

FreeSurfer Group Analysis

<https://surfer.nmr.mgh.harvard.edu/fswiki/FsTutorial/GroupAnalysis>

FSDG

<https://surfer.nmr.mgh.harvard.edu/fswiki/FsgdExamples>

<https://surfer.nmr.mgh.harvard.edu/fswiki/FsgdFormat>

Primero hay que construir el archivo de diseño del experimento,

```
[osotolongo@detritus fsdg]$ head codes.csv
Subject,PSubject
0001,F001
0002,F002
0003,F003
0004,F004
0005,F005
0006,F006
0007,F007
0008,F008
0009,F009
[osotolongo@detritus fsdg]$ head demographics.csv
PSubject,edat_v0,Anyos_Escolaridad_FAC_v0,Sex_1H_0M_v0
F001,71,8,0
F002,70,12,1
F003,70,8,0
F004,76,16,0
F005,68,20,1
F006,64,14,0
F007,59,19,1
F008,55,16,0
F009,67,16,0
[osotolongo@detritus fsdg]$ join -t"," -1 2 -2 1 codes.csv demographics.csv
| awk -F"," '{print "facehbi_"$2","$3","$4","$5}' | sed
's/facehbi_Subject/Variables/;s/edat_v0/Age/;s/Anyos_Escolaridad_FAC_v0/Educ
ation/;s/Sex_1H_0M_v0/Gender/' | sed 's/facehbi_\([^,]*\),/Input facehbi_\1
Main /; s/,/ /g' > body.csv
[osotolongo@detritus fsdg]$ head body.csv
Variables Age Education Gender
Input facehbi_0001 Main 71 8 0
Input facehbi_0002 Main 70 12 1
Input facehbi_0003 Main 70 8 0
Input facehbi_0004 Main 76 16 0
Input facehbi_0005 Main 68 20 1
Input facehbi_0006 Main 64 14 0
```

```
Input facehbi_0007 Main 59 19 1
Input facehbi_0008 Main 55 16 0
Input facehbi_0009 Main 67 16 0
[osotolongo@detritus fsdg]$ cat headers.txt
GroupDescriptorFile 1
Title FACEHBI_all
Class Main
[osotolongo@detritus fsdg]$ cat headers.txt body.csv > facehbi.fsdg
[osotolongo@detritus fsdg]$ head facehbi.fsdg
GroupDescriptorFile 1
Title FACEHBI_all
Class Main
Variables Age Education Gender
Input facehbi_0001 Main 71 8 0
Input facehbi_0002 Main 70 12 1
Input facehbi_0003 Main 70 8 0
Input facehbi_0004 Main 76 16 0
Input facehbi_0005 Main 68 20 1
Input facehbi_0006 Main 64 14 0
```

GLM Analysis (mri_glmfit)

Primero construimos los contrastes, diciendole a FS cual es la variable que nos interesa, en este caso la edad,

<https://surfer.nmr.mgh.harvard.edu/fswiki/Fsgdf1G2V>

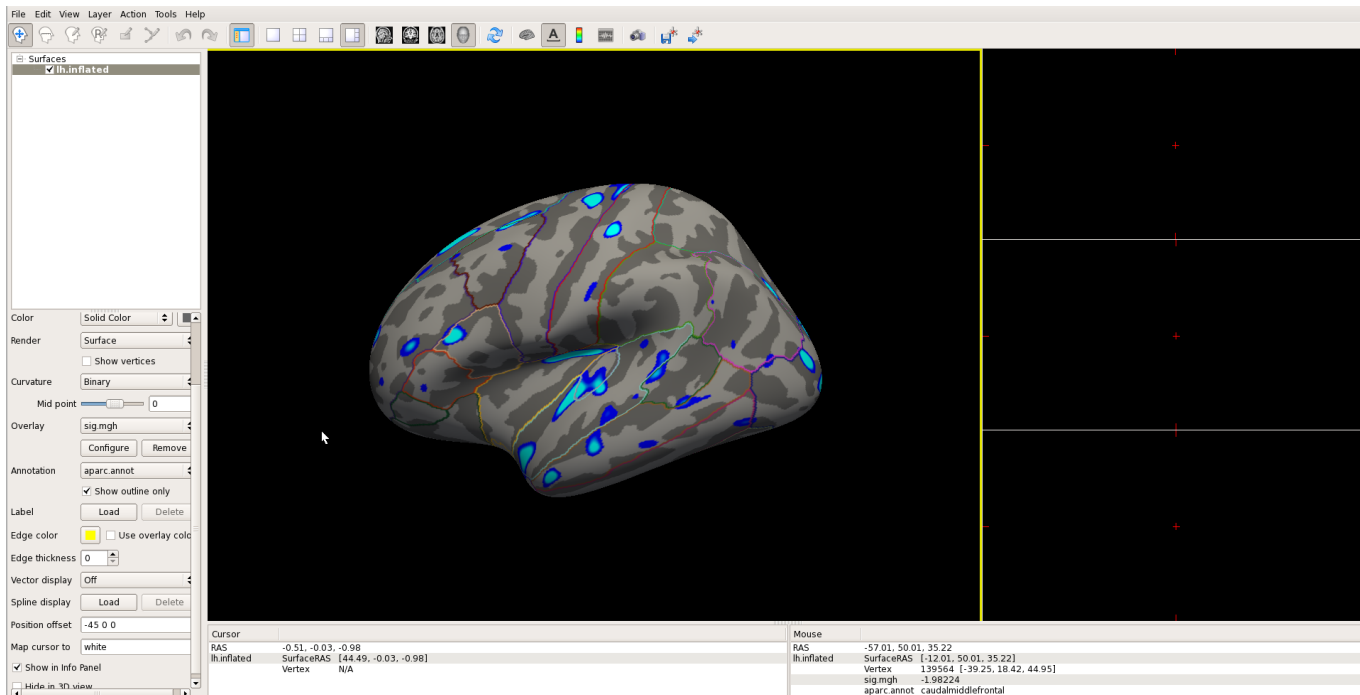
```
[osotolongo@detritus fsdg]$ cat facehbi.mtx
0 1 0 0
```

