

Improving coregistration by skullstripping of EPI images

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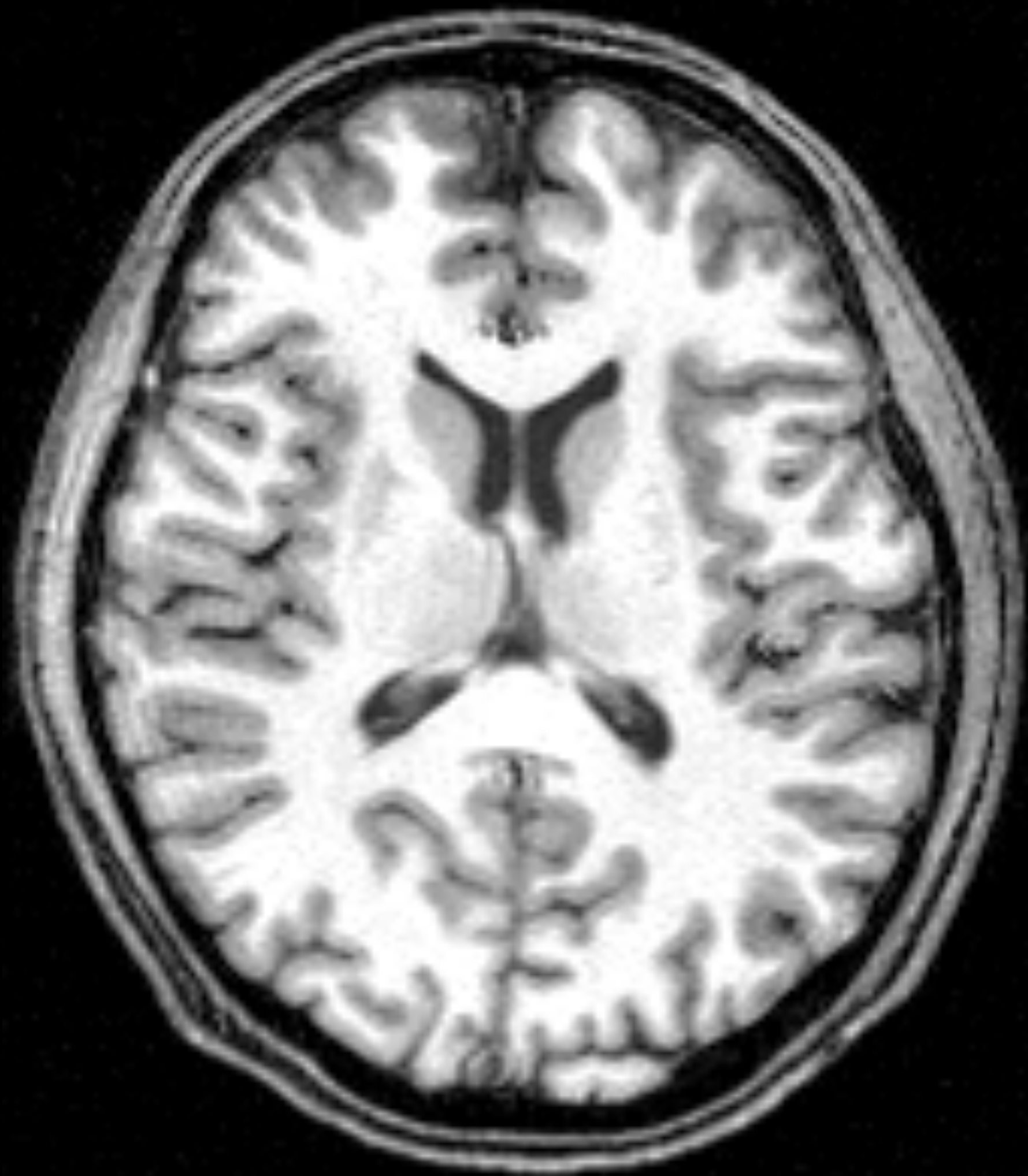
Outline

- **Motivation: why coregistration matters**
- **How to check: visual inspection always!**
- **How to improve: skullstripping T1w & EPI images**

Registration to a template (or spatial normalisation)

- To draw conclusion of a group-level analysis (either commonality or variability)**
- To enable accumulation of knowledge about brain**
- EPI to T1w (higher res.) then to MNI-T1w**

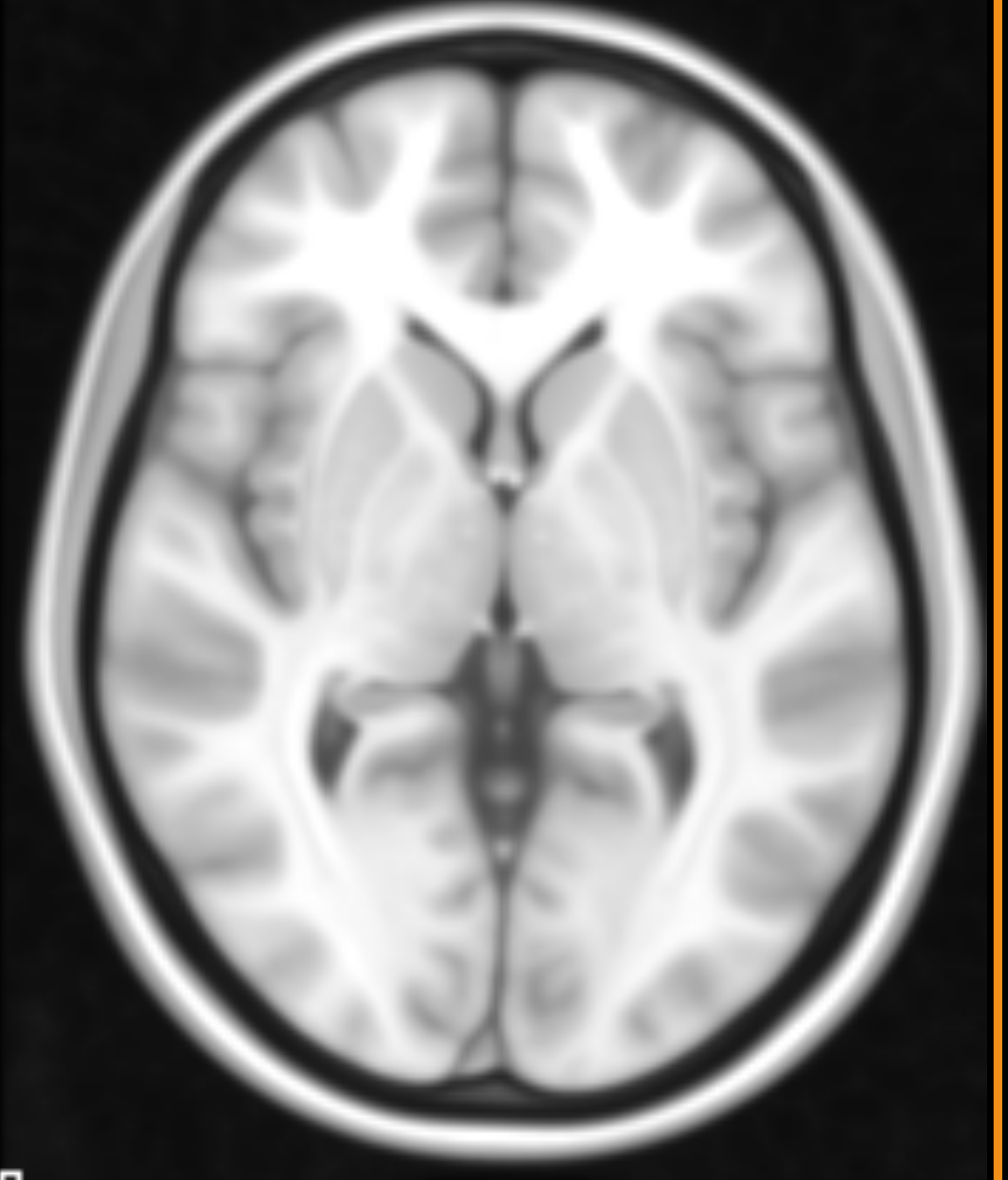
Native T1w space



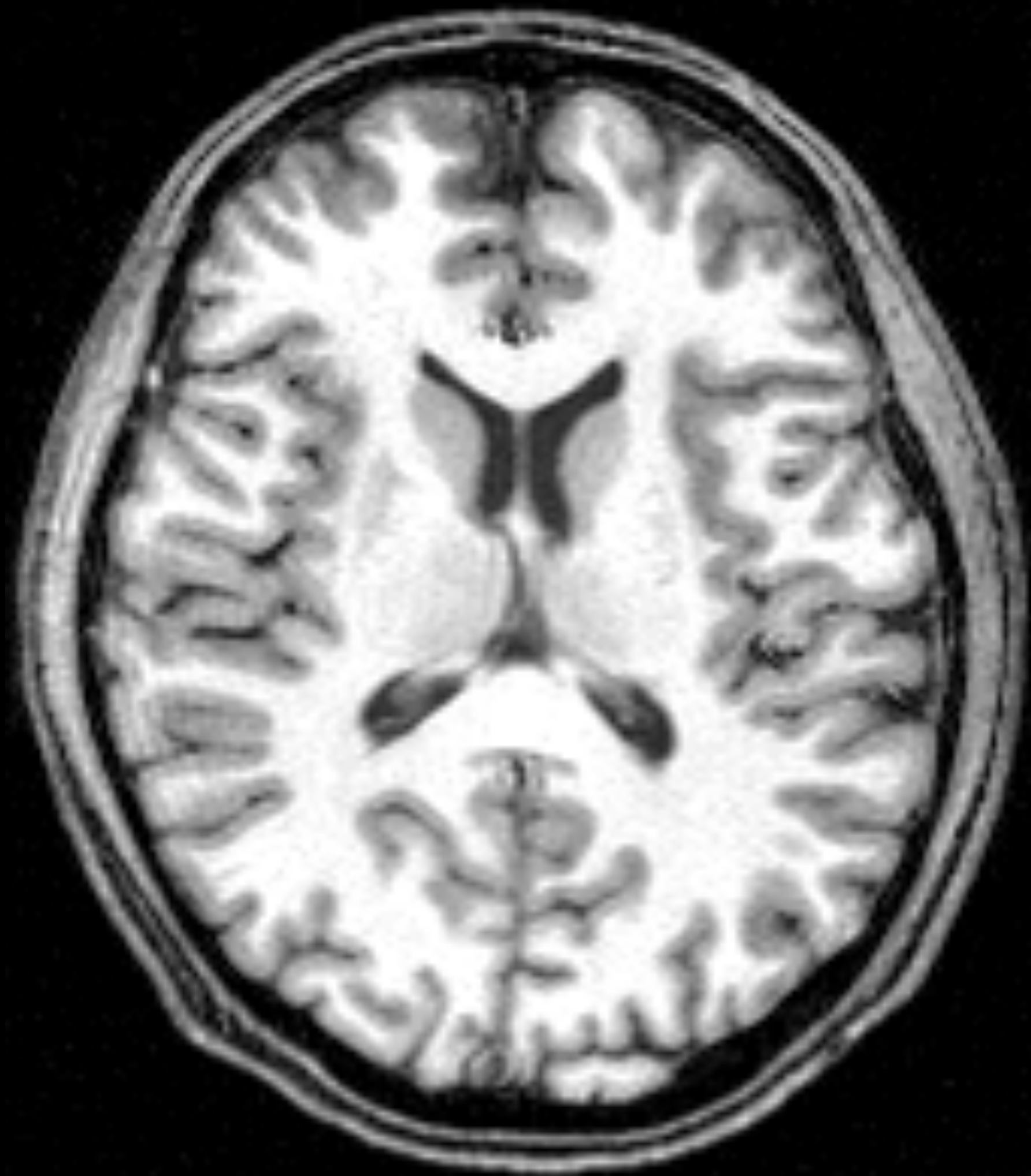
$f(x)$?



