slice Viewer" button to open a new window.



Open Template AAL, and Yoke (lock) the two windows. Do it again and open BA template.



Make sure that all 3 windows yoked together. Within the cluster, slightly move the red cross in the left window and see which BA and AAL regions this cluster covers.



You can move the cursor from the upper to the lower side of this cluster, and then from the left border to the right border, from the anterior border to the posterior border, to see if it covers multiple BA and AAL regions. In this example, whatever you move the cursor within the cluster, the BA template always report 19, and the AAL template frequently reports left inferior occipital cortex and sometimes reports Left middle occipital cortex. Therefore, we conclude that this cluster covers BA19, Left inferior occipital, and Left middle occipital cortices. Although a small portion of the low part of the cluster touches left cerebellum crus1, because it is a visual stimulation task, we expect the activation area occur at the visual cortex, rather than cerebellum. Therefore this little touch to the cerebellum crus1 region should be a registration error. So we do not need to report it.

Step 3. Go through the cl. report information to validate Step 2 and add more information.

After quickly go through "# voxels structure", we can validate the spatial location of this cluster: most part of the cluster located in "inferior occipital gyrus" and "brodmann area 19", part of it extends to "left fusiform" (this is new information that we did not find in Step 2, so we decide to add it into our result report). Note that you don't have to look at the gross structure like "left cerebrum" because it is not spatially specific; and you don't have to look at the very few voxels like those in "brodmann area 18, sub-gyral, cerebellum posterior lobe, left cerebellum, etc". Note that you will see "40 Middle occipital gyrus", which means nearly half of the cluster locates in middle occipital gyrus. This is not true according to your finding from Step 2 (the truth is only a small part of the cluster reaches middle occipital gyrus).

```
Cluster 1
Number of voxels: 112
Peak MNI coordinate: -45 -78 -12
Peak MNI coordinate region:  // Left Cerebrum // Occipital Lobe // Middle Occipital Gyrus // Gray Matter // brodmann area 19 // Occipital_Inf_L (aal)
Peak intensity: 17.5958
# voxels    structure
  112   --TOTAL # VOXELS--
   91   Left Cerebrum
   75   Occipital Lobe
   68   Occipital_Inf_L (aal)
   54   White Matter
   40   Middle Occipital Gyrus
   34   Gray Matter
   27   brodmann area 19
   21   Inferior Occipital Gyrus
   20   Cerebelum_Crus1_L (aal)
   16   Temporal Lobe
   13   Fusiform Gyrus
   12   Fusiform_L (aal)
   10   Inferior Temporal Gyrus
    9   Left Cerebellum
    9   Declive
    9   Cerebellum Posterior Lobe
    6   Sub-Gyral
    5   brodmann area 18
    2   Occipital_Mid_L (aal)
----------------------
```

Step 4. Form the final report on this cluster location.

As a conclusion, we report that this cluster mainly covers left inferior occipital gyrus, and partly covers left middle occipital gyrus and fusiform. The BA region is BA 19. Therefore, in the future Table, you will write cluster size (112), Peak MNI coordinates (-45, -78, -12), Peak intensity (t = 17.6), Location (left inferior occipital gyrus, left middle occipital gyrus, left fusiform), BA (19).

OK, let's do a more complex case for cluster 2. After Step 2 and 3, we decide to report those regions in red, and ignore those in blue. Note that either too gross or too small region should not been reported (i.e., you probably need to report the middle section of the table below).

```
Cluster 2
Number of voxels: 1301
Peak MNI coordinate: 36 -66 -15
Peak MNI coordinate region:   // Right Cerebrum // Occipital Lobe // Sub-Gyral // White Matter // undefined // Fusiform_R (aal)
Peak intensity: 18.9077
# voxels  structure
  1301  --TOTAL # VOXELS--
  1203  Right Cerebrum
  1076  Occipital Lobe
   774  White Matter
   381  Gray Matter
   305  Middle Occipital Gyrus
   288  Lingual Gyrus
   229  Lingual_R (aal)
   203  Cuneus
   179  brodmann area 18
   153  Fusiform_R (aal)
```

```
152  Occipital_Inf_R (aal)
149  Sub-Gyral
141  Calcarine_R (aal)
138  Occipital_Mid_R (aal)
127  Temporal Lobe
113  brodmann area 19
105  Occipital_Sup_R (aal)
 93  Inferior Occipital Gyrus
 88  Fusiform Gyrus
 83  Temporal_Inf_R (aal)
 58  Temporal_Mid_R (aal)
 57  Right Cerebellum
 51  Declive
 51  Cerebellum Posterior Lobe
 45  Cerebelum_6_R (aal)
 44  brodmann area 17
 43  Middle Temporal Gyrus
 38  Cuneus_R (aal)
 32  Cerebelum_Crus1_R (aal)
 30  brodmann area 37
 24  Inferior Temporal Gyrus
  6  Cerebellum Anterior Lobe
  6  Culmen
  4  Superior Occipital Gyrus
  1  brodmann area 39
  1  Vermis_6 (aal)
```

