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## An introduction to neuroinformatics

Camille Maumet

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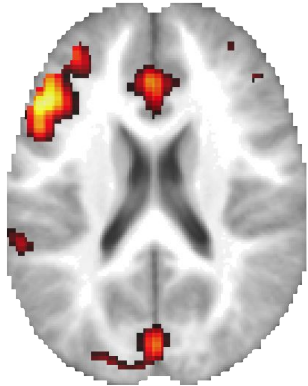
**<https://inserm.hal.science/inserm-03670072>**

Submitted on 17 May 2022

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R-Ladies Gaborone + PyData Botswana - May 13, 2022



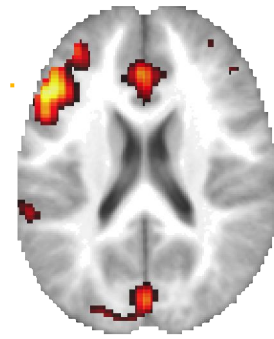
# An introduction to neuroinformatics

Camille Maumet

Univ Rennes, Inria, Inserm, CNRS, IRISA



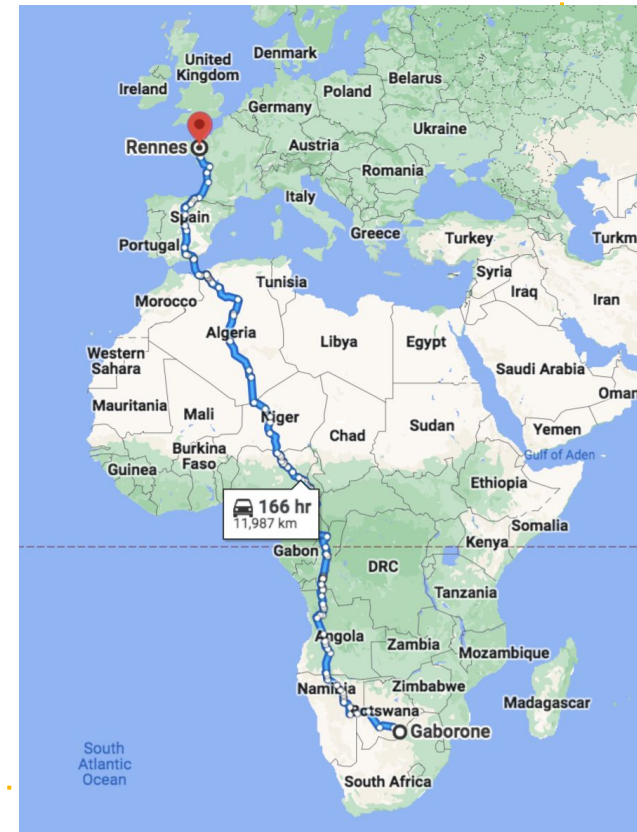
# Who am I?



Neuroinformatician

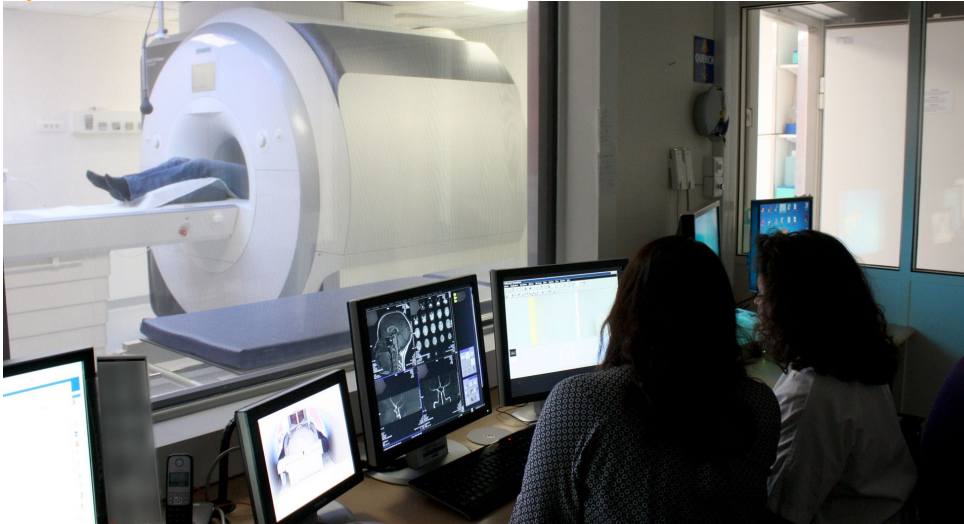
Data science + brain imaging

- PhD in computer science applied to neuroimaging data analysis
- Rennes (France)

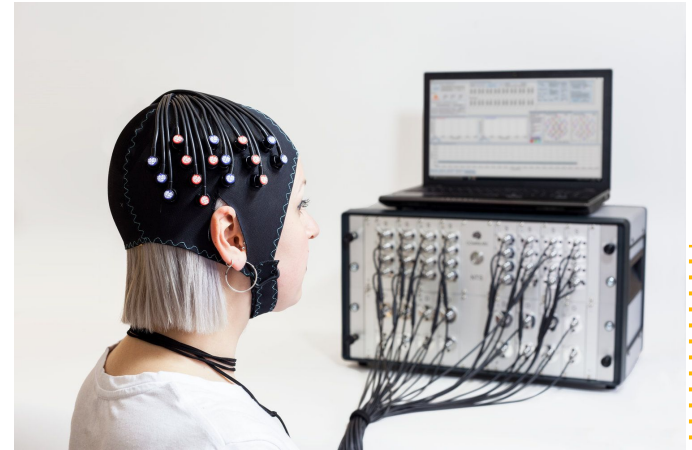


# Brain imaging

# Imaging the brain



Magnetic resonance imaging (MRI)



Near infrared spectroscopy (NIRS)



Electroencephalography (EEG)

# Images of the brain