Ahora vamos a correr el modelo con este contraste,

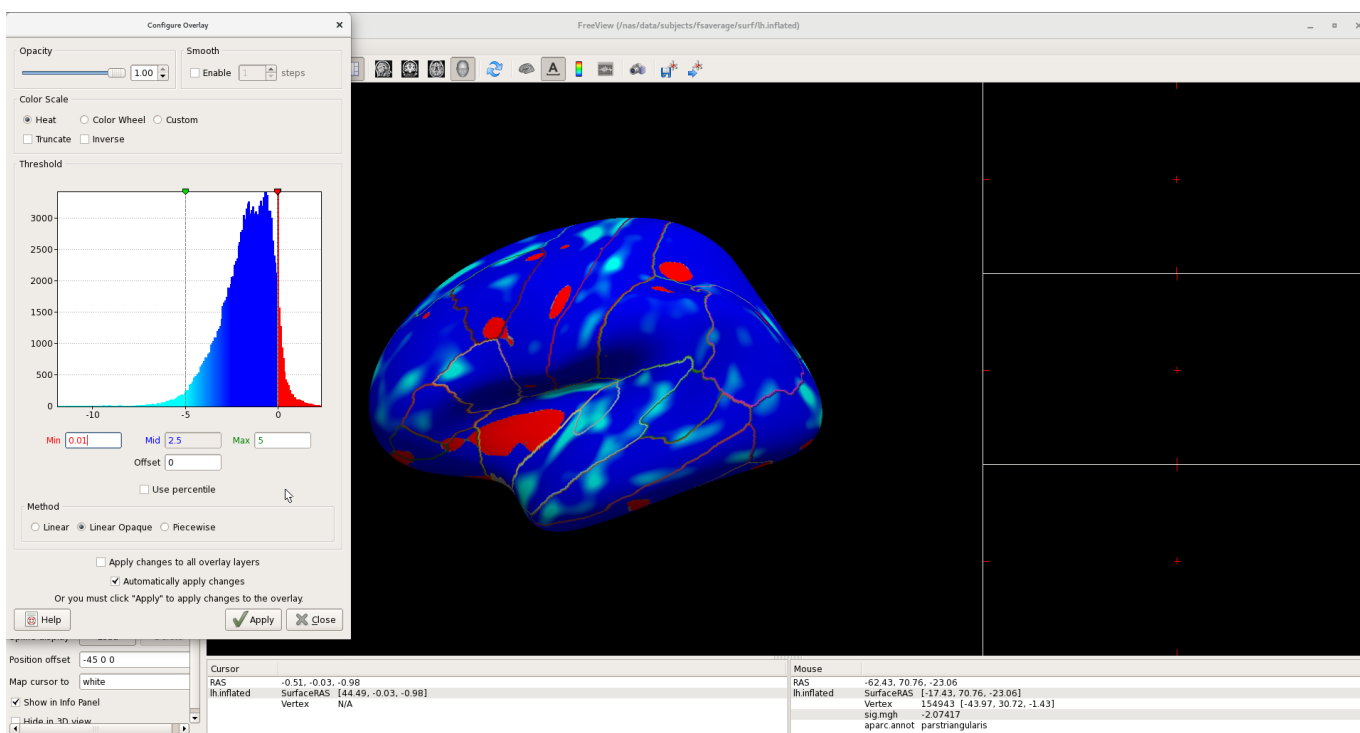
```
[osotolongo@detritus fsdg]$ mris_preproc --fsgd facehbi.fsdg --cache-in
thickness.fwhm10.fsaverage --target fsaverage --hemi lh --out
lh.facehbi.age.thickness.10.mgh
[osotolongo@detritus fsdg]$ mri_glmfit --y lh.facehbi.age.thickness.10.mgh -
-fsgd facehbi.fsdg --C facehbi.mtx --surf fsaverage lh --cortex --glmdir
lh.facehbi.age.glmdir
```