Important, you cannot rely on the cl. report that was printed in Matlab. The best way is check the location by using "yoke" function and by your own eyes. In lots of cases, "Peak MNI coordinate region" reports "undefined", you have to do Step 2 and check by your own eyes.

Sometimes, the cl. report will get a one big cluster with, for example, more than 5000 voxels. In this case, you should be much careful, because this cluster should cover lots of brain areas. The "Peak MNI coordinate region" only reports one region, which is thus quite wrong! You should increase threshold by using more stringent *p* value, to make it split into different smaller clusters and then report them separately. Another method is integrating SPM result (see a following example).

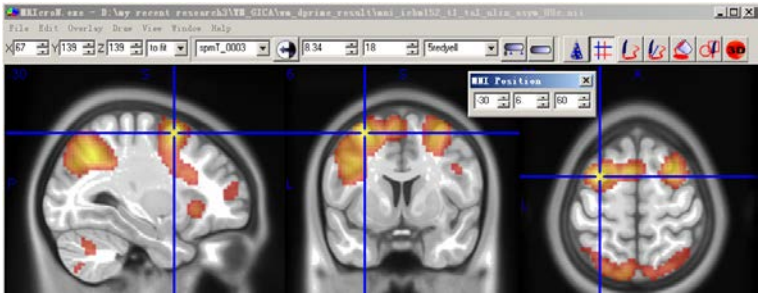
[Added in 3/1/2014, for version 2]

In this new example, I will show how to report a very big—probably encompassed lots of brain regions—cluster, based on REST-slice viewer, SPM and MRIcron.

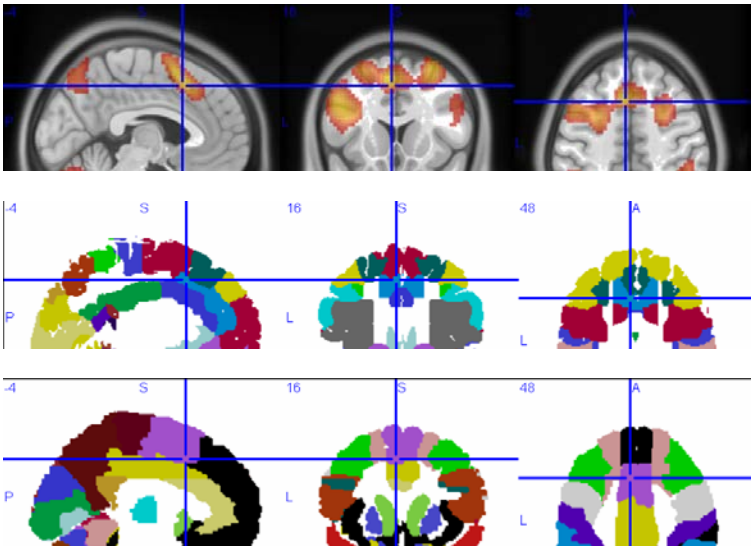
```
Cluster 6
Number of voxels: 2342
Peak MNI coordinate: -30    6   60
Peak MNI coordinate region:    // Left Cerebrum // Frontal Lobe // Middle Frontal Gyrus // White Matter // undefined // Frontal_Mid_L (aal)
Peak intensity: 18.5588
# voxelsstructure
 2342  --TOTAL # VOXELS--
 2068  Frontal Lobe
 1607  Left Cerebrum
 1313  White Matter
  940  Middle Frontal Gyrus
  699  Gray Matter
  523  Right Cerebrum
  401  Frontal_Mid_L (aal)
  357  Sub-Gyral
  355  brodmann area 6
  349  Superior Frontal Gyrus
  297  Precentral_L (aal)
  241  Frontal_Inf_Tri_L (aal)
  213  Supp_Motor_Area_L (aal)
  202  Inferior Frontal Gyrus
  197  Frontal_Sup_L (aal)
  196  Frontal_Mid_R (aal)
  175  Frontal_Sup_R (aal)
  158  Medial Frontal Gyrus
  138  Frontal_Inf_Oper_L (aal)
  125  brodmann area 9
  118  brodmann area 8
   92  Supp_Motor_Area_R (aal)
   83  Cingulate Gyrus
   74  Frontal_Sup_Medial_L (aal)
   60  Limbic Lobe
   57  brodmann area 32
   55  Inter-Hemispheric
   35  Frontal_Sup_Medial_R (aal)
   33  Precentral Gyrus
   22  brodmann area 46
   17  Cingulum_Mid_R (aal)
   13  brodmann area 45
    7  Precentral_R (aal)
    6  brodmann area 44
```