MNI152 space



Native T1w space



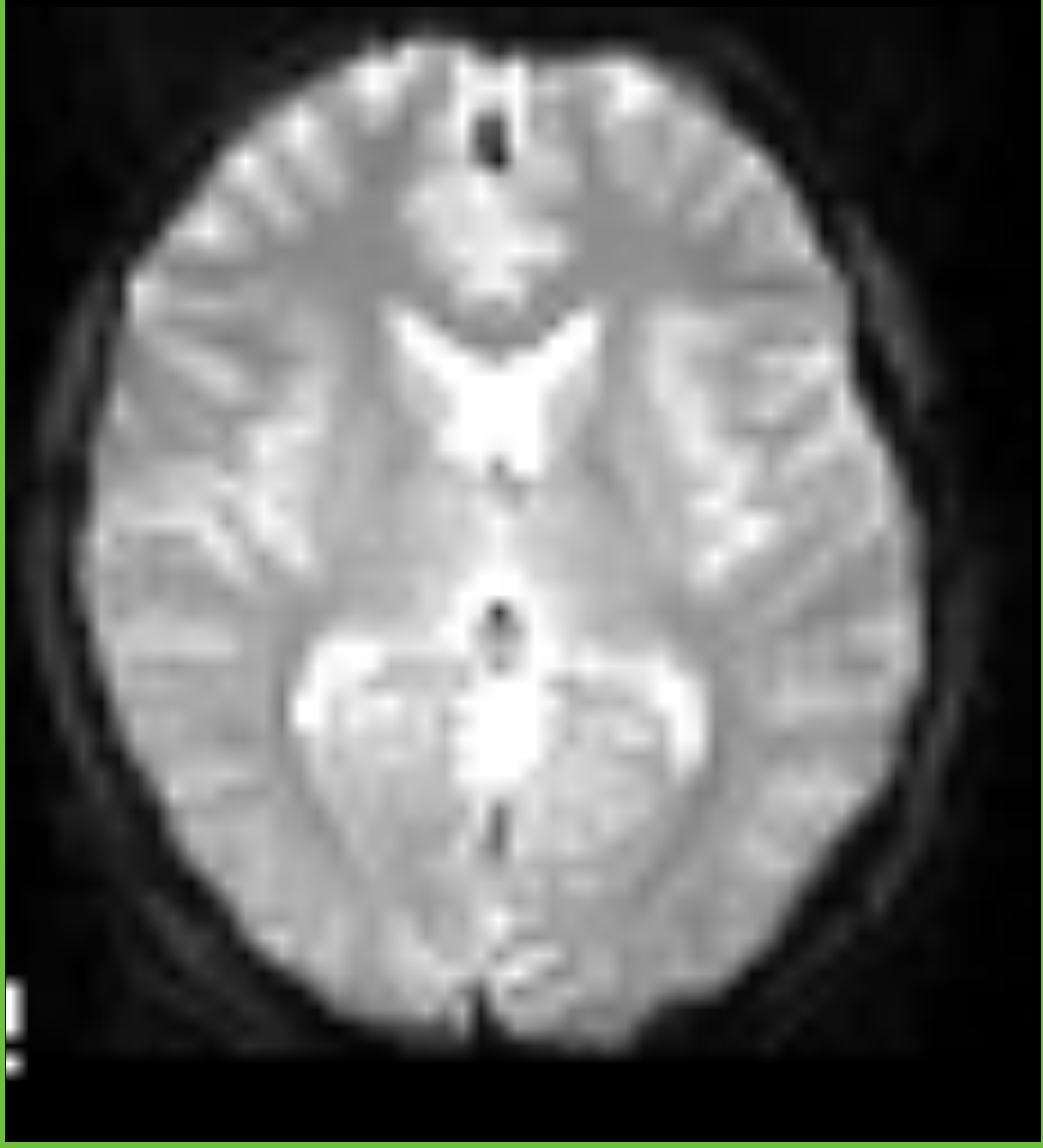
$$f^*(x)$$



MNI152 space



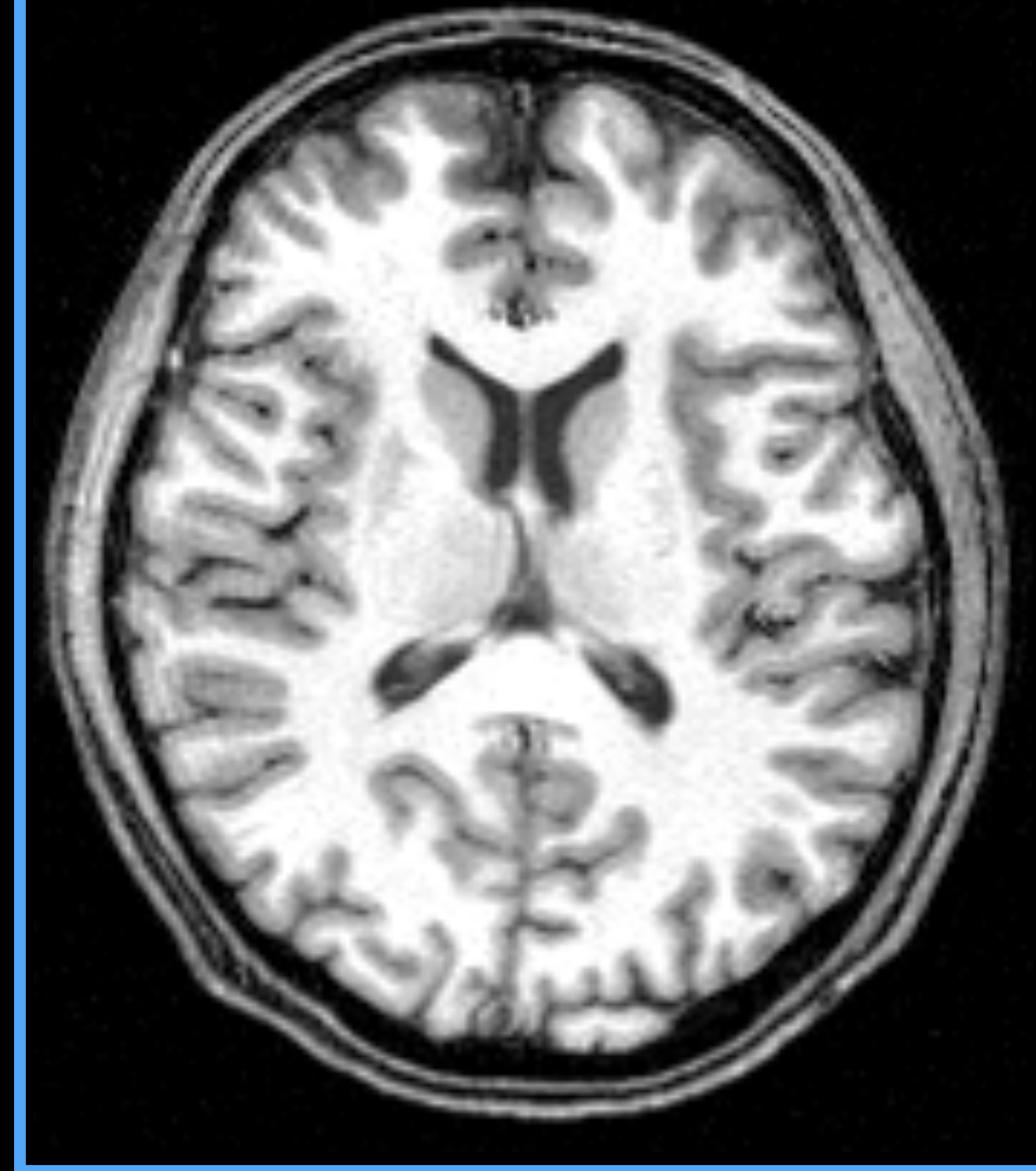
Native EPI space



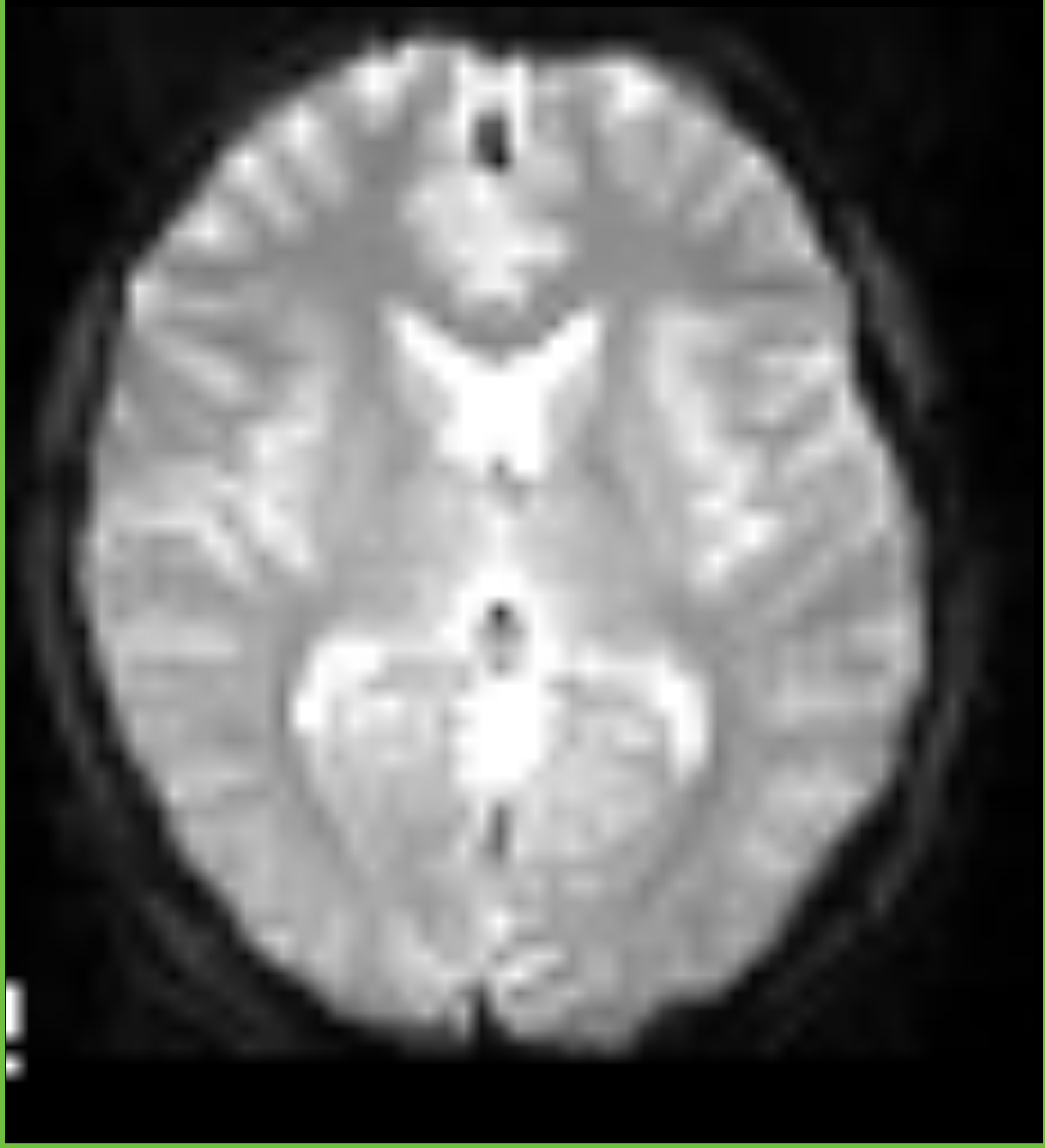
$g(x)$

→

Native T1w space



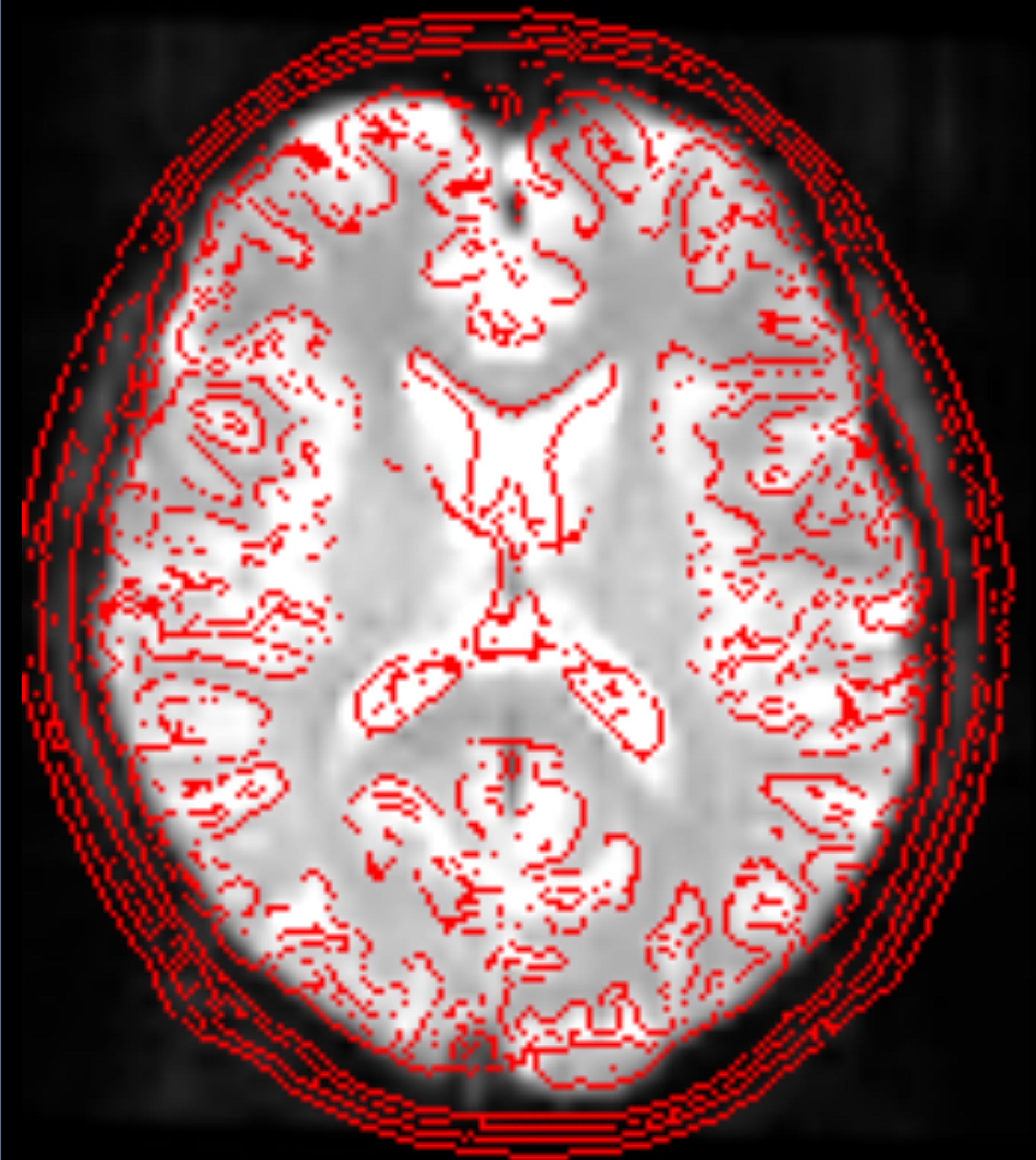
Native EPI space



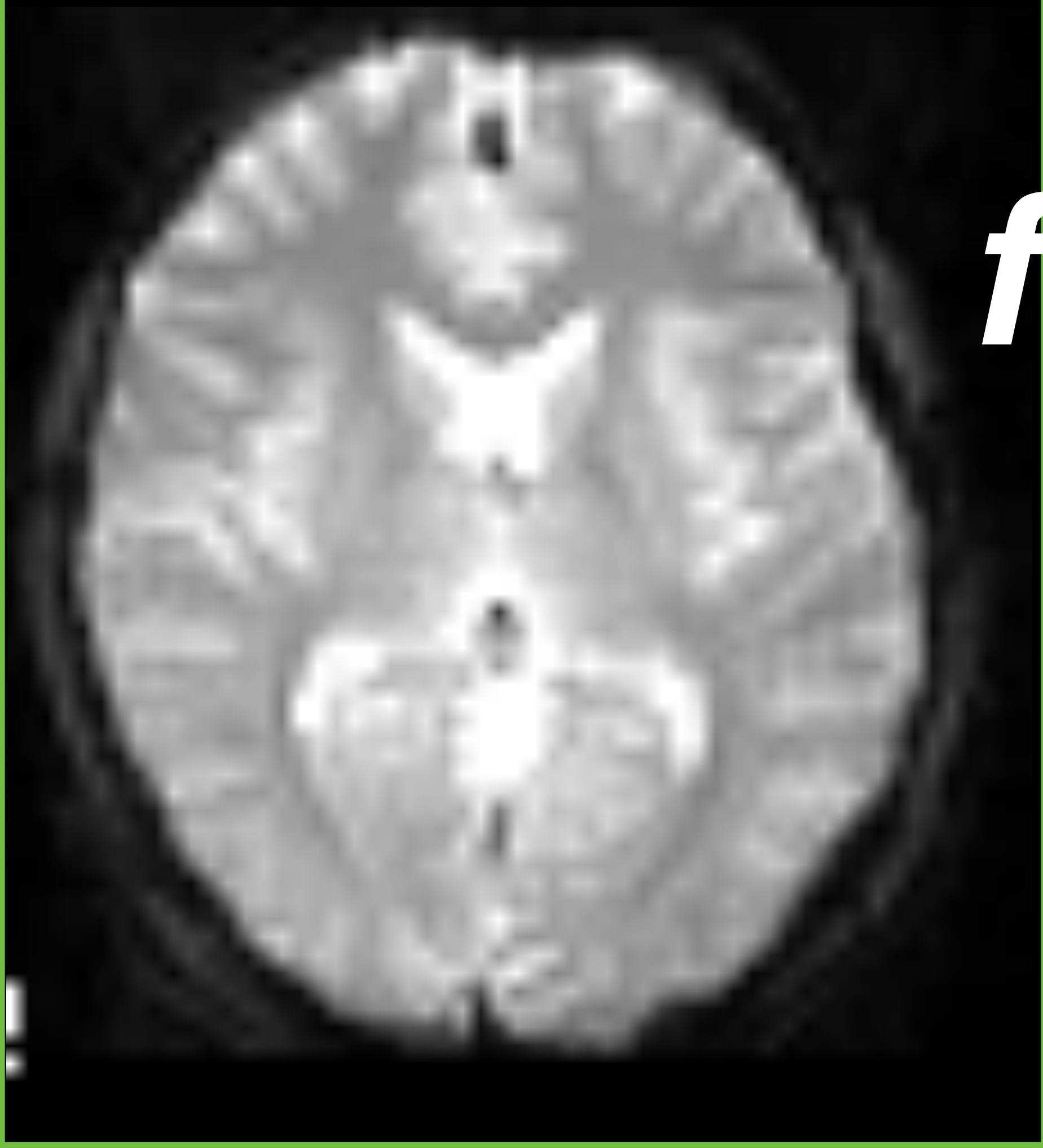
$g^*(\mathbf{x})$



Native T1w space



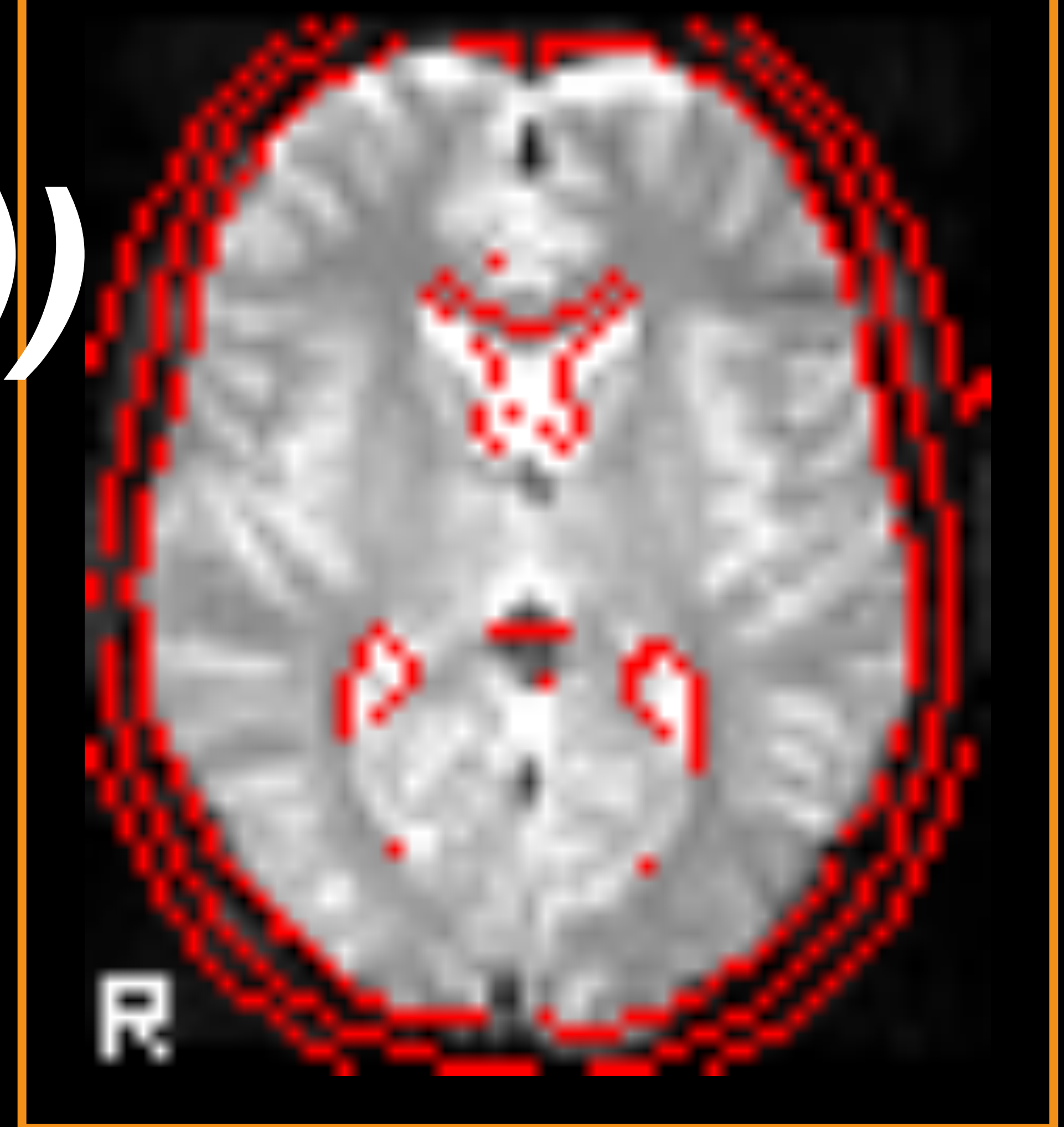
Native EPI space



$$f^*(g^*(x))$$



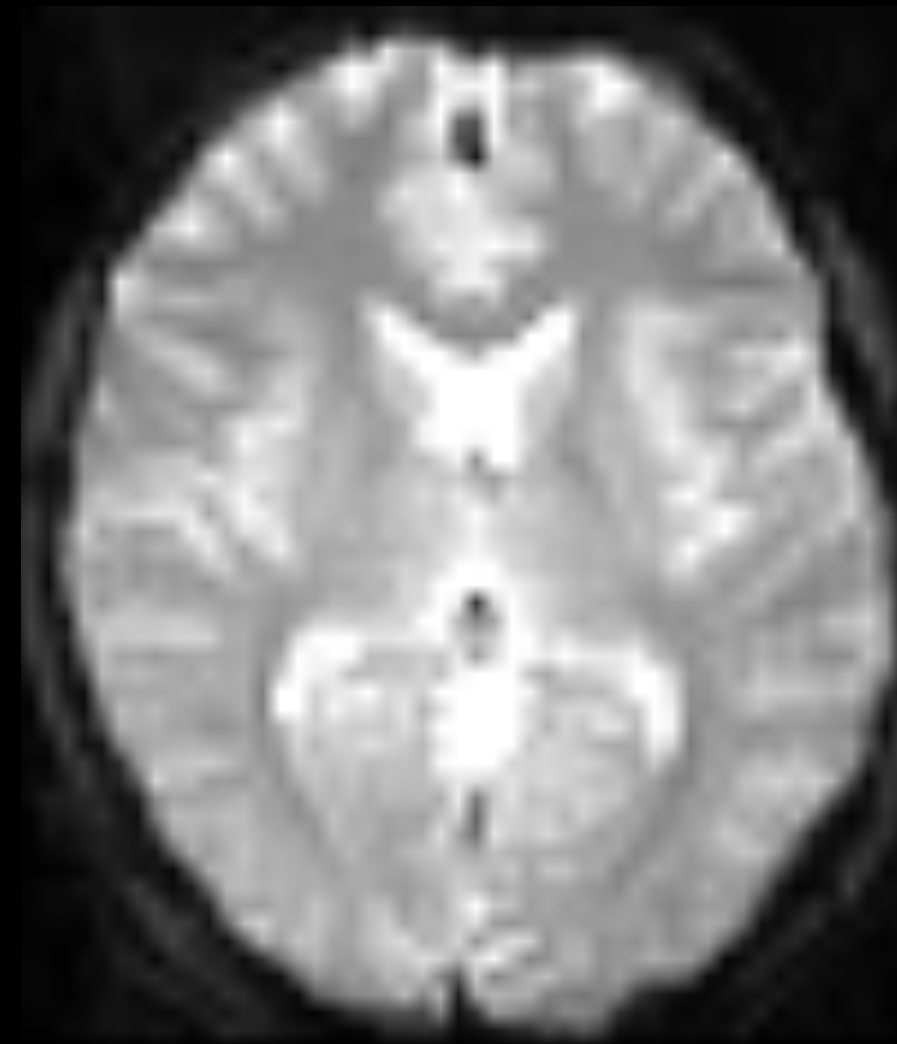
MNI152 space



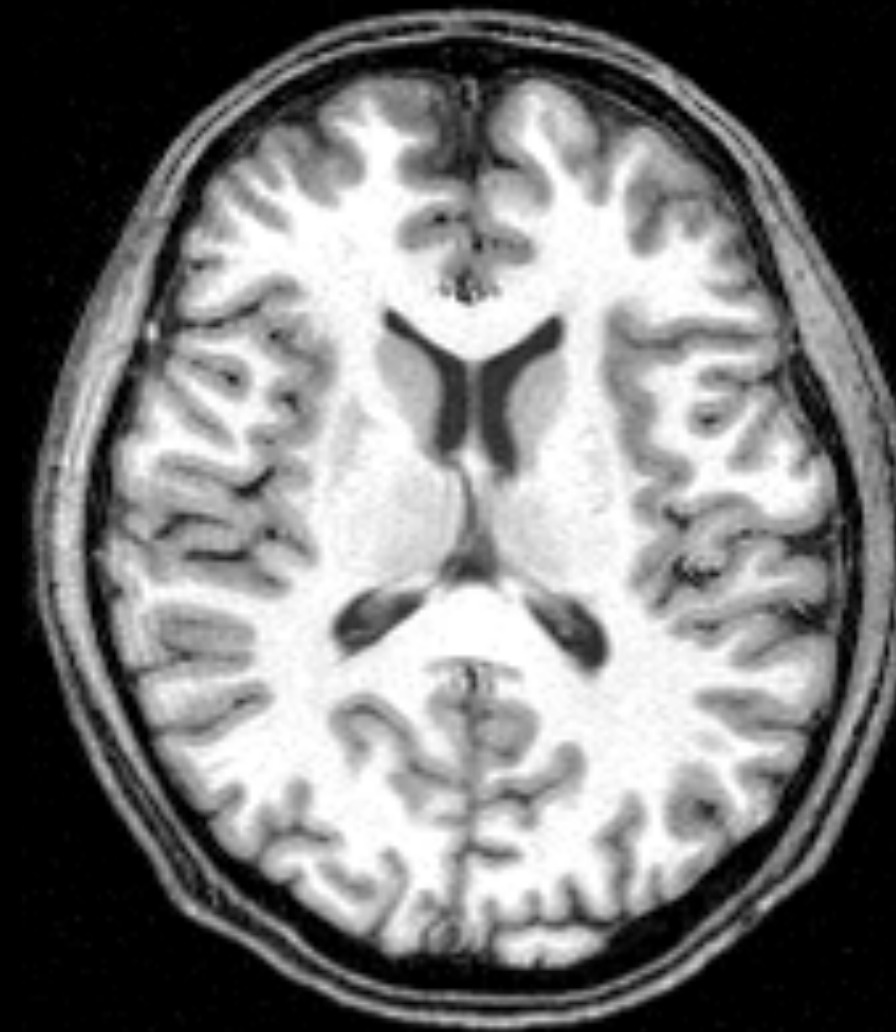