Para usar freeview me he tenido que ir a la [FSL VM](#)

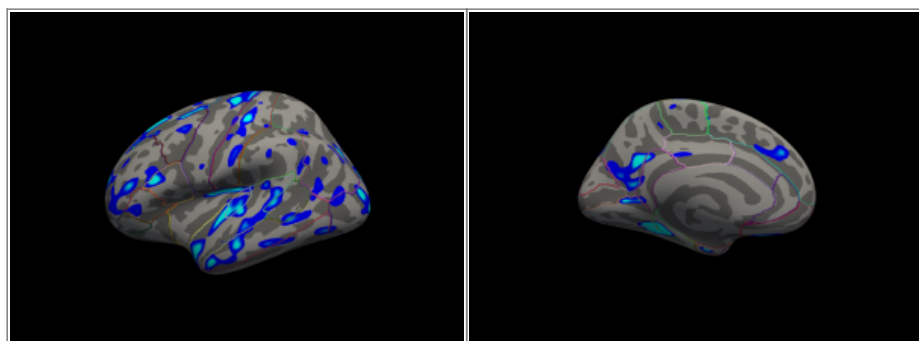
```
[fsluser@FSLVm7_64 fsdg]$ freeview -f
$SUBJECTS_DIR/fsaverage/surf/lh.inflated:annot=aparc.annot:annot_outline=1:0
verlay=lh.facehbi.age.glmdir/facehbi/sig.mgh:overlay_threshold=4,5 -viewport
3d
```



Cambiando el *overlay threshold* para que muestre toda la significancia,



Ejemplo, fijando *uncorrected p < 0.001*,



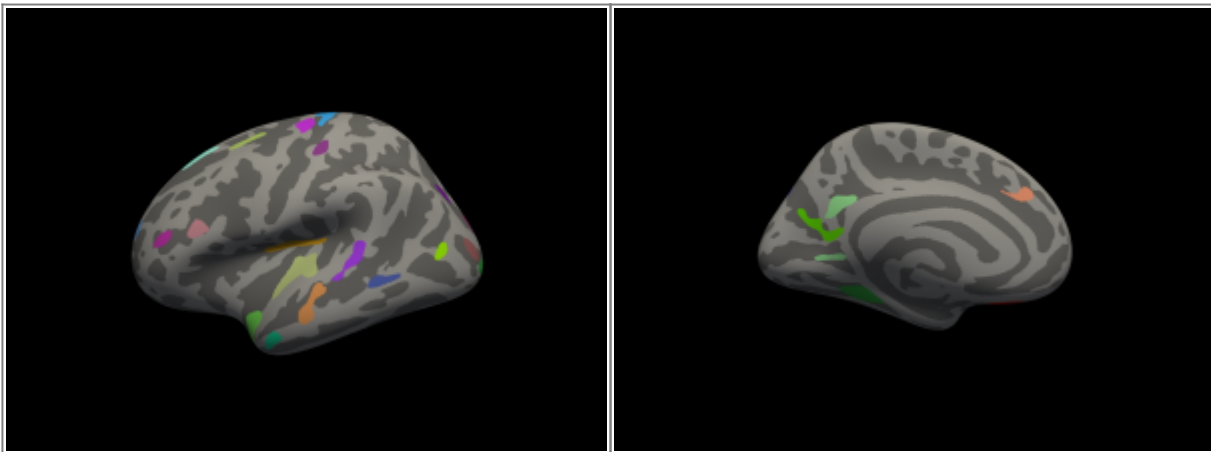
Clusterwise Correction for Multiple Comparisons

Ahora voy a buscar los clusters con una $p > 0.05$

```
[osotolongo@detritus fsdg]$ mri_glmfit-sim --glmdir lh.facehbi.age.glmdir --cache 4 neg --cwp 0.05 --2spaces
```

A ver,

```
freeview -f
$SUBJECTS_DIR/fsaverage/surf/lh.inflated:overlay=lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.cluster.mgh:overlay_threshold=2,5:annot=lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.ocn.annot -viewport 3d
```