3 Insula
2 brodmann area 24
2 Cingulum_Mid_L (aal)
2 Sub-lobar
1 brodmann area 13

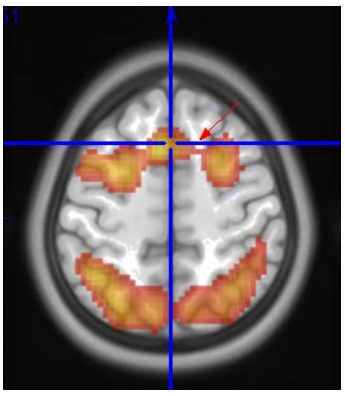
In this example, there were 9 clusters: 7 clusters were small (cluster size = 40-140 voxels), and another 2 clusters were too big (cluster size > 2000 voxels). See above for the cluster 6.



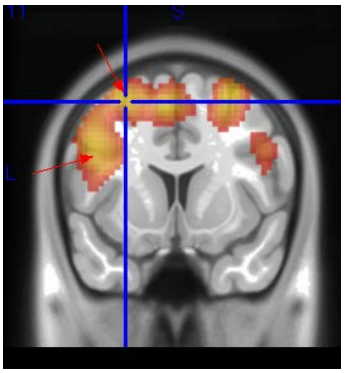
In the peak voxel of this cluster (-30, 6, 60), I, using three MRIcron windows, saw a big cluster extended from left middle frontal gyrus (see similar report in REST: 401 Frontal_Mid_L (aal), 355 brodmann area 6) to Supplementary motor area (BA6/8/32, see similar report in REST: 213 Supp_Motor_Area_L (aal), 197 Frontal_Sup_L (aal),), see figure below.



When I move the cursor within this big cluster in MRIcron, I found it also connected to right-sided frontal areas, which is mirrored to the left sided ones (see red arrow in figure below).