Native EPI

Native T1w

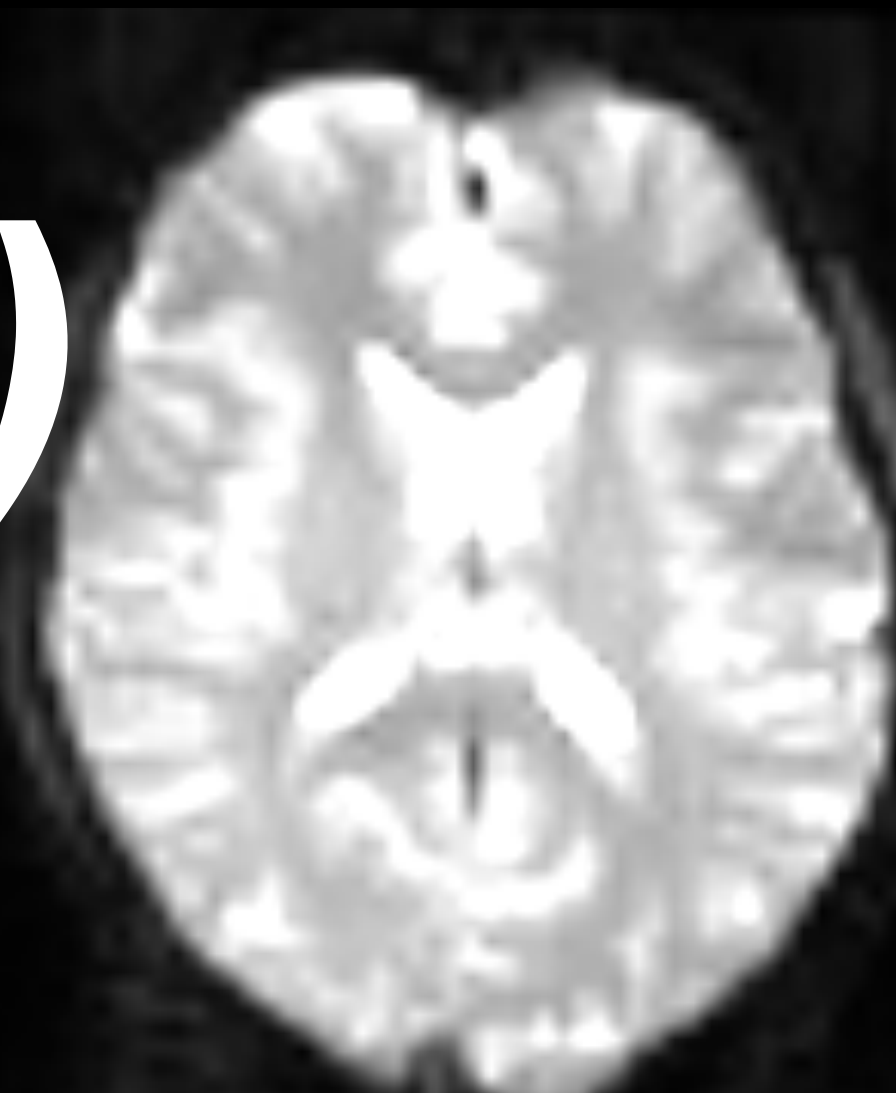
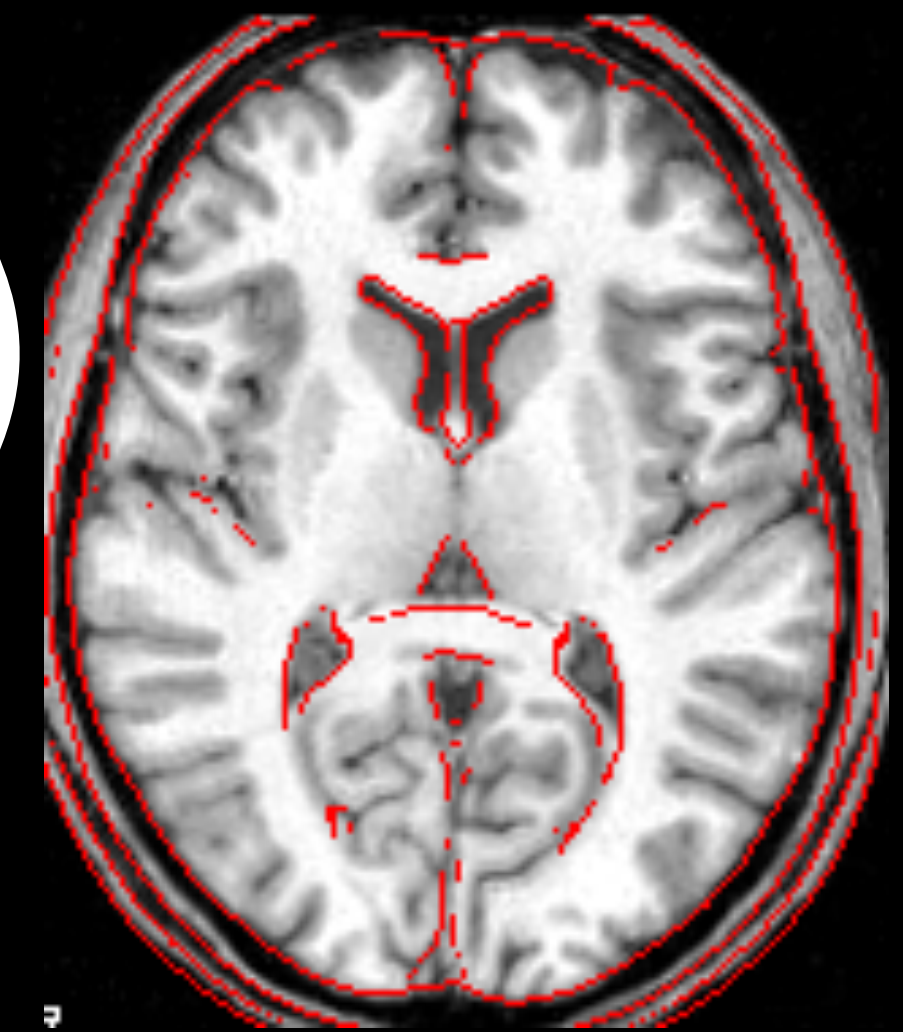
MNI152



$g^*(x)$



$f^*(x)$



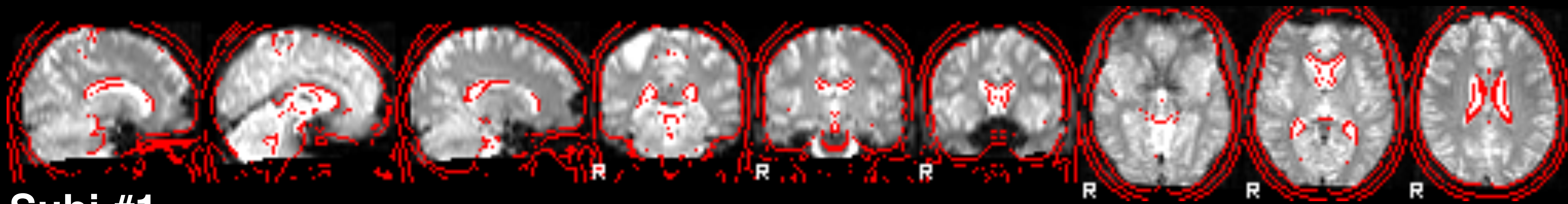
$f^*(x)$



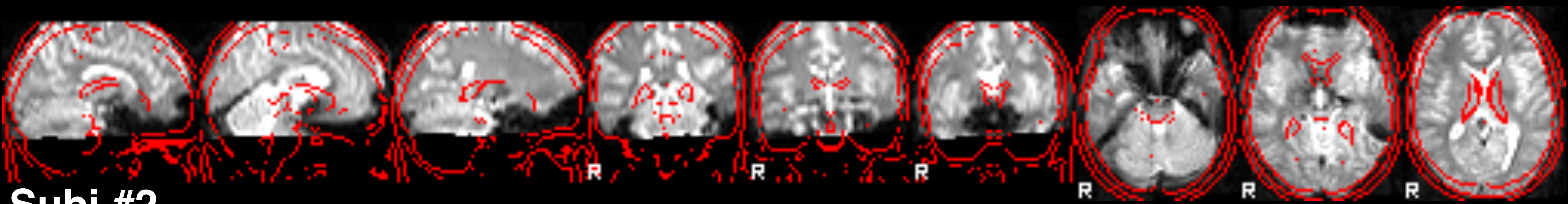
Common practice for coregistration

- Only 6 parameters for rigid-body transformation
 - It's too simple to be wrong! $\backslash_(_/)_/$
- SPM12 batch: skull-stripping of T1w only
- SPM8 batch by Karsten and Jöran: no skull-stripping at all

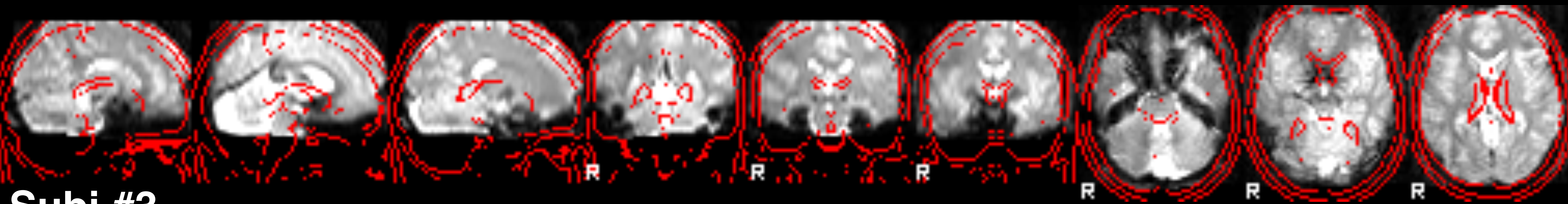
[SPM12]: coregistration is usually trivial...?