También hay un resumen de los clusters que se han encontrado a esta significancia,

```
[osotolongo@detritus fsdg]$ cat
lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.cluster.summary
# Cluster Growing Summary (mri_surfcluster)
# $Id: mri_surfcluster.c,v 1.57.2.3 2016/11/17 18:19:42 zkaufman Exp $
# $Id: mrisurf.c,v 1.781.2.6 2016/12/27 16:47:14 zkaufman Exp $
# CreationTime 2020/06/11-08:12:12-GMT
# cmdline mri_surfcluster.bin --in lh.facehbi.age.glmdir/facehbi/sig.mgh --mask lh.facehbi.age.glmdir/mask.mgh --cwsig lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.cluster.mgh --sum lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.cluster.summary --ocn lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.ocn.mgh --annot aparca --cwpvalthresh 0.05 --o lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.masked.mgh --no-fixmni --csd /usr/local/freesurfer/average/mult-comp-cor/fsaverage/lh/cortex/fwhm14/neg/th40/mc-z.csd --csdpdf lh.facehbi.age.glmdir/facehbi/cache.th40.neg.pdf.dat --vwsig lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.voxel.mgh --vwsigmax lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.voxel.max.dat --oannot lh.facehbi.age.glmdir/facehbi/cache.th40.neg.sig.ocn.annot --bonferroni 2 --
```

```

surf white
# cwd /nas/data/facehbi/fsdg
# sysname Linux
# hostname detritus.fundacioace.com
# machine x86_64
# FixVertexAreaFlag 1
# FixSurfClusterArea 1
#
# Input lh.facehbi.age.glmdir/facehbi/sig.mgh
# Frame Number 0
# srcsubj fsaverage
# hemi lh
# surface white
# group_avg_surface_area 82220
# group_avg_vtxarea_loaded 1
# annot aparc
# SUBJECTS_DIR /nas/data/subjects
# SearchSpace_mm2 75610.7
# SearchSpace_vtx 147840
# Bonferroni 2
# Minimum Threshold 4
# Maximum Threshold infinity
# Threshold Sign neg
# AdjustThreshWhenOneTail 1
# CW PValue Threshold: 0.05
# Area Threshold 0 mm^2
# CSD thresh 4.000000
# CSD nreps 10000
# CSD simtype null-z
# CSD contrast NA
# CSD confint 90.000000
# Overall max 2.34317 at vertex 124430
# Overall min -11.9208 at vertex 75951
# NClusters 27
# FixMNI = 0
#
# ClusterNo Max VtxMax Size(mm^2) MNIX MNIY MNIZ CWP CWPLow
# CWPHi NVtxs WghtVtx Annot
  1 -6.017 60982 491.13 -47.9 -18.5 -2.1 0.00020 0.00000
0.00040 1098 -5034.35 superiortemporal
  2 -11.921 75951 428.53 -31.7 -41.3 -9.1 0.00020 0.00000
0.00040 941 -6762.90 parahippocampal
  3 -7.640 112606 361.05 -20.6 -99.6 -2.3 0.00020 0.00000
0.00040 432 -2179.37 lateraloccipital
  4 -5.486 105941 331.99 -17.1 -32.3 56.5 0.00020 0.00000
0.00040 865 -3748.97 precentral
  5 -5.449 35788 316.75 -44.9 6.5 -23.4 0.00020 0.00000
0.00040 611 -2771.80 superiortemporal
  6 -7.472 67375 290.75 -20.6 30.7 50.4 0.00020 0.00000
0.00040 424 -2270.56 superiorfrontal
  7 -4.824 159440 286.63 -8.8 -58.3 11.9 0.00020 0.00000

```

0.00040	622	-2552.03	precuneus						
8	-6.970	138044	273.27	-30.3	-20.0	68.2	0.00020	0.00000	
0.00040	626	-3090.95	precentral						
9	-6.527	35125	264.21	-35.4	-12.7	18.8	0.00020	0.00000	
0.00040	820	-4057.14	insula						
10	-5.259	113827	256.47	-58.3	-17.5	-17.2	0.00020	0.00000	
0.00040	522	-2207.87	middletemporal						
11	-6.063	142574	227.96	-18.1	-91.7	16.1	0.00020	0.00000	
0.00040	329	-1494.23	lateraloccipital						
12	-4.901	142130	215.89	-61.7	-35.5	5.4	0.00020	0.00000	
0.00040	478	-2005.09	bankssts						
13	-7.124	88387	197.22	-10.7	-56.5	26.6	0.00020	0.00000	
0.00040	436	-2167.82	precuneus						
14	-5.977	112248	187.37	-31.2	-83.9	6.5	0.00040	0.00000	
0.00080	312	-1449.31	lateraloccipital						
15	-5.741	127670	174.29	-54.6	-0.9	-30.3	0.00080	0.00040	
0.00140	210	-946.11	middletemporal						
16	-5.957	110612	155.97	-44.6	23.1	18.8	0.00180	0.00100	
0.00260	258	-1195.22	parsopercularis						
17	-5.156	102514	136.16	-22.9	56.1	15.5	0.00459	0.00340	
0.00579	163	-710.54	rostralmiddlefrontal						
18	-5.618	43104	128.92	-24.3	6.2	48.4	0.00619	0.00479	
0.00759	289	-1317.77	caudalmiddlefrontal						
19	-5.445	91005	128.90	-21.8	-66.5	0.5	0.00619	0.00479	
0.00759	285	-1241.01	lingual						
20	-4.760	47386	121.71	-8.2	33.1	33.9	0.00759	0.00599	
0.00918	190	-780.64	superiorfrontal						
21	-4.778	107013	120.23	-19.8	-83.3	38.4	0.00798	0.00639	
0.00958	223	-941.62	superiorparietal						
22	-4.954	58975	118.93	-10.8	25.6	-17.8	0.00818	0.00659	
0.00978	269	-1155.28	medialorbitofrontal						
23	-4.799	38711	117.04	-60.9	-46.0	-1.9	0.00898	0.00739	
0.01077	232	-956.50	bankssts						
24	-6.095	1815	116.62	-47.1	-19.1	56.1	0.00918	0.00739	
0.01097	319	-1485.15	postcentral						
25	-4.976	77509	113.61	-35.6	37.8	13.2	0.01057	0.00878	
0.01236	190	-814.05	rostralmiddlefrontal						
26	-4.228	51760	87.69	-45.5	-72.1	10.1	0.02524	0.02247	
0.02800	140	-552.81	inferiorparietal						
27	-6.056	126177	68.80	-27.1	-68.1	22.7	0.04898	0.04508	
0.05288	181	-854.08	superiorparietal						