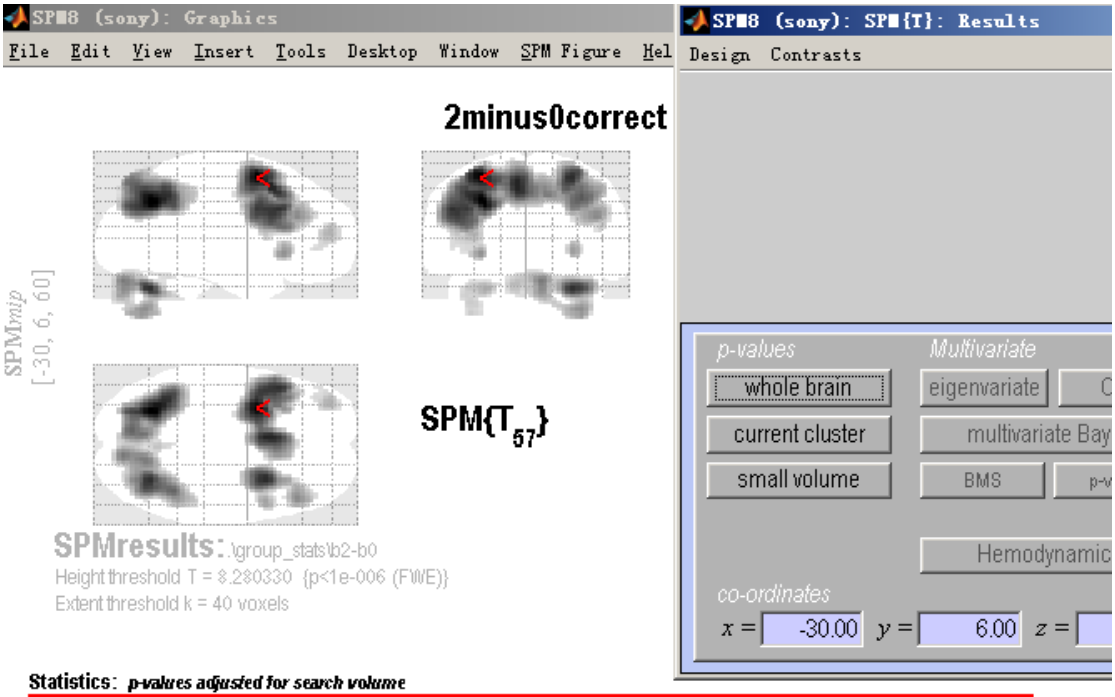


And the left-sided cluster can be divided into an upper one and a lower one (see figure below).



Therefore, I decided to report this big cluster to be **four clusters**. The next step is to use SPM to find all the peaks in this big cluster.

In SPM, we found the same cluster by clicking “whole brain” button and the peak coordinates in the right column of the table (i.e., -30, 6, 60). We found the cluster size as reported by SPM was the same as that reported by REST (i.e., k_E = 2342).

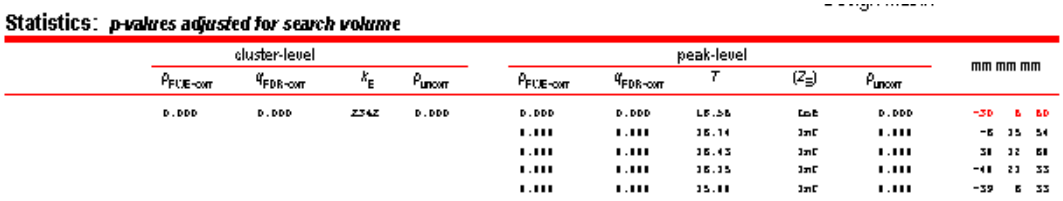


Statistics: ***p-values adjusted for search volume***

set-level		cluster-level				peak-level					mm mm mm
p	c	$p_{FWE-corr}$	$q_{FDR-corr}$	k_E	p_{uncorr}	$p_{FWE-corr}$	$q_{FDR-corr}$	T	$(Z_=)$	p_{uncorr}	
0.000	9	0.000	0.000	2393	0.000	0.000	0.000	18.88	Inf	0.000	-21 -63 39
						1.000	1.000	14.32	Inf	1.000	36 -88 45
						1.000	1.000	13.83	Inf	1.000	-32 -15 54
		0.000	0.000	2342	0.000	0.000	0.000	18.36	Inf	0.000	-30 6 60
						1.000	1.000	16.14	Inf	1.000	-6 15 54
						1.000	1.000	16.43	Inf	1.000	38 12 68
		0.000	0.000	892	0.000	0.000	0.000	18.20	Inf	0.000	30 -63 -33
						1.000	1.000	12.84	Inf	1.000	9 -83 -21
						1.000	1.000	11.98	Inf	1.000	36 -86 -53
		0.000	0.000	192	0.000	0.000	0.000	12.18	Inf	0.000	45 33 27
		0.000	0.000	60	0.000	0.000	0.000	11.73	Inf	0.000	-30 24 -3
						1.000	1.000	8.44	8.11	1.000	-42 18 0
		0.000	0.000	45	0.000	0.000	0.000	11.32	Inf	0.000	30 24 -3
		0.000	0.000	95	0.000	0.000	0.000	11.16	Inf	0.000	48 12 33
						1.000	1.000	9.21	1.21	1.000	48 15 18
		0.000	0.000	135	0.000	0.000	0.000	10.74	Inf	0.000	-27 -63 -33
						1.000	1.000	9.35	1.25	1.000	-36 -66 -45
						1.000	1.000	9.23	1.19	1.000	-36 -12 -54
		0.000	0.000	116	0.000	0.000	0.001	10.36	1.74	0.000	-36 54 12
						1.000	1.000	8.13	0.93	1.000	-39 45 0
						1.000	1.000	8.08	0.86	1.000	-48 48 3

table shows 3 local maxima more than 8.0mm apart

To find out all peaks in this big cluster, I click “current cluster” button. SPM showed a new table, including five peaks. Write down these coordinates and put them into MRIcron to find out which regions they corresponded to.