Subj #1

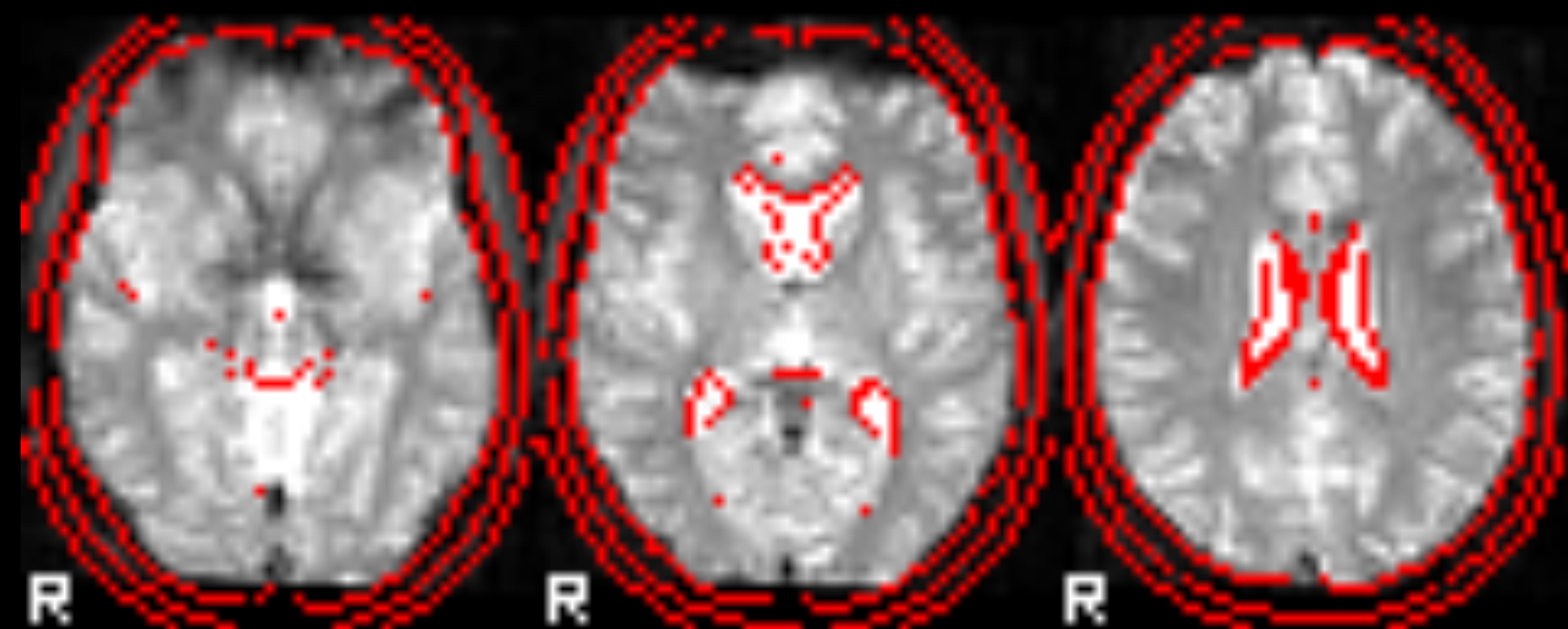
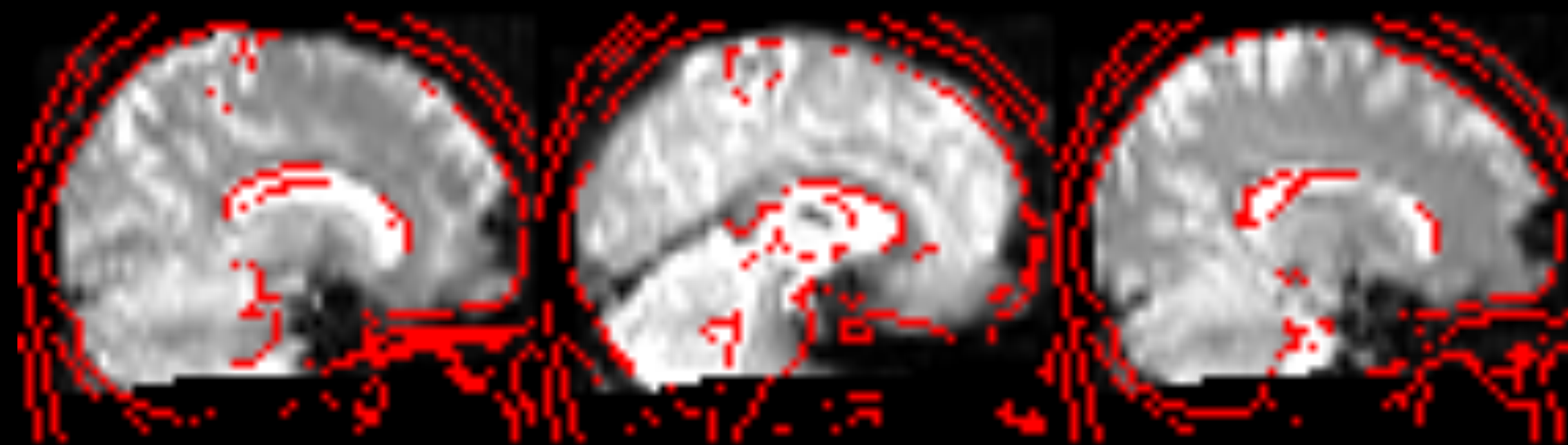


Subj #2

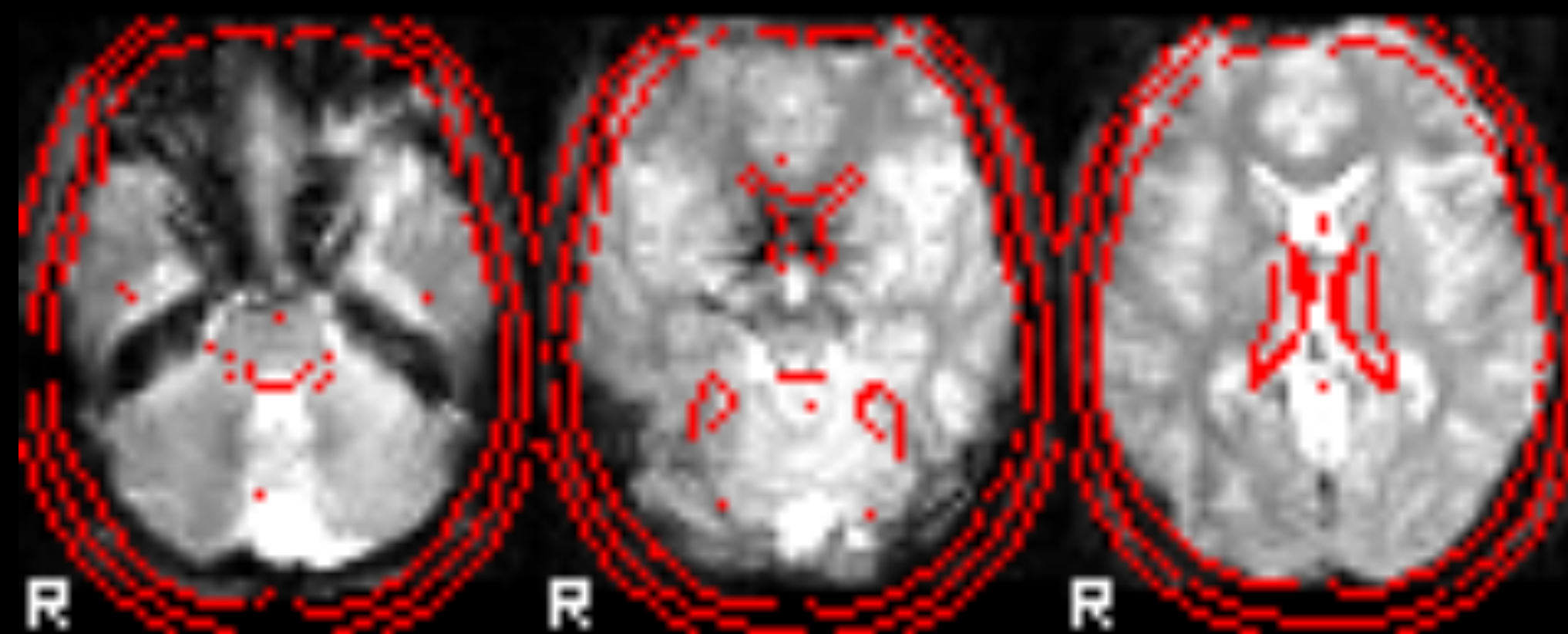
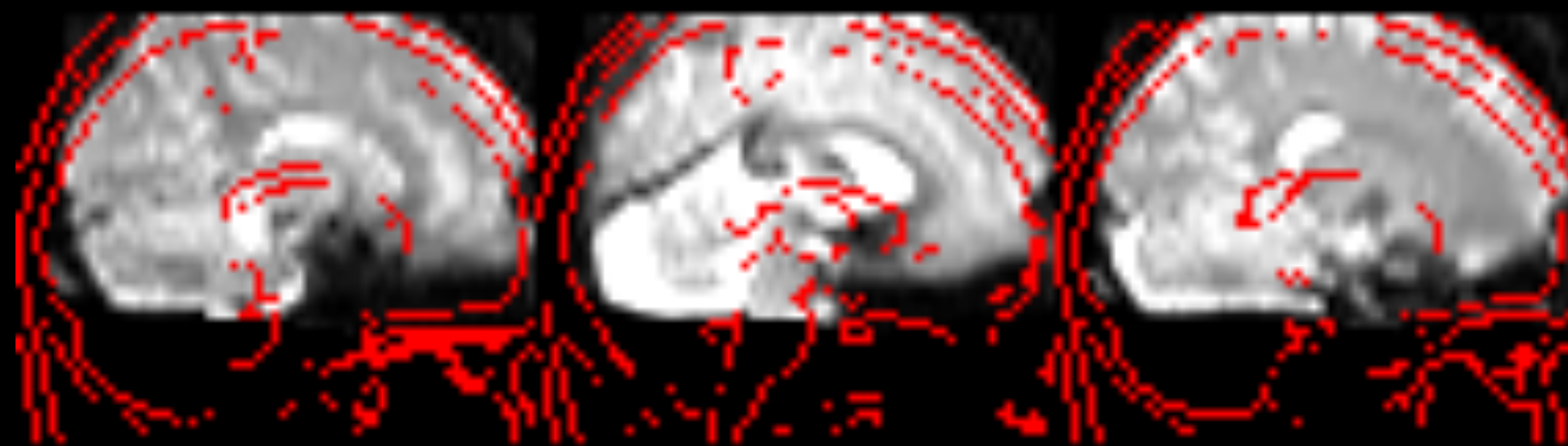


Subj #3

Subj #1: EPI -> MNI

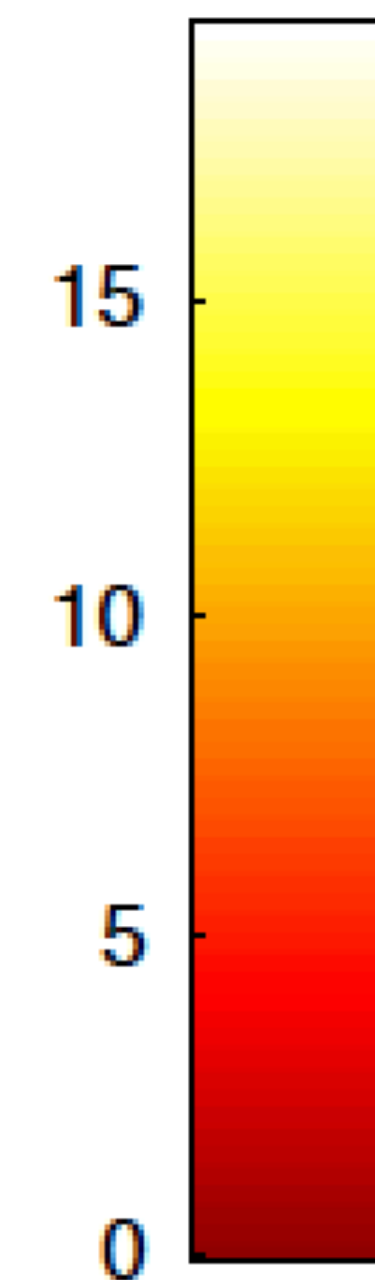
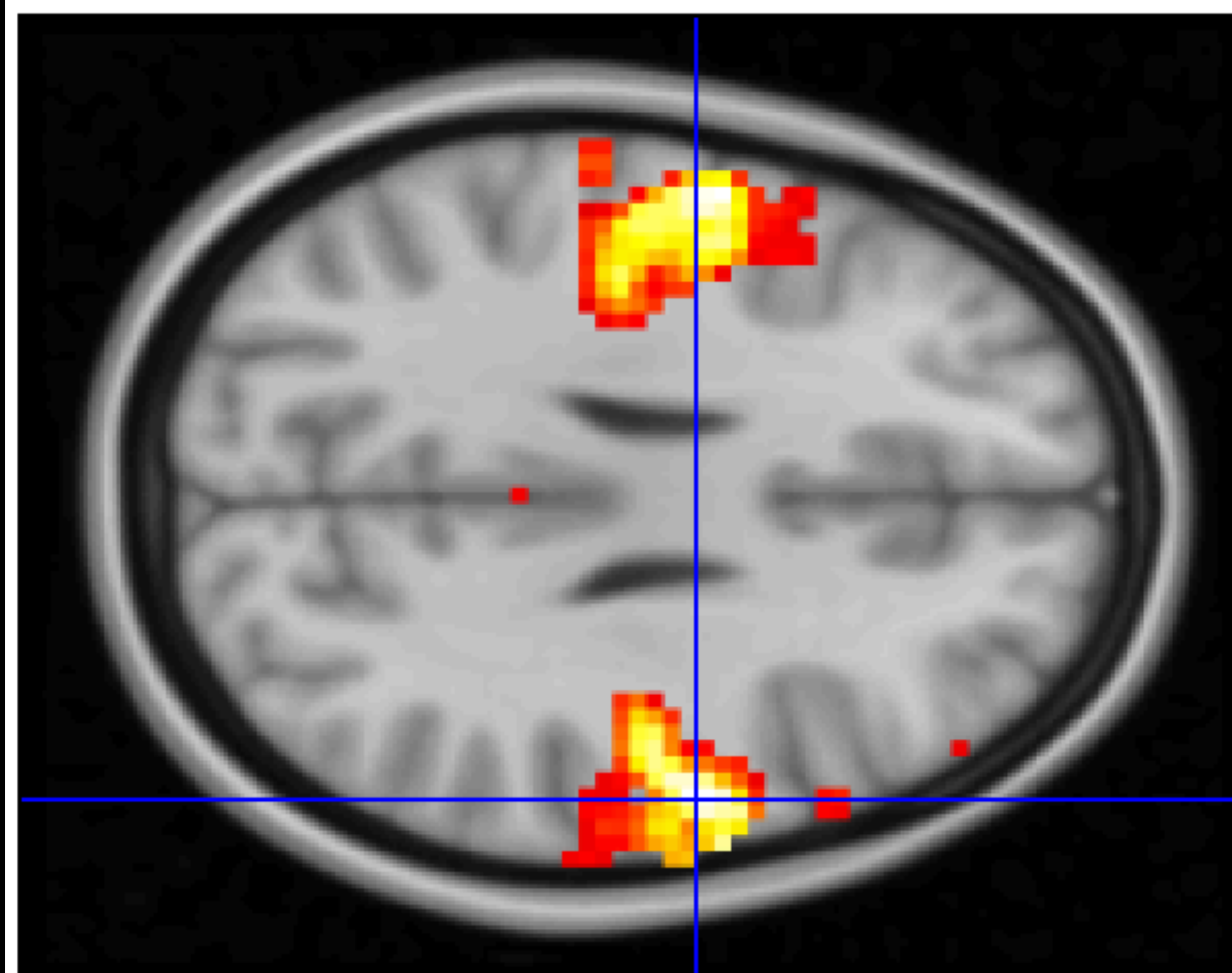
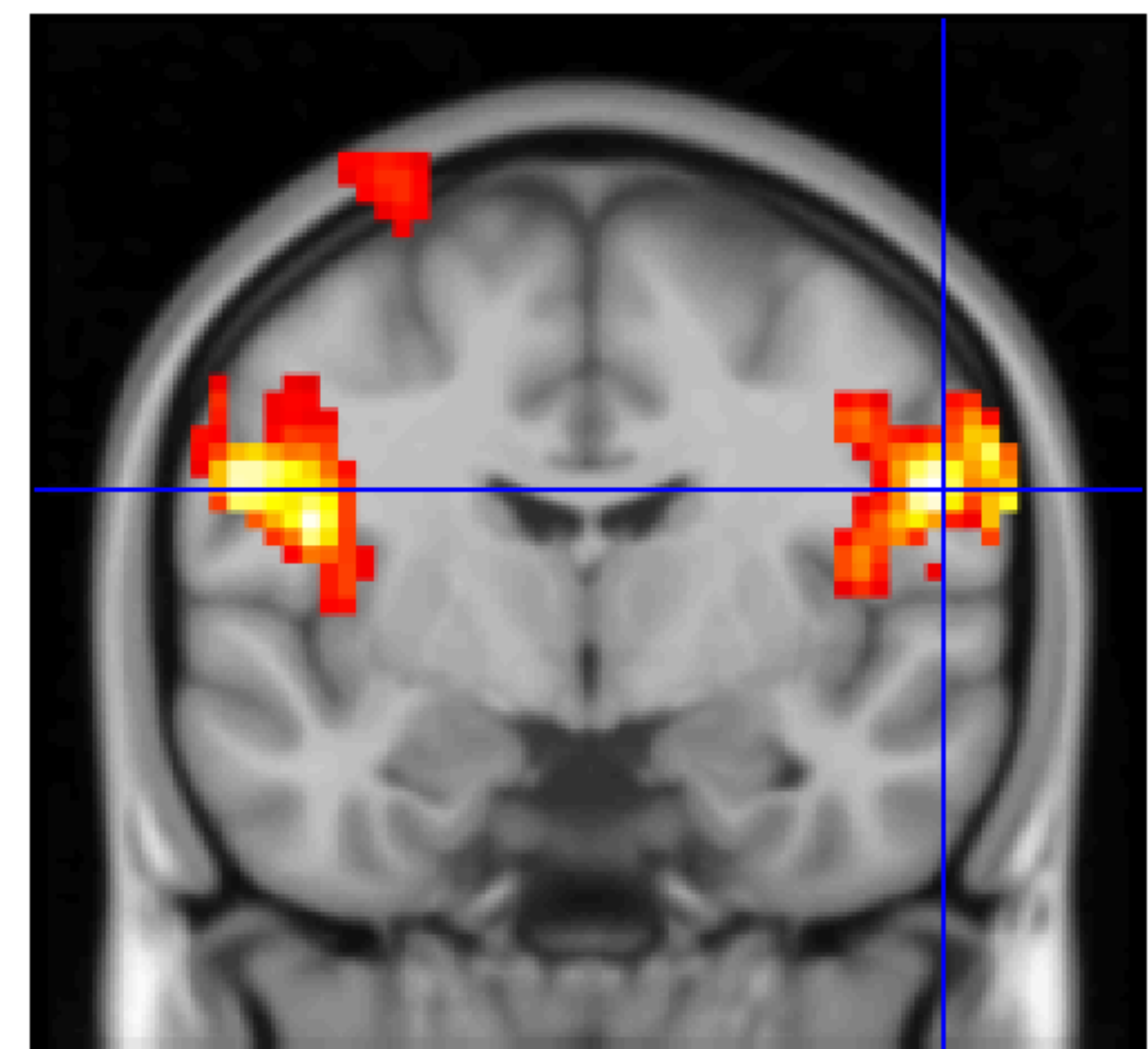
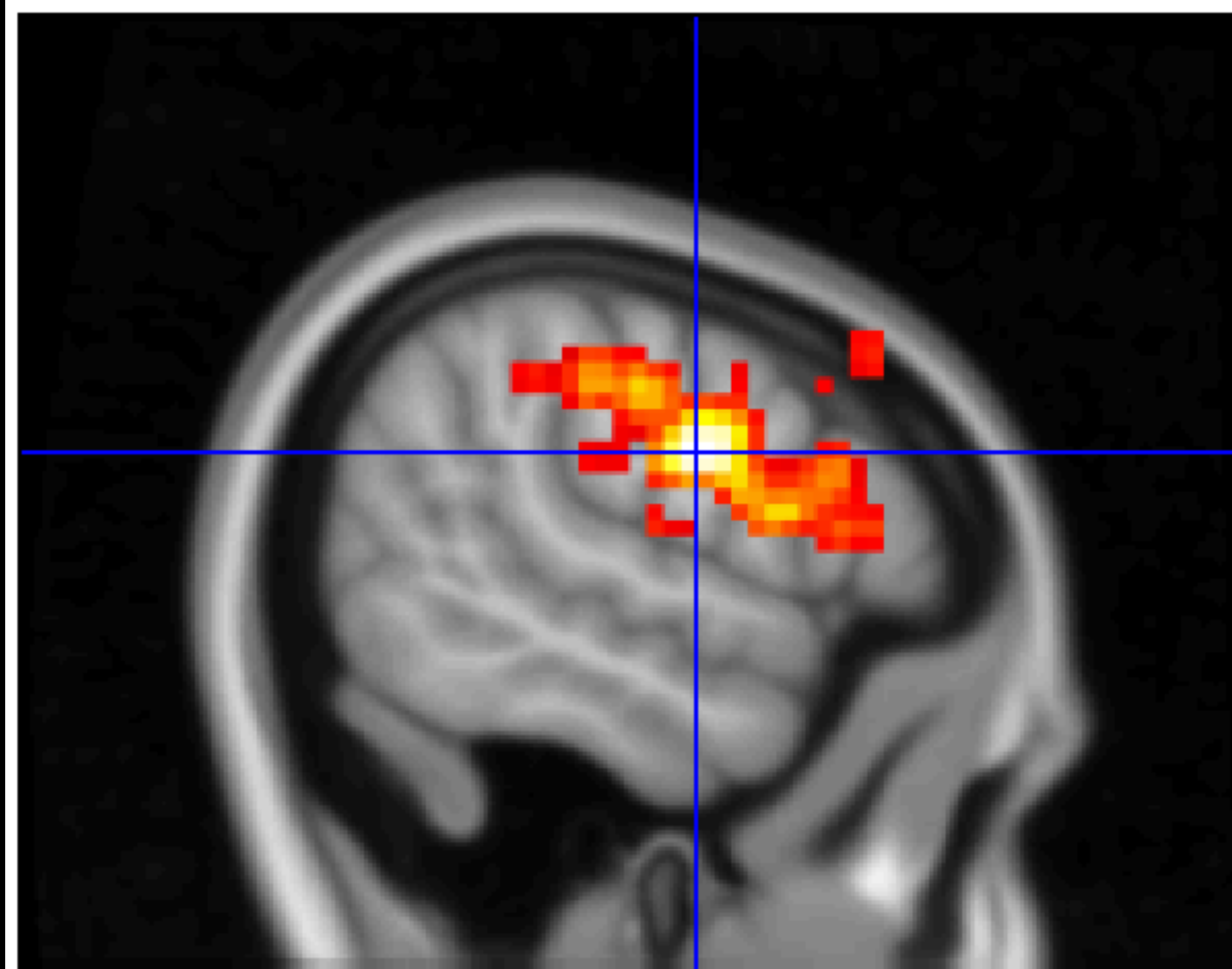