Full data

```
osotolongo@detritus:facehbi$ head datacomb_freesurfer_neuro_v0_scdSUMCC.csv
Subject,SubjID,code_facehbi,N_Interno,Date,edat,Anyos_Escolaridad_FAC,Sex_1H
_OM,SCDplus_Memorycomplaint,SCDplus_APOE4,SCDplus_concernsaboutcognition,SCD
```

```

plus_feelingworsethancontemporarypeers,SCDplus_informantcorroboratessymptoms
,SCDplus_onset60Y,SCDplus_onsetwithinlast5Y,SCDplus_SUVRgt1.35,SCDplus_SUVRg
t1.45,SCDplus_Total7,Q_QSM_JPO,SUVR,Centilod,APOE,COMPOSITE_executive_fluenc
y,COMPOSITE_executive_processing_speed,COMPOSITE_executive_attention
,COMPOSITE_memory_FNAME_professions,COMPOSITE_memory_FNAME_names
,COMPOSITES_memory_WMS,COMPOSITE_memory_RBANS
,COMPOSITE_gnosis,COMPOSITE_praxis,COMPOSITE_languge_naming
1,/nas/data/subjects/facehbi_0001,F001,20090806,11.12.2014,71,8,0,0,1,1,0,1,
1,1,0,0,5,39,0.973316491,-5.593250248,e3e4,-0.5748,-0.270392,-0.532514,-0.61
6904,0.876729,-0.453361,1.130826,0.168598,0.515105,-0.579091
2,/nas/data/subjects/facehbi_0002,F002,20131084,11.12.2014,70,12,1,0,0,0,0,1
,1,1,0,0,3,18,1.088375542,12.05680811,e3e3,0.849066,-0.703145,0.071122,0.912
43,0.399876,0.259093,1.048653,1.256325,0.515105,0.926364
3,/nas/data/subjects/facehbi_0003,F003,20130456,18.12.2014,70,8,0,0,0,0,0,0,
1,1,0,0,2,19,0.961914381,-7.342333945,e3e3,-1.381163,1.677785,-1.150127,-1.0
24665,0.195343,-0.809587,1.426227,1.256325,-0.772658,-0.388182
4,/nas/data/subjects/facehbi_0004,F004,20080130,18.12.2014,76,16,0,0,0,1,0,0
,1,1,0,0,3,21,1.075781955,10.12495194,e3e3,-0.630893,-0.4805,-1.13615,-0.512
863,-0.622202,-0.152722,-0.907758,0.168598,-2.060421,0.164545
5,/nas/data/subjects/facehbi_0005,F005,20141272,22.01.2015,68,20,1,0,0,0,1,1
,1,0,0,0,3,29,0.95654587,-8.16586361,e2e3,1.256741,-0.549082,1.320324,0.7043
47,1.321653,0.630976,0.512283,0.168598,-2.060421,0.396364
6,/nas/data/subjects/facehbi_0006,F006,20141107,15.01.2015,64,14,0,0,1,1,1,1
,1,1,1,0,6,56,1.253344903,37.36310815,e3e4,1.002492,0.610598,0.688735,0.6106
31,-0.71047,0.116602,-0.507294,-0.91913,-2.060421,-0.039091
7,/nas/data/subjects/facehbi_0007,F007,20080716,15.01.2015,59,19,1,1,0,1,0,0
,0,0,1,1,2,15,1.504516347,75.89280769,e3e3,1.040233,0.70185,-0.518537,-0.204
993,0.311608,0.345995,-0.114041,-0.91913,-3.348184,0.090909
8,/nas/data/subjects/facehbi_0008,F008,20131483,15.01.2015,55,16,0,0,0,1,0,1
,0,1,0,0,3,72,0.897682014,-17.19557899,e3e3,-1.363541,0.552768,-0.532514,-0.
111277,0.980961,-0.781793,1.473992,-0.91913,0.515105,-0.439091
9,/nas/data/subjects/facehbi_0009,F009,20141277,29.01.2015,67,16,0,0,0,0,0,0
,1,1,0,0,2,18,1.033333445,3.613350513,e3e3,0.674792,0.532426,0.688735,-0.920
727,-0.826734,-1.110226,-1.451403,-0.91913,-0.772658,1.016462