Statistics: ***p-values adjusted for search volume***

cluster-level				peak-level					mm mm mm
$p_{FWE-corr}$	$q_{FDR-corr}$	k_E	p_{uncorr}	$p_{FWE-corr}$	$q_{FDR-corr}$	T	$(Z_=)$	p_{uncorr}	
0.000	0.000	2342	0.000	0.000	0.000	18.56	Inf	0.000	-30 6 60
				0.000	0.000	16.74	Inf	0.000	-6 15 54
				0.000	0.000	16.43	Inf	0.000	30 12 60
				0.000	0.000	16.15	Inf	0.000	-48 21 33
				0.000	0.000	15.88	Inf	0.000	-39 6 33

Finally, I found out there were totally three clusters in the big cluster. Their peaks were:

1) -30, 6, 60 in the BA6/8 and Front_Mid/Sup L, Precentral L, *t* = 18.56;
2) -48, 21, 33 in the BA 44/45/48 and Front_Inf_Tri/Oper L, *t* = 16.15;
3) -6 15 54 in the BA6/8/32 and Supplementary motor area R/L, *t* = 16.74; and
4) 30, 12, 60 in the BA6/8 and Front_Mid/Sup R, *t* = 16.43;

Note that the last coordinates in the SPM table (i.e., -39 6 33) is too nearby to (-48, 21, 33) and both of them were in the same cluster of cluster (2), therefore I decided not to report this.

After comparisons with the REST report, I generate this form for this big cluster:

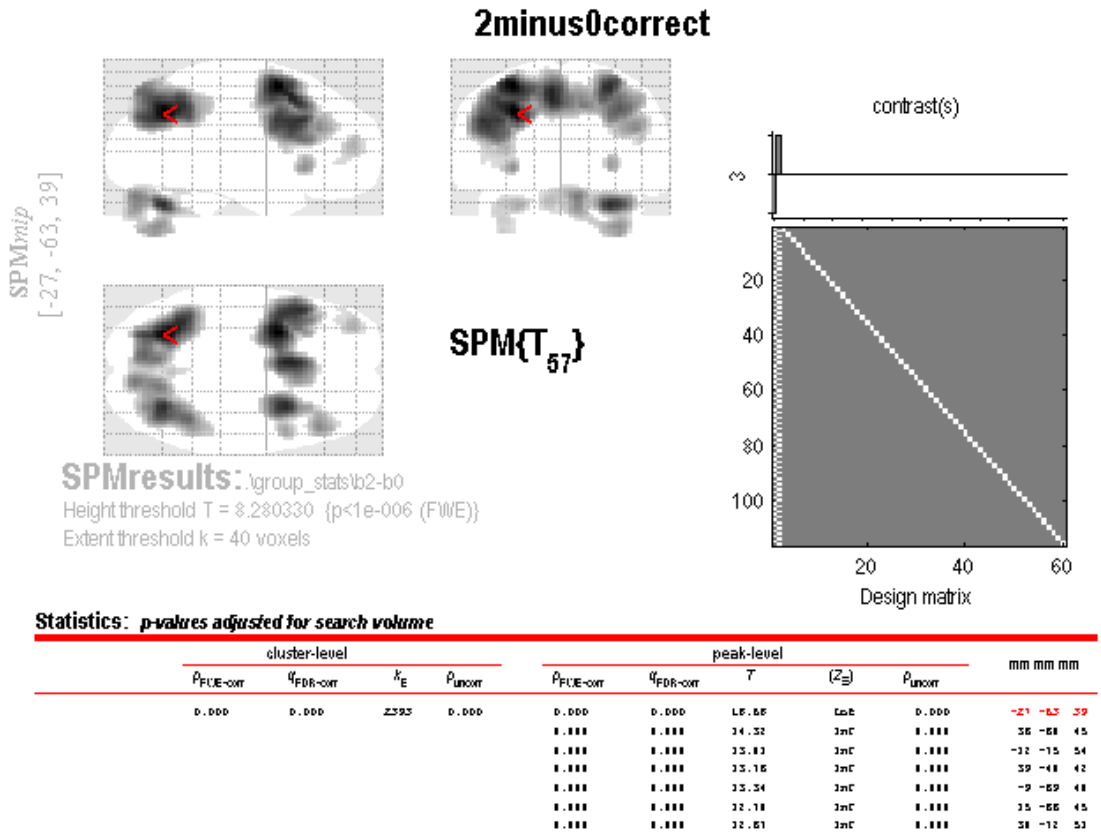
Regions	Hemisphere	BA	Number of voxels	Peak activation strength (*t*)		Peak coordinates		
						x	*y*	*z*
Front Mid/Sup Gyrus, Precentral Gyrus	L	6,8	2342	18.56		-30	6	60
Front Inf Tri/Oper	L	44,45, 48		16.15		-48	21	33
Supp Mot Area	L/R	6,8,32		16.74		-6	15	54
Front Mid/Sup Gyrus	R	6,8		16.43		30	12	60