Subj #3: EPI -> MNI



**Music
activated
bilateral motor
cortices!**

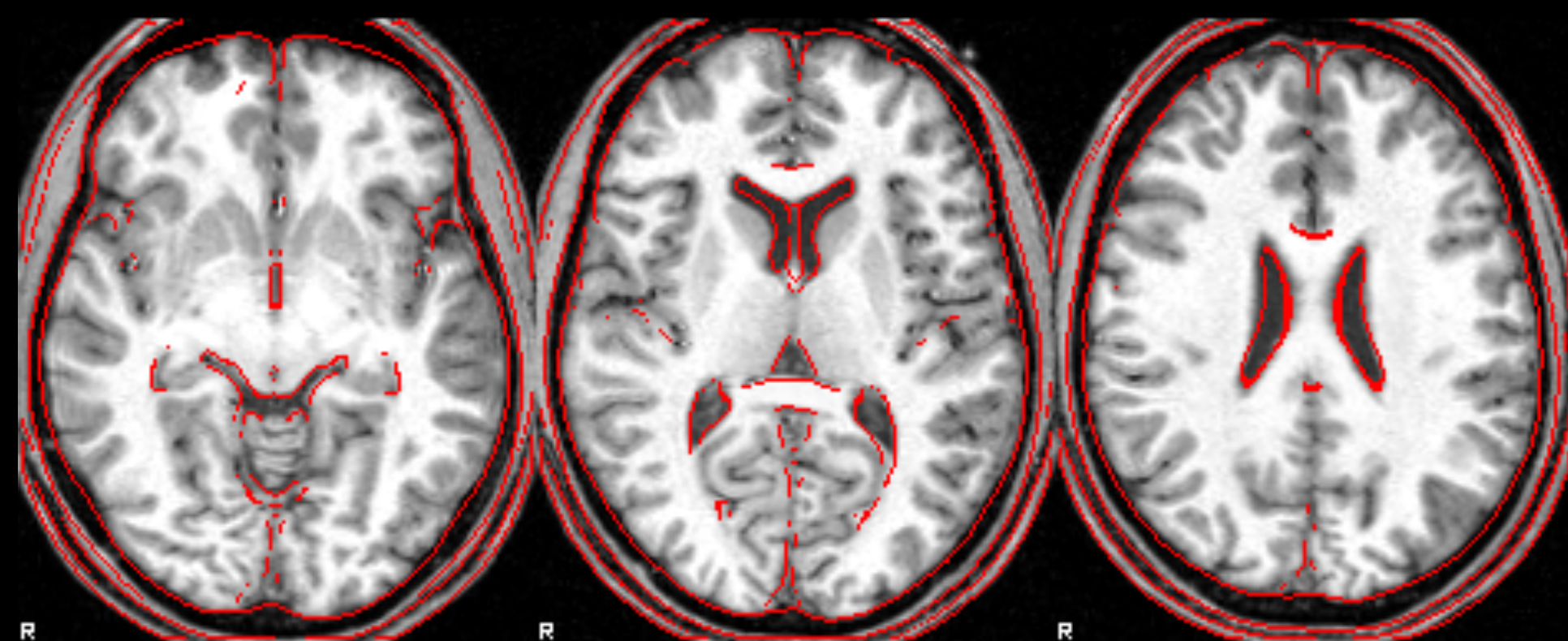
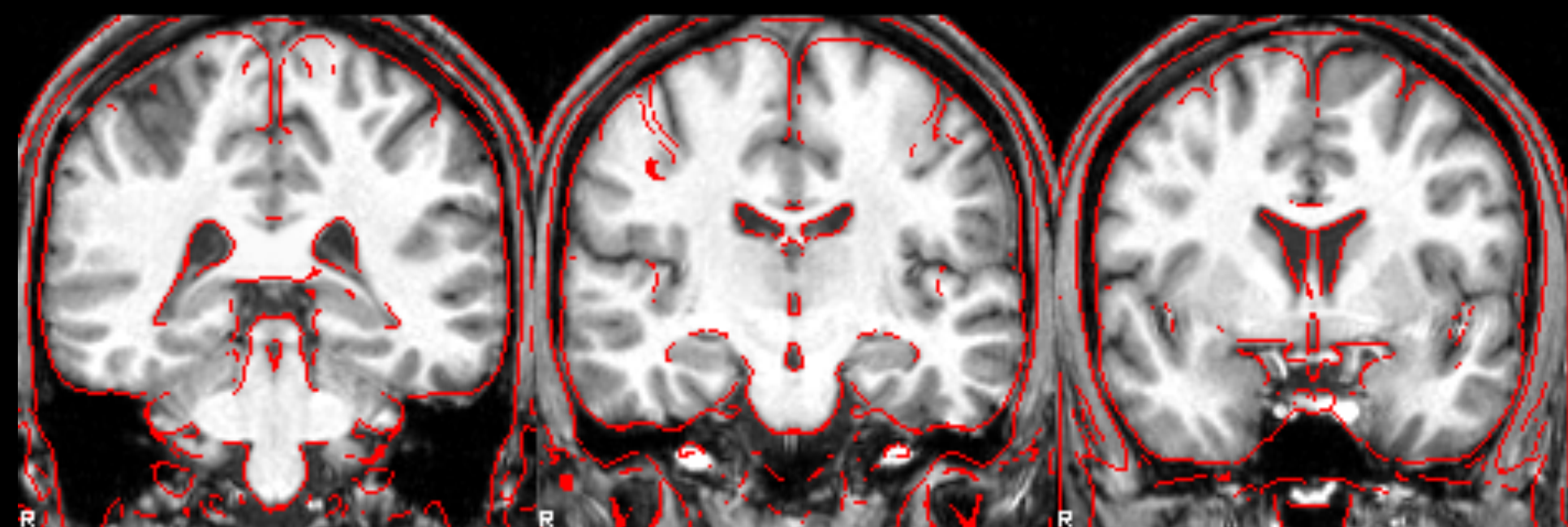
**..because of
mirror
neurons?! (no)**



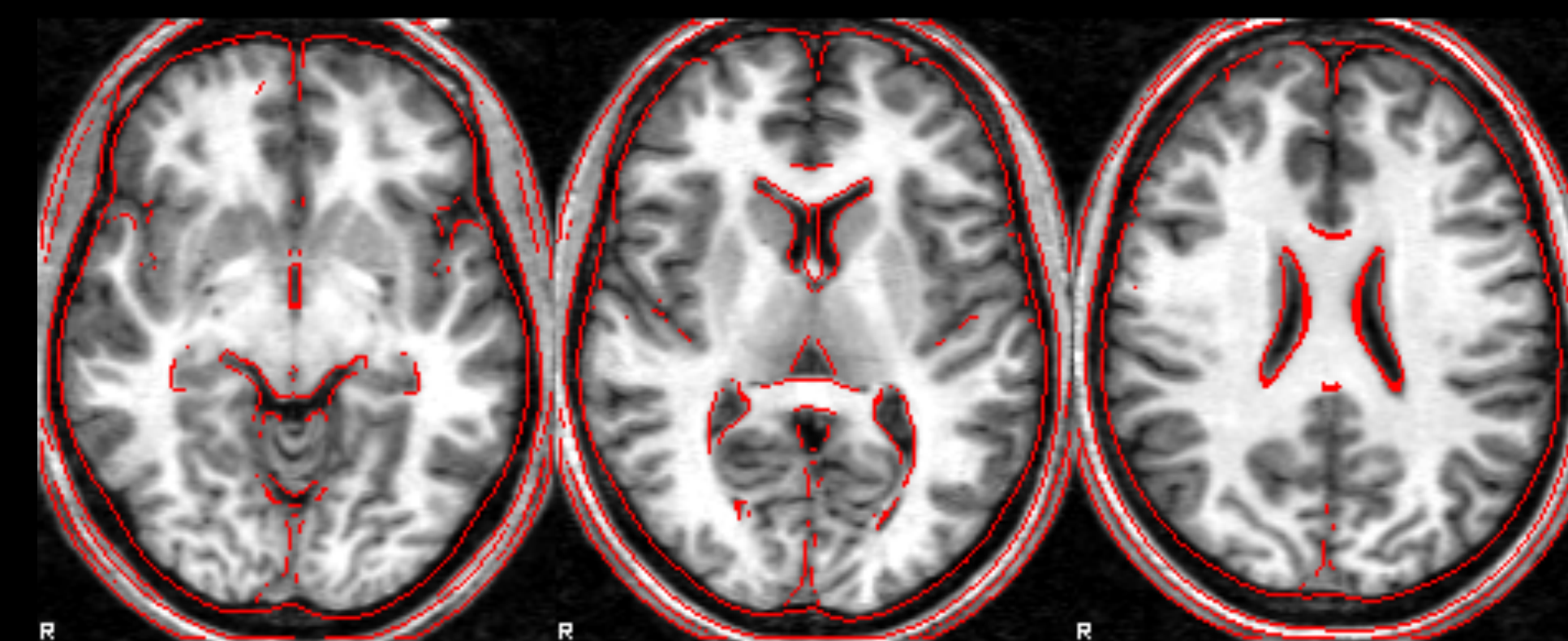
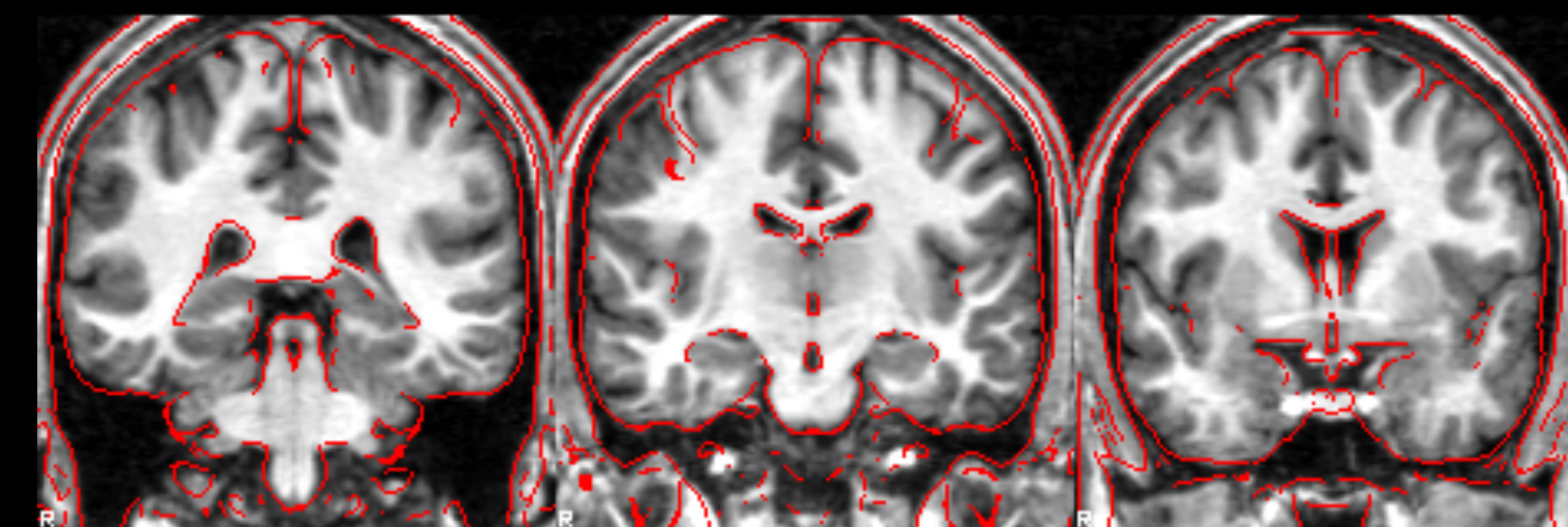
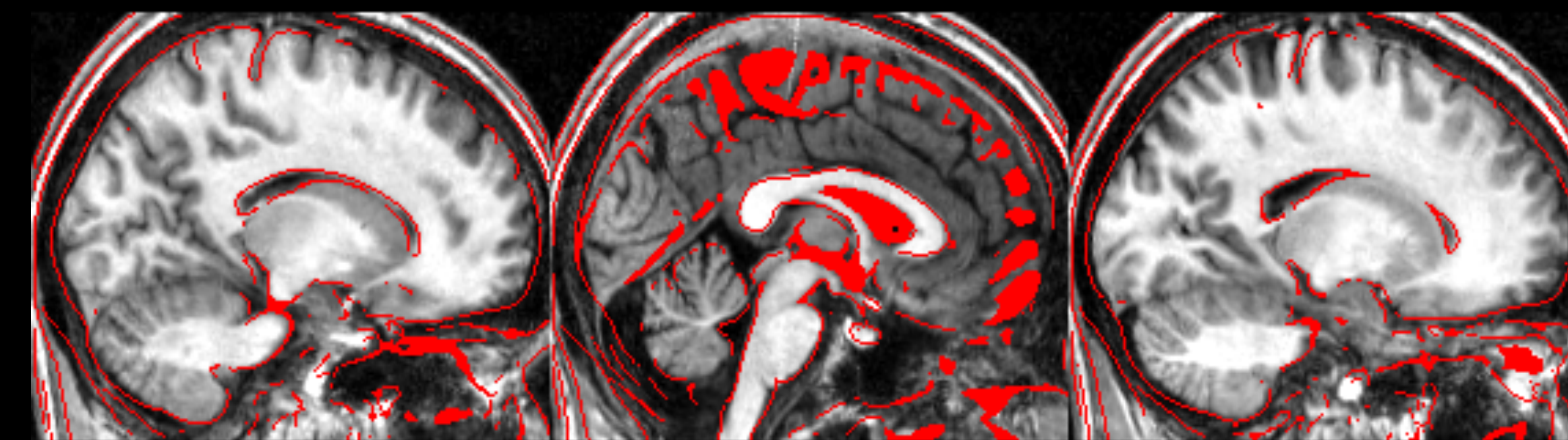
**Subj#3
clus-p < 0.05**