```

```

osotolongo@detritus:facehbi$ head -n 1
datacomb_freesurfer_neuro_v0_scdSUMCC.csv | sed 's/,/\n/g' | cat -n
 1 Subject
 2 SubjID
 3 code_facehbi
 4 N_Interno
 5 Date
 6 edat
 7 Anyos_Escolaridad_FAC
 8 Sex_1H_0M
 9 SCDplus_Memorycomplaint
10 SCDplus_APOE4
11 SCDplus_concernsaboutcognition
12 SCDplus_feelingworsethancontemporarypeers
13 SCDplus_informantcorroboratessymptoms

```

```
14 SCDplus_onset60Y
15 SCDplus_onsetwithinlast5Y
16 SCDplus_SUVRgt1.35
17 SCDplus_SUVRgt1.45
18 SCDplus_Total7
19 Q_QSM_JPO
20 SUVR
21 Centilod
22 APOE
23 COMPOSITE_executive_fluency
24 COMPOSITE_executive_processing speed
25 COMPOSITE_executive_attention
26 COMPOSITE_memory_FNAME professions
27 COMPOSITE_memory_FNAME names
28 COMPOSITES_memory_WMS
29 COMPOSITE_memory_RBANS
30 COMPOSITE_gnosis
31 COMPOSITE_praxis
32 COMPOSITE_langue_naming
```

Voy a tomar uno de los composites para probar,

```
osotolongo@detritus:facehbi$ awk -F"," {'print $2","$6","$7","$8","$23'}
datacomb_freesurfer_neuro_v0_scdSUMCC.csv | sed
's/.*/facehbi_/facehbi_/;s/SubjID/Variables/;s/edat/age/;s/Anyos_Escolarida
d_FAC/education/;s/Sex_1H_0M/gender/;s/COMPOSITE_//;s/facehbi_\([^,]*\)\/Inp
ut facehbi_\1 Main /; s/,/ /g' > executive_fluency_body.tsv
osotolongo@detritus:facehbi$ cat executive_fluency_header.txt
GroupDescriptorFile 1
Title FACEHBI_executive_fluency
Class Main
osotolongo@detritus:facehbi$ cat executive_fluency_header.txt
executive_fluency_body.tsv > executive_fluency.fsgd
osotolongo@detritus:facehbi$ head executive_fluency.fsgd
GroupDescriptorFile 1
Title FACEHBI_executive_fluency
Class Main
Variables age education gender executive_fluency
Input facehbi_0001 Main 71 8 0 -0.5748
Input facehbi_0002 Main 70 12 1 0.849066
Input facehbi_0003 Main 70 8 0 -1.381163
Input facehbi_0004 Main 76 16 0 -0.630893
Input facehbi_0005 Main 68 20 1 1.256741
Input facehbi_0006 Main 64 14 0 1.002492
osotolongo@detritus:facehbi$ cat comps.mtx
0 0 0 0 1
```

ahora empezamos,


```

osotolongo@detritus:facehbi$ mris_preproc --fsgd executive_fluency.fsgd --
cache-in thickness.fwhm10.fsaverage --target fsaverage --hemi lh --out
lh.executive_fluency.thickness.10.mgh
osotolongo@detritus:facehbi$ mri_glmfit --y
lh.executive_fluency.thickness.10.mgh --fsgd executive_fluency.fsgd --C
comps.mtx --surf fsaverage lh --cortex --glmdir lh.executive_fluency.glmdir
osotolongo@detritus:facehbi$ mri_glmfit-sim --glmdir
lh.executive_fluency.glmdir --cache 4 neg --cwp 0.05 --2spaces
osotolongo@detritus:facehbi$ grep -v "#"
lh.executive_fluency.glmdir/comps/cache.th40.neg.sig.cluster.summary
osotolongo@detritus:facehbi$ mri_glmfit-sim --glmdir
lh.executive_fluency.glmdir --cache 4 pos --cwp 0.05 --2spaces
osotolongo@detritus:facehbi$ grep -v "#"
lh.executive_fluency.glmdir/comps/cache.th40.pos.sig.cluster.summary