Blow there is another example for how to report a big cluster:

Cluster 9
Number of voxels: 2395
Peak MNI coordinate: -27 -63 39
Peak MNI coordinate region: // Left Cerebrum // Parietal Lobe // Precuneus // White Matter // undefined // Parietal_Inf_L (aal)
Peak intensity: 18.6826
voxelsstructure
2395 --TOTAL # VOXELS--
1959 Parietal Lobe
1186 White Matter
1107 Left Cerebrum
890 Right Cerebrum
744 Gray Matter
701 Precuneus
558 Inferior Parietal Lobule
401 brodmann area 7
378 Parietal_Inf_L (aal)
325 Superior Parietal Lobule
306 Parietal_Sup_L (aal)
277 Sub-Gyral
253 brodmann area 40
221 Parietal_Sup_R (aal)
208 Precuneus_L (aal)
205 Parietal_Inf_R (aal)
195 Angular_R (aal)
148 Precuneus_R (aal)
129 Occipital_Mid_L (aal)
85 Supramarginal Gyrus
78 Angular_L (aal)
75 Occipital_Sup_R (aal)
59 brodmann area 19
46 Occipital_Sup_L (aal)
41 Occipital_Mid_R (aal)
39 Angular Gyrus
31 brodmann area 39
24 SupraMarginal_R (aal)

17 Temporal Lobe
16 Inter-Hemispheric
15 Occipital Lobe
6 Cuneus
3 Postcentral Gyrus
3 Superior Occipital Gyrus
2 SupraMarginal_L (aal)
2 Frontal Lobe
1 Middle Temporal Gyrus

The SPM current cluster report table was:



Statistics: ***p-values adjusted for search volume***

cluster-level				peak-level					mm mm mm
$p_{FWE-corr}$	$q_{FDR-corr}$	k_E	p_{uncorr}	$p_{FWE-corr}$	$q_{FDR-corr}$	T	$(Z_\equiv)$	p_{uncorr}	
0.000	0.000	2395	0.000	0.000	0.000	18.68	Inf	0.000	-27 -63 39
				0.000	0.000	14.32	Inf	0.000	36 -60 45
				0.000	0.000	13.83	Inf	0.000	-12 -75 54
				0.000	0.000	13.16	Inf	0.000	39 -48 42
				0.000	0.000	13.14	Inf	0.000	-9 -69 48
				0.000	0.000	12.78	Inf	0.000	15 -66 45
				0.000	0.000	12.61	Inf	0.000	38 -72 53

I saw only two clusters in this big cluster, which centering at the first two peaks. All the others were not identifiable as separated clusters. Therefore, the resultant table is:

Regions	Hemisphere	BA	Number of voxels	Peak activation strength (t)		Peak coordinates		
						x	y	z
Parietal Inf/Sup Gyrus, Occipital Mid/Sup Gyrus, Angular Gyrus, Precuneus	L	7,39,40	2395	18.68		-27	-63	39
Parietal Inf/Sup Gyrus, Occipital Mid/Sup Gyrus, Angular Gyrus, Precuneus	R	7,39,40		14.32		36	-60	45