Okay, why?

Subj #1: T1w -> MNI

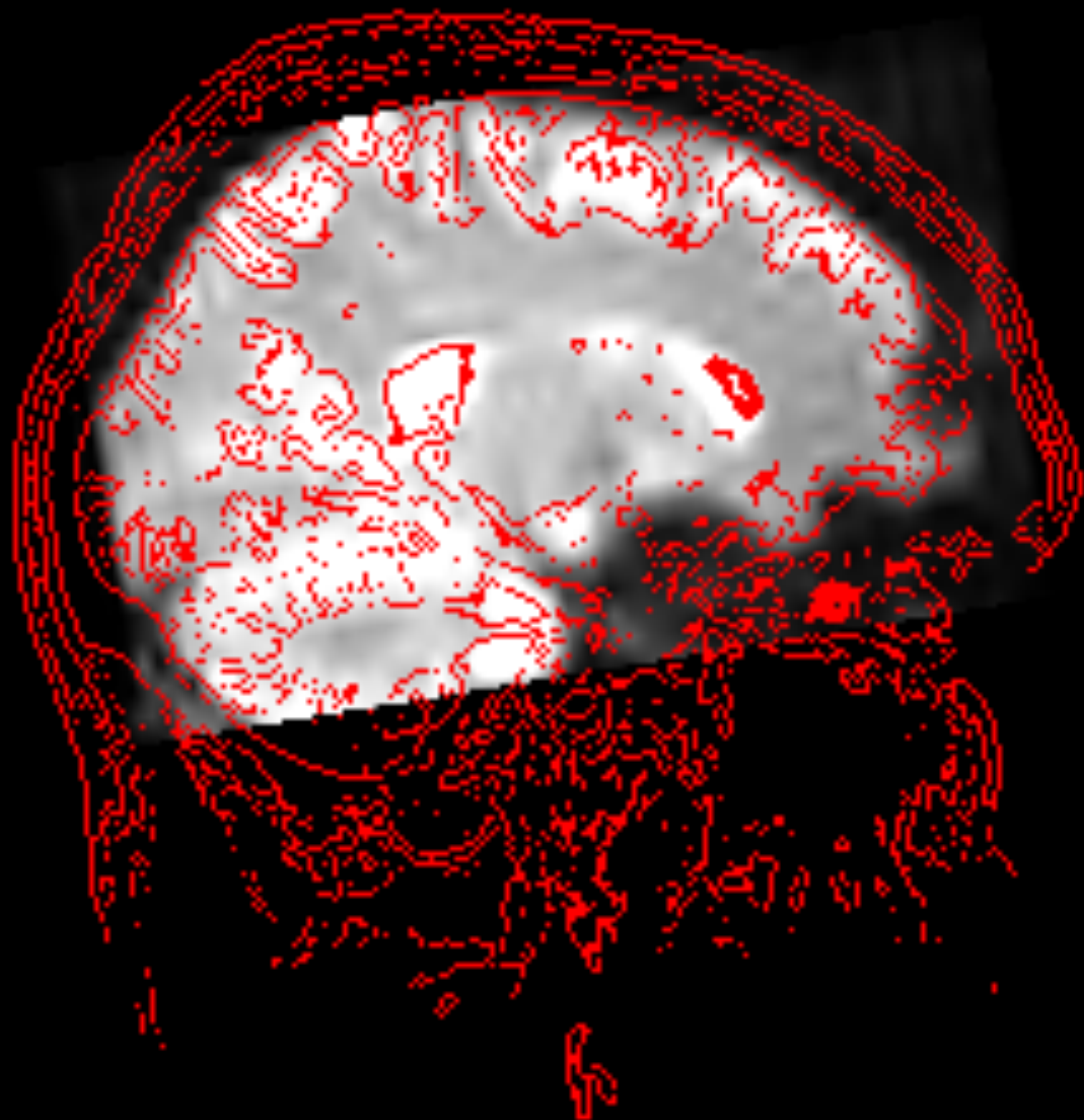


Subj #3: T1w -> MNI

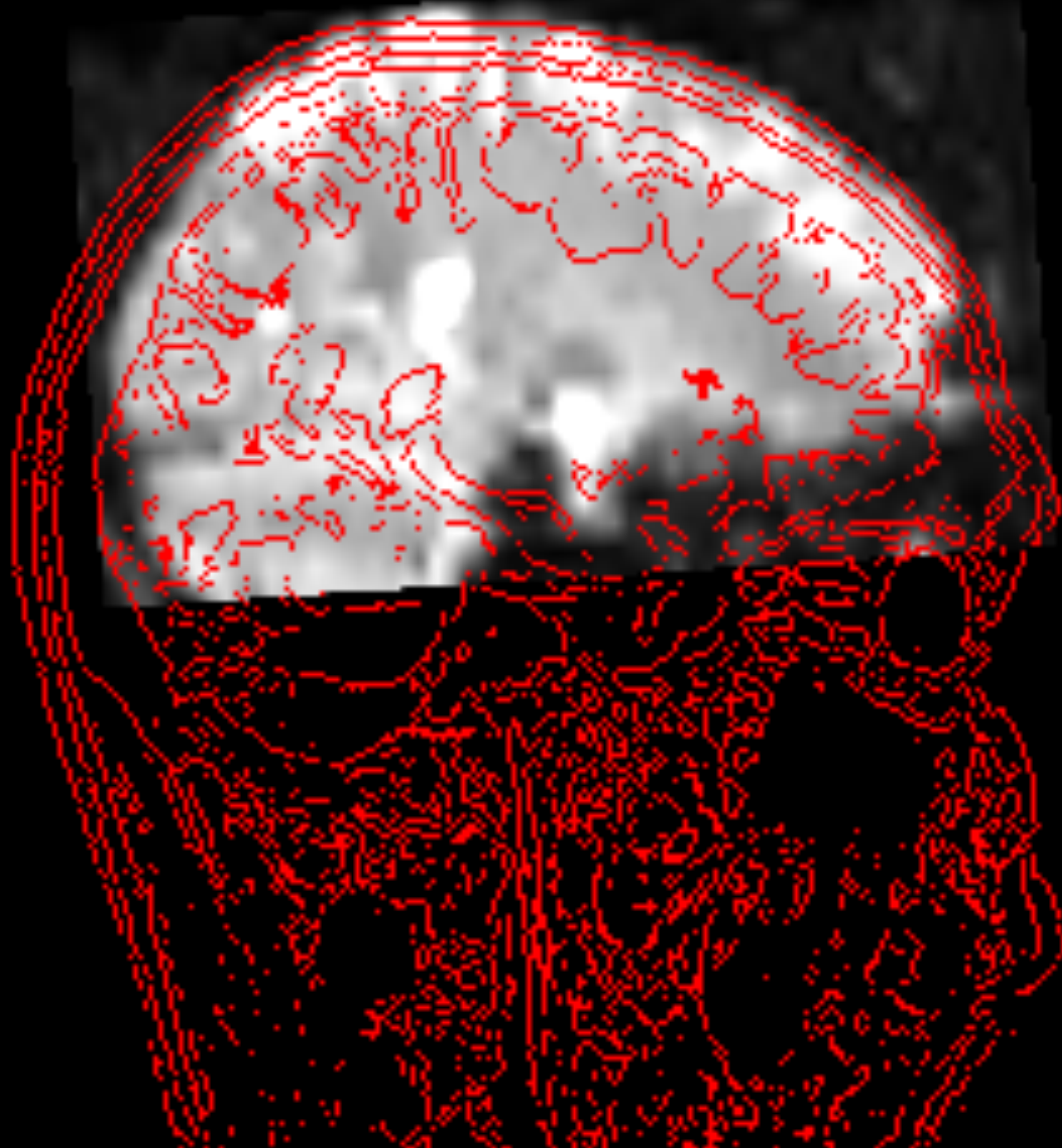


Because of UNIFIED segmentation (skullstripping) + normalization

Subj #1: EPI -> T1w (SS)



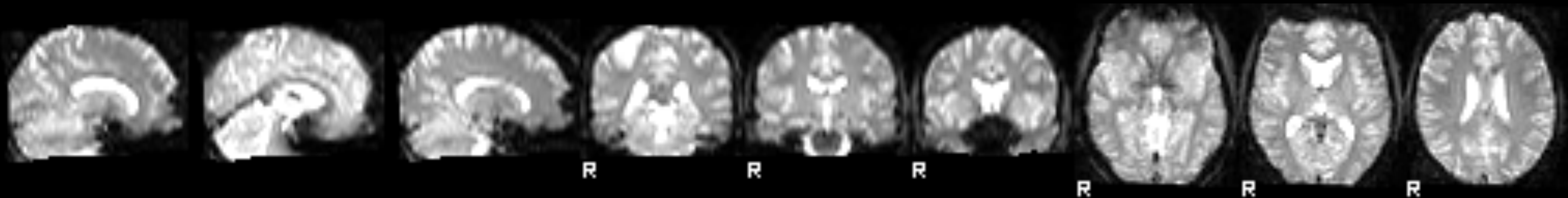
Subj #3: EPI -> T1w (SS)



**You MUST see ALL the images!
(at least the registered EPIs)**

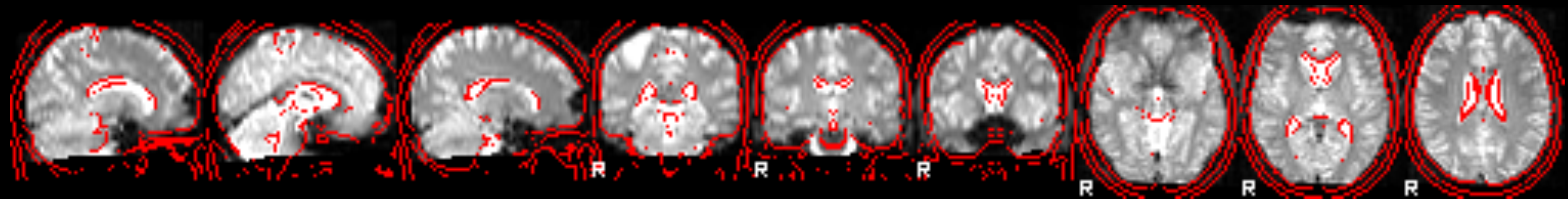
The easiest way of visual inspection (FSL)

```
$ slicerdir *.nii
```



With an overlaid **reference**?

```
$slicesdir -p ~/mni_3mm.nii \  
*.nii
```



DEMO: `slicesdir`

1. Setting FSL/Freesurfer paths/ variables

```
$ FSL --version 5.0
```

```
$ FREESURFER
```

2. Create a reference image in the same dimension as target images

```
$ mri_convert --like ${epi} ${mni_1mm} \  
  ${mni_3mm}
```


2. Create a reference image in the same dimension as target images

```
$ epi=${depends_on_your_data}/wuafunc.nii
```

```
$ mni_1mm=${FSLDIR}/data/standard/  
MNI152_T1_1mm.nii.gz
```

```
$ mni_3mm=~ /mni_3mm.nii
```

```
$ mri_convert --like ${epi} ${mni_1mm} \  
${mni_3mm}
```

2. Create a reference image in the same dimension as target images

```
$ epi=${depends_on_your_data}/wuafunc.nii
```

```
$ mni_1mm=${FSLDIR}/data/standard/  
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```
$ mni_3mm=~ /mni_3mm.nii
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$ mri_convert --like ${epi} ${mni_1mm} \  
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MNI152_T1_1mm.nii.gz
```

```
$ mni_3mm=~ /mni_3mm.nii
```

```
$ mri_convert --like ${epi} ${mni_1mm} \  
${mni_3mm}
```

3. Run a script and see results

```
$ slicesdiro -p ~/mni_3mm.nii */wuafunc.nii
```

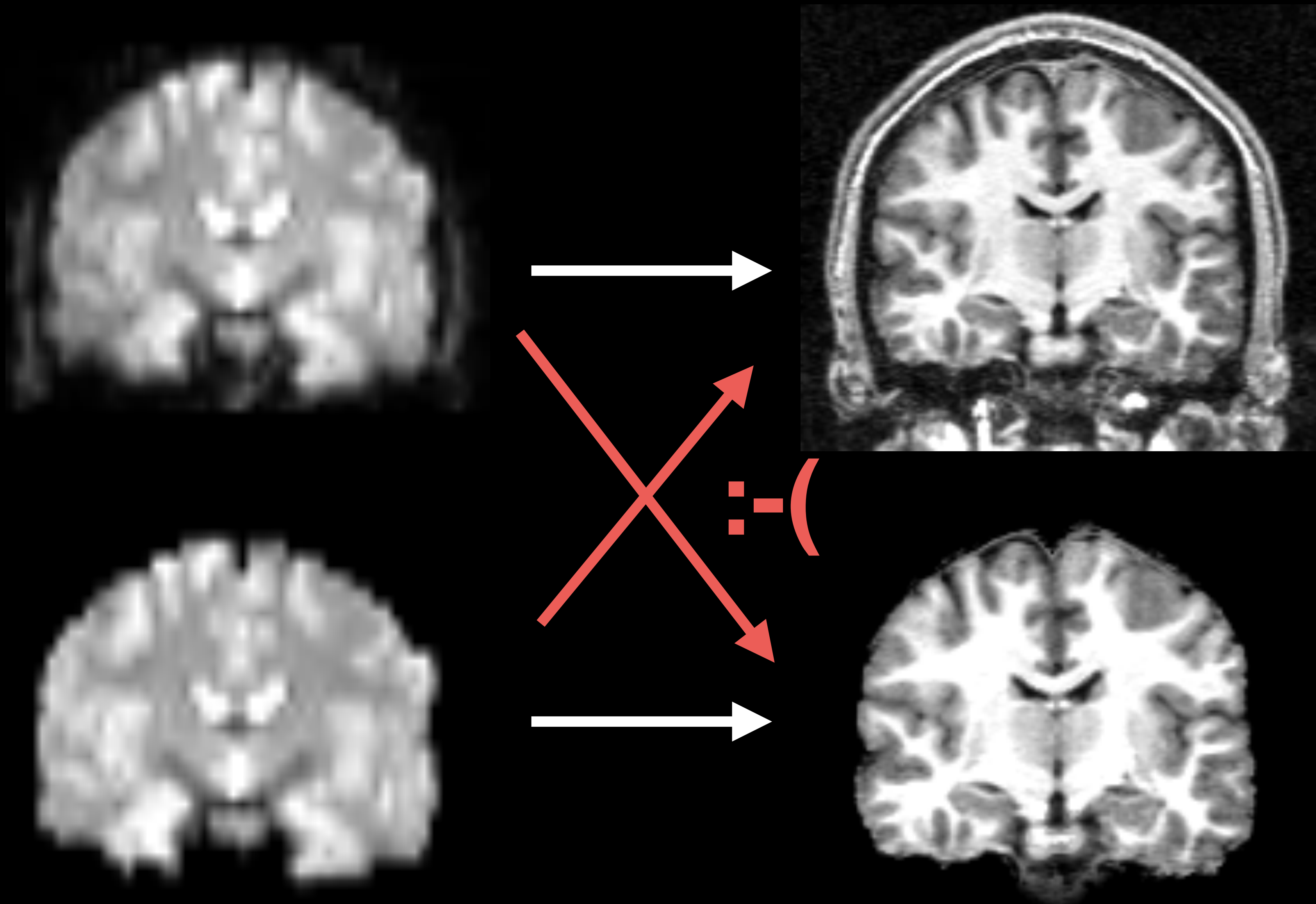
```
$ firefox slicesdiro/index.html
```


Now, how can we fix it?