```

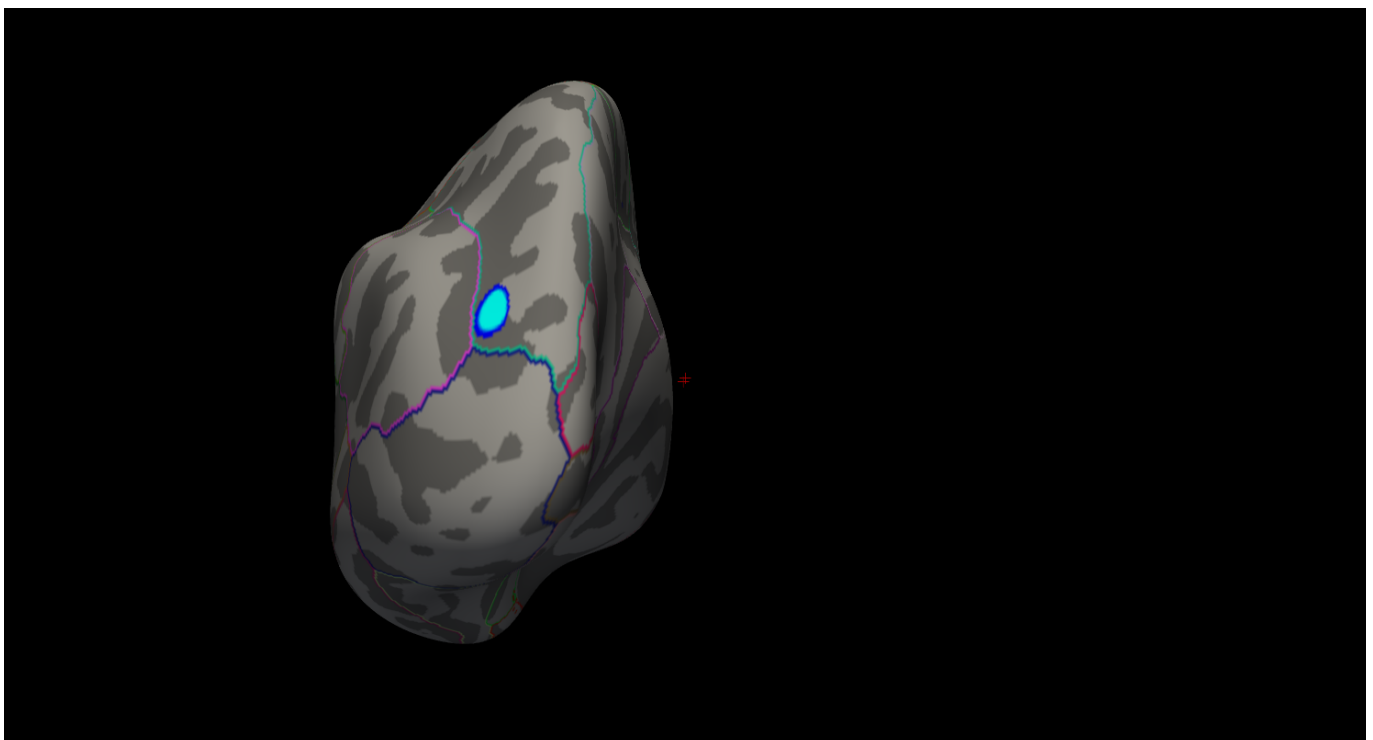
Y esto lo hacemos para el otro hemisferio igualmente. Aquí no hay nada así que podemos seguir hacia la siguiente variable, 😊