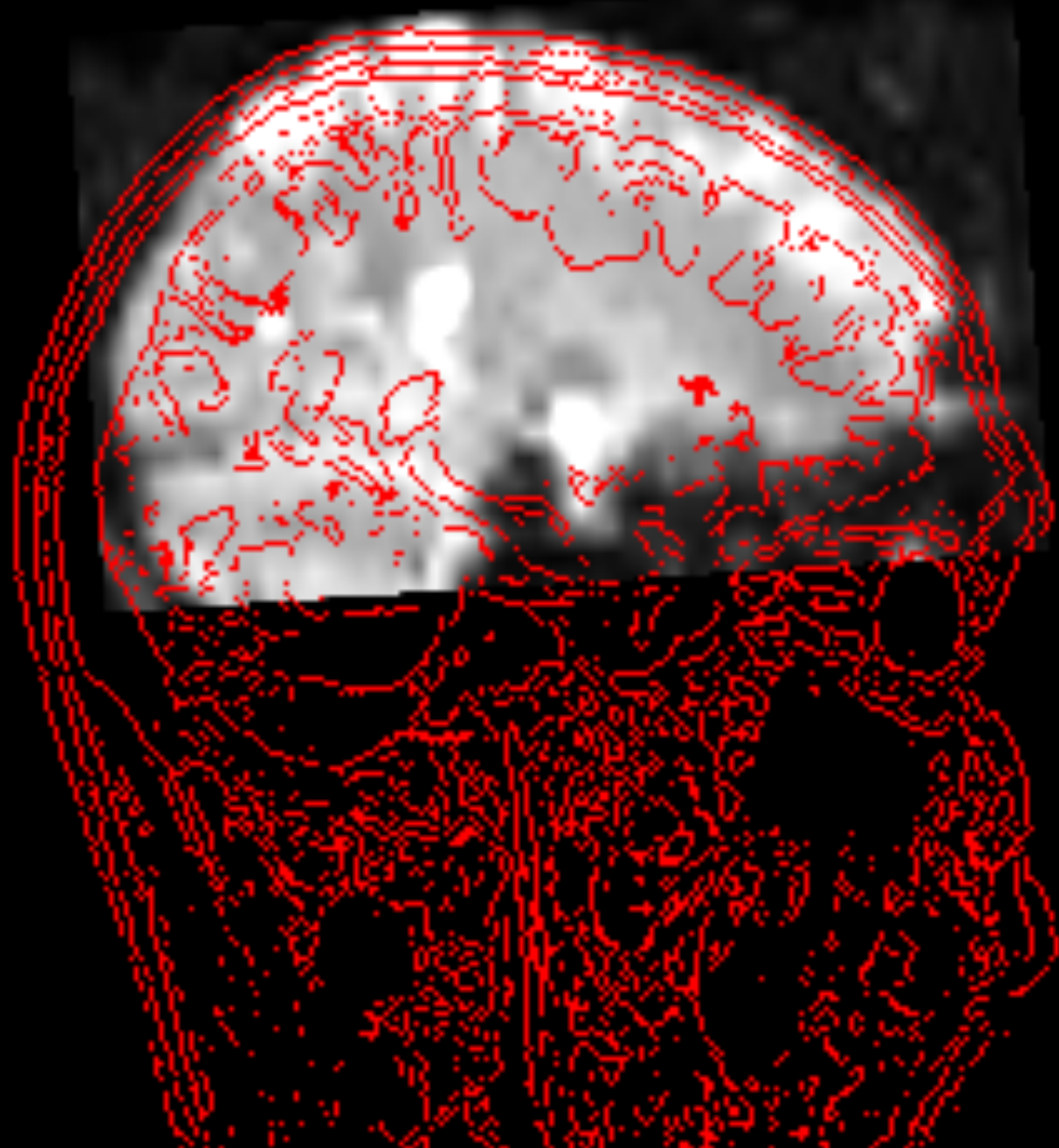
It depends on your data..

- **Poor image quality?**
- **Wide difference between T1w and EPI images in terms of orientation and position?**
- **Or maybe discrepancy in skullstripping?**

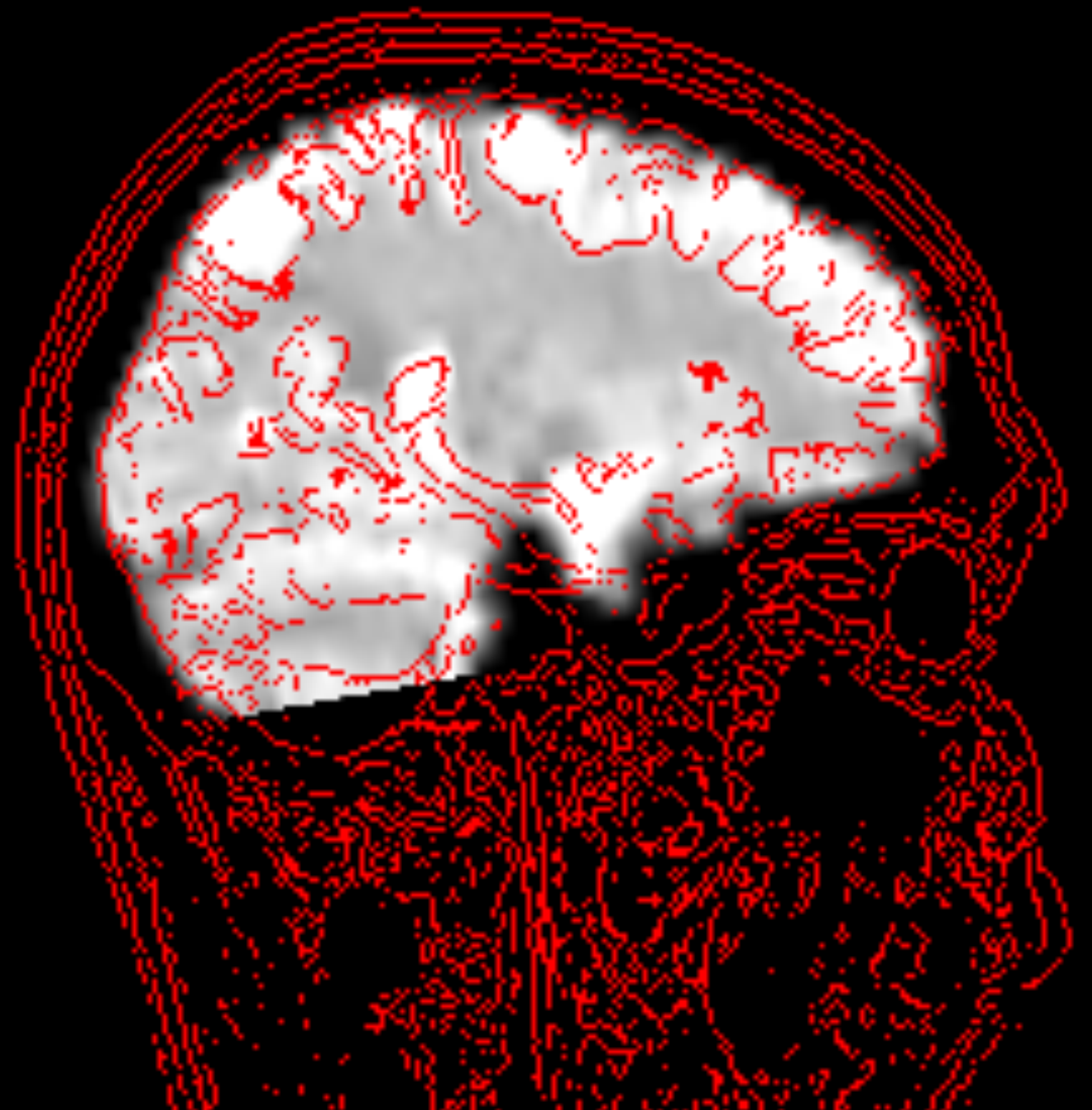
One possible solution: skullstrip BOTH?



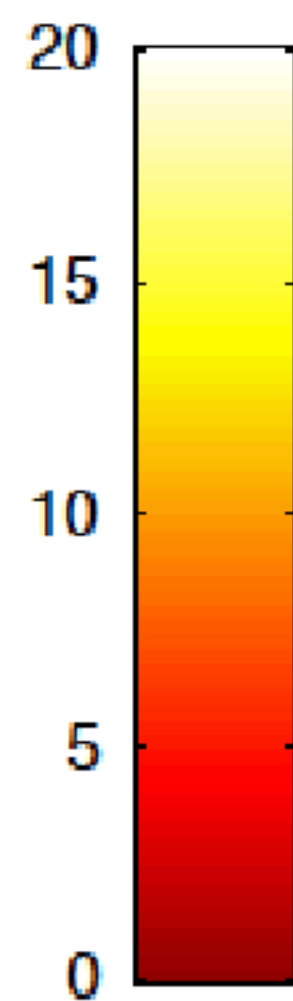
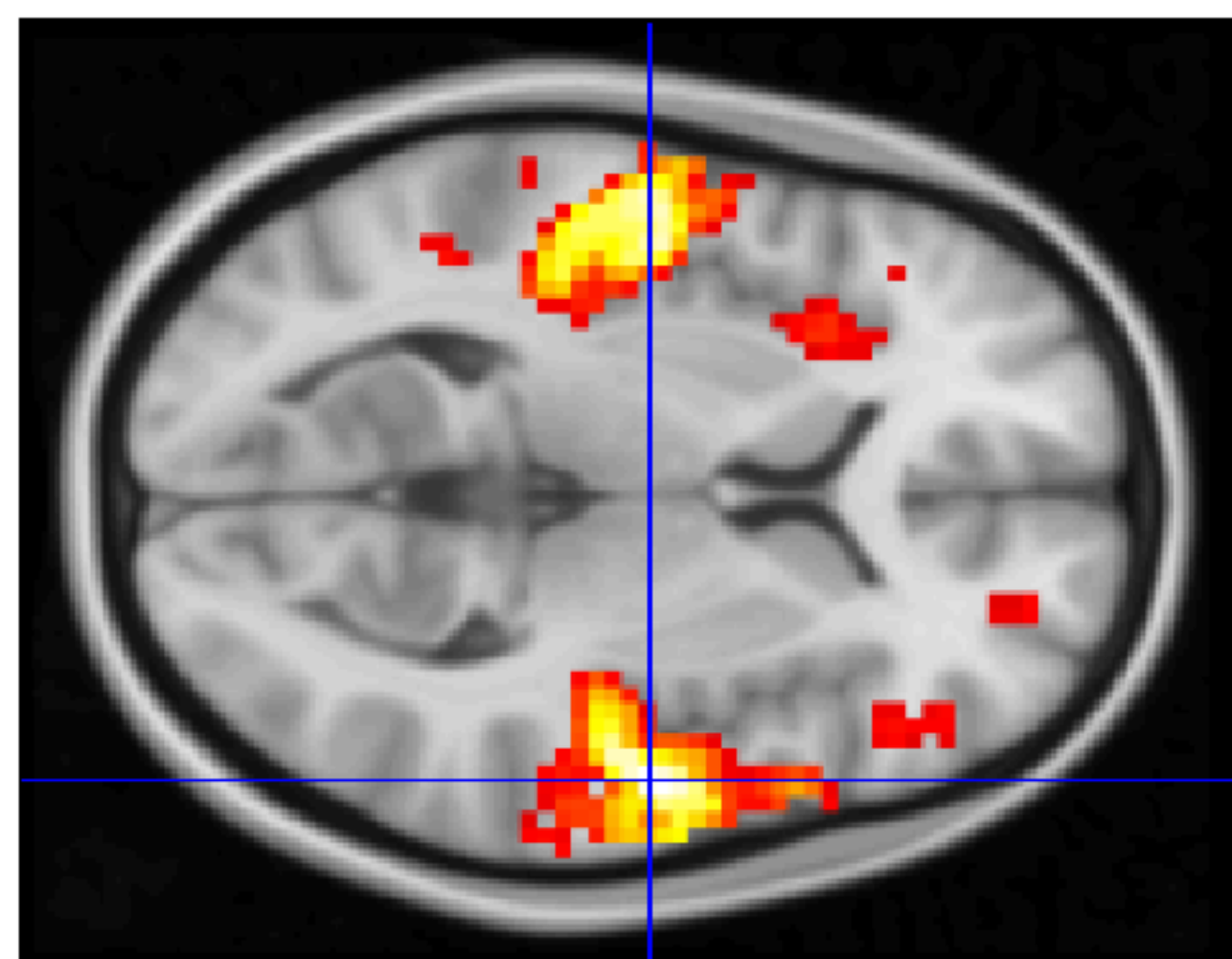
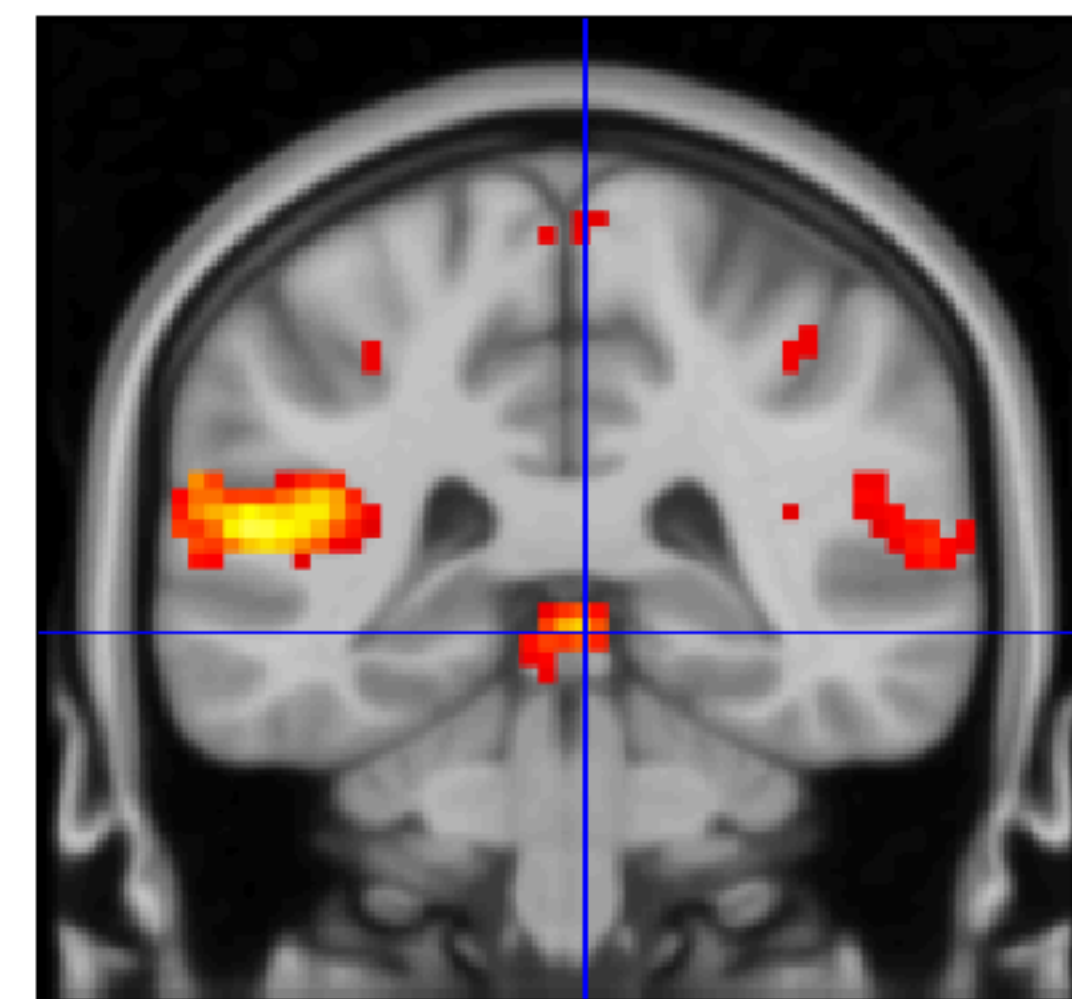
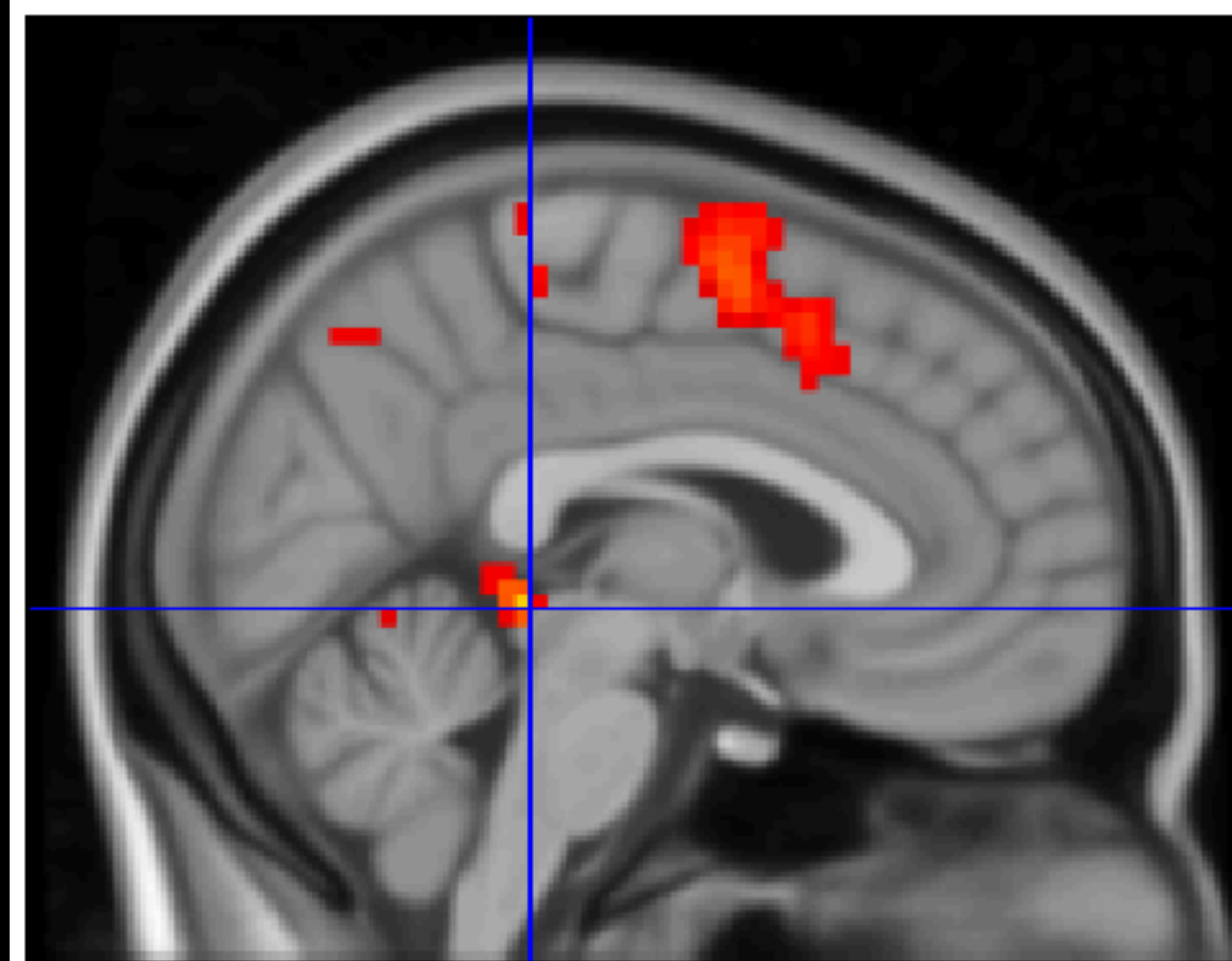
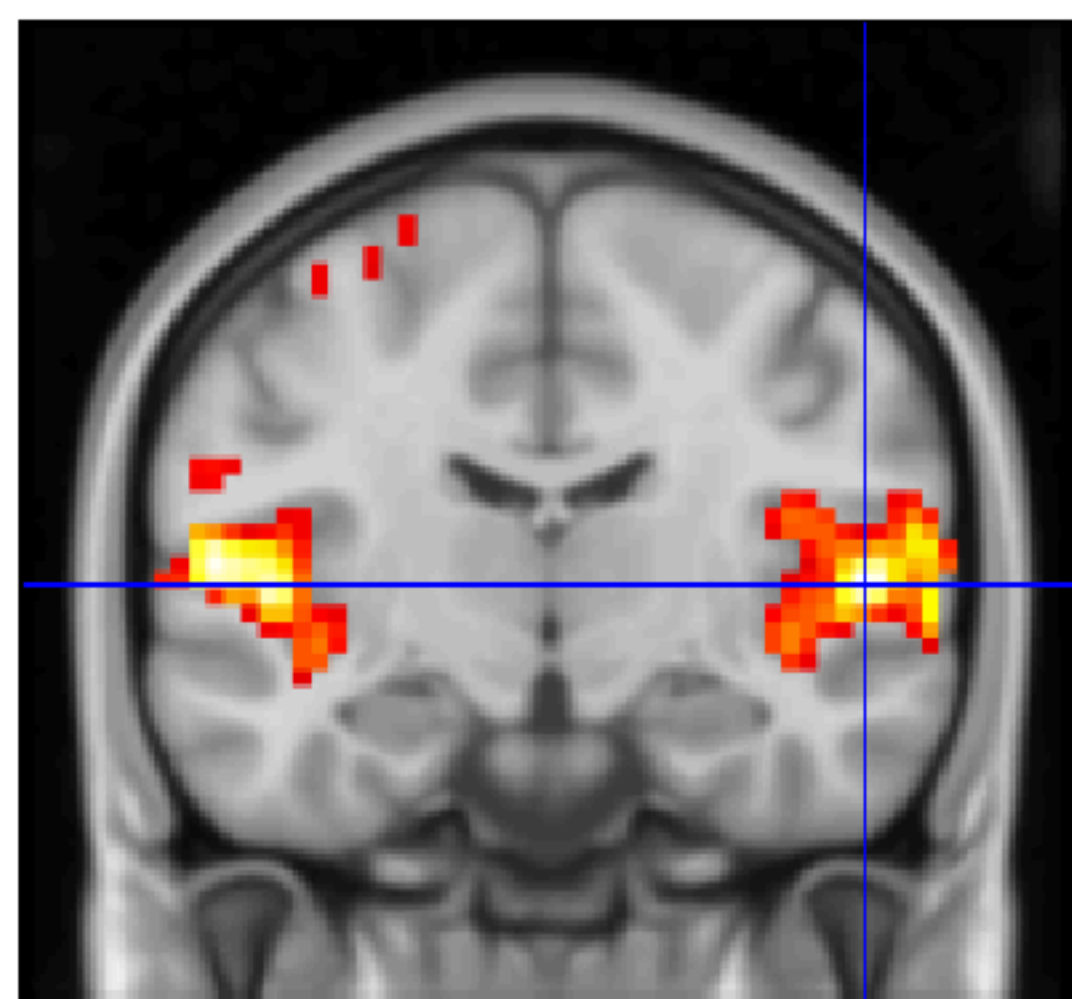
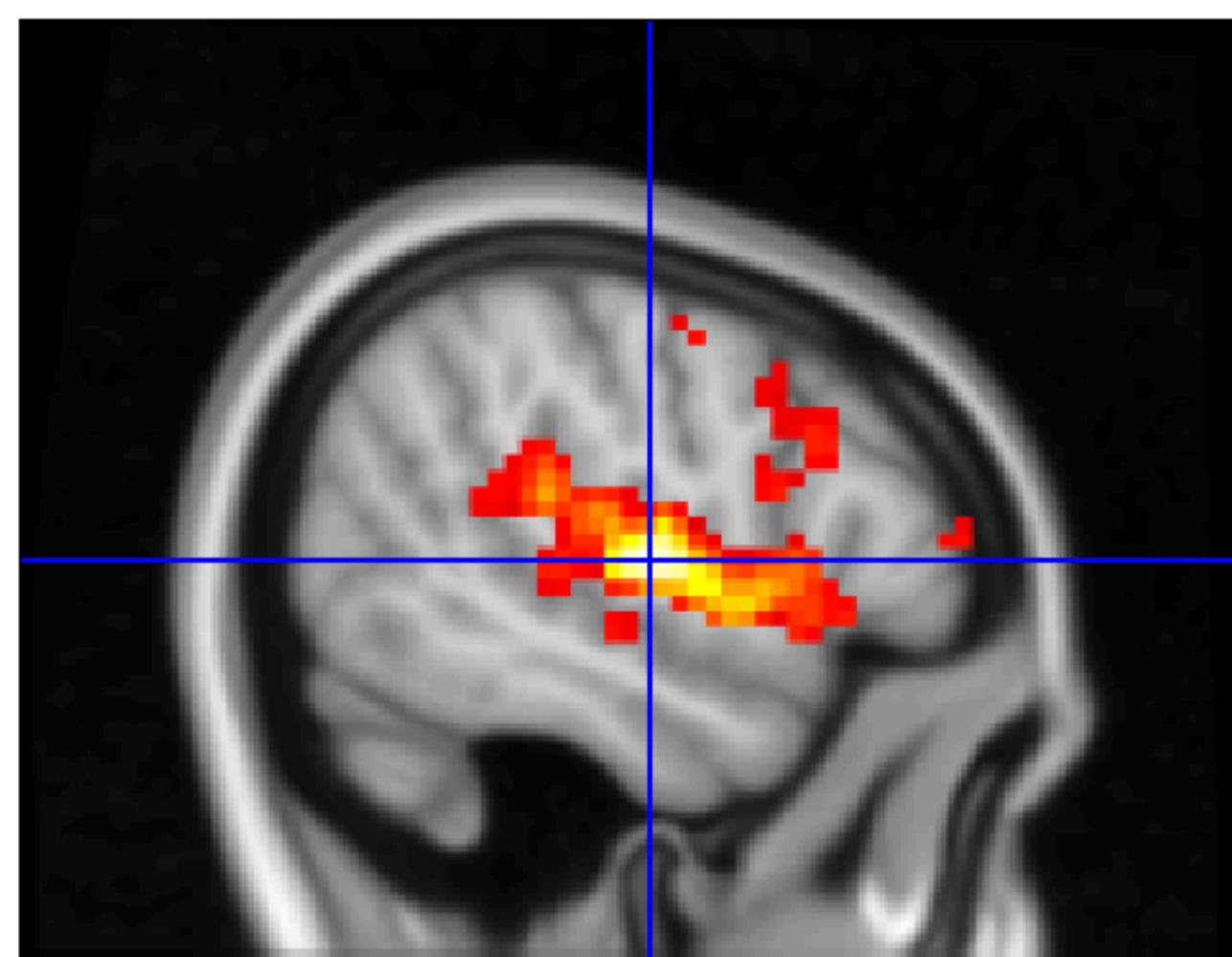
Subj #3: EPI -> T1w (SS)



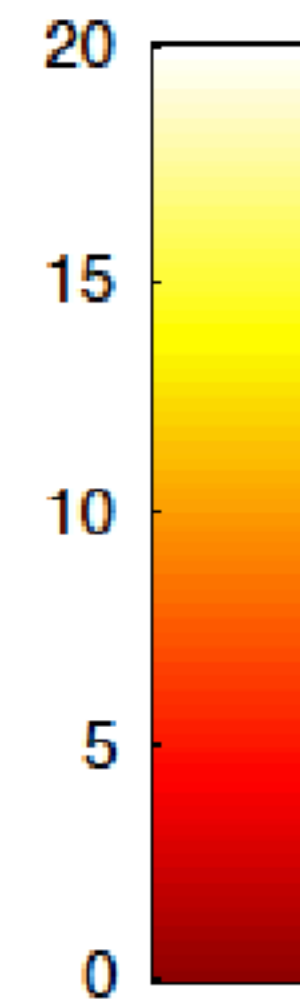
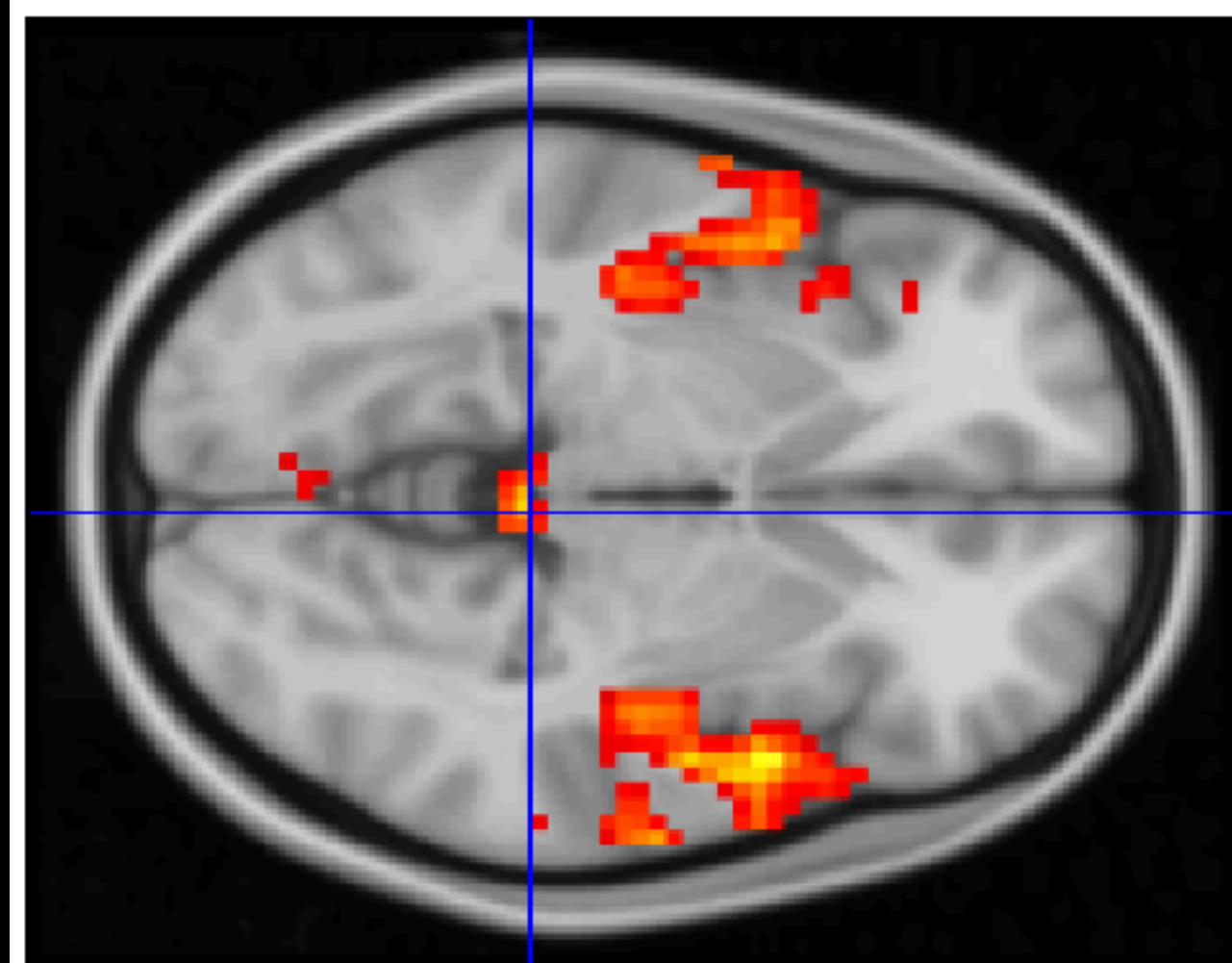
Subj #3: EPI (SS) -> T1w (SS)



More sensible results:



Subj#3
clus-p
< 0.05



Even
inferior-
colliculi!

(If something's wrong) Try skullstripping EPI

- **Skullstrip the mean EPI image, exactly in the same fashion for the T1w image**
- **and use the skullstripped EPI image as a source image and the skullstripped T1w image as a target image for coregistration**

(If something's wrong) Try skullstripping EPI

- Or if you're brave enough:
<https://github.com/solleo/myspm>
*[!] No test for dependency at all: it requires **SOME** efforts to get things to work in a new user's env.*

Take home messages

- **Always do VISUAL INSPECTION!!!**
- **Skullstripping of T1w & EPI images improves registration.**
- **Ask any questions: skim@cbs.mpg.de**