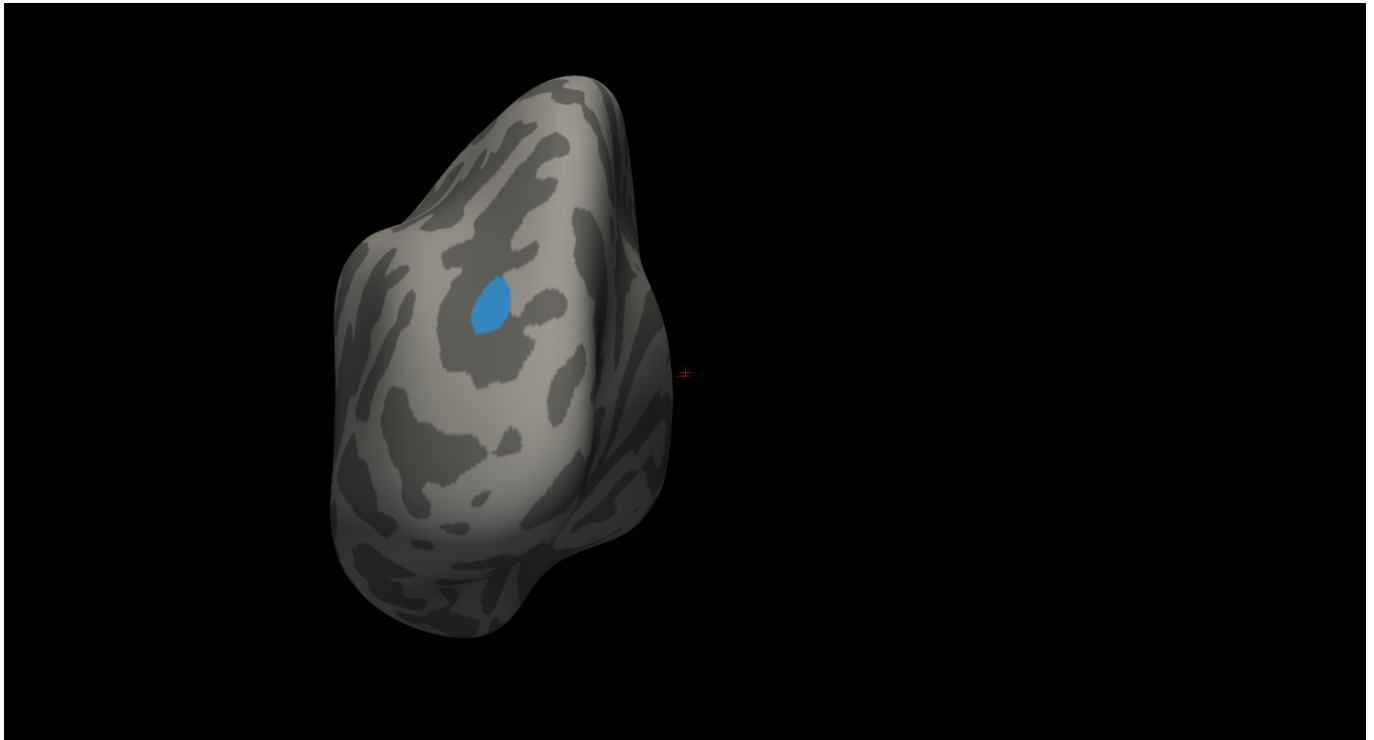
ejemplo de resultados

```

osotolongo@detritus:facehbi$ grep -v "#"
lh.executive_processing.glmdir/comps/cache.th40.neg.sig.cluster.summary
  1      -6.662  147537    122.63   -24.1  -78.1   17.4  0.00739  0.00579
0.00898   237    -1176.13  superiorparietal

```





bulk processing

Esto es muy aburrido, así que vamos a hacerlo todo junto,

`fsgd.sh`

```
avar=$1
shift
mris_preproc --fsgd ${avar}.fsgd --cache-in thickness.fwhm10.fsaverage
--target fsaverage --hemi lh --out lh.${avar}.thickness.10.mgh
mris_preproc --fsgd ${avar}.fsgd --cache-in thickness.fwhm10.fsaverage
--target fsaverage --hemi rh --out rh.${avar}.thickness.10.mgh
mri_glmfit --y lh.${avar}.thickness.10.mgh --fsgd ${avar}.fsgd --C
comps.mtx --surf fsaverage lh --cortex --glmdir lh.${avar}.glmdir
mri_glmfit --y rh.${avar}.thickness.10.mgh --fsgd ${avar}.fsgd --C
comps.mtx --surf fsaverage rh --cortex --glmdir rh.${avar}.glmdir
mri_glmfit-sim --glmdir lh.${avar}.glmdir --cache 4 neg --cwp 0.05 -
-2spaces
mri_glmfit-sim --glmdir rh.${avar}.glmdir --cache 4 neg --cwp 0.05 -
-2spaces
mri_glmfit-sim --glmdir lh.${avar}.glmdir --cache 4 pos --cwp 0.05 -
-2spaces
mri_glmfit-sim --glmdir rh.${avar}.glmdir --cache 4 pos --cwp 0.05 -
-2spaces
echo "lh, neg"
grep -v "#" lh.${avar}.glmdir/comps/cache.th40.neg.sig.cluster.summary
echo "rh, neg"
```

```
grep -v "#" rh.${avar}.glmdir/comps/cache.th40.neg.sig.cluster.summary
echo "lh, pos"
grep -v "#" lh.${avar}.glmdir/comps/cache.th40.pos.sig.cluster.summary
echo "rh, pos"
grep -v "#" rh.${avar}.glmdir/comps/cache.th40.pos.sig.cluster.summary
```

todavia hay que hacer el archivo fsgd a mano pero despues de eso,

```
osotolongo@detritus:facehbi$ head executive_fname_n.fsgd
GroupDescriptorFile 1
Title FACEHBI_executive_fname_n
Class Main
Variables age education gender memory_FNAME_names
Input facehbi_0001 Main 71 8 0 0.876729
Input facehbi_0002 Main 70 12 1 0.399876
Input facehbi_0003 Main 70 8 0 0.195343
Input facehbi_0004 Main 76 16 0 -0.622202
Input facehbi_0005 Main 68 20 1 1.321653
Input facehbi_0006 Main 64 14 0 -0.71047
```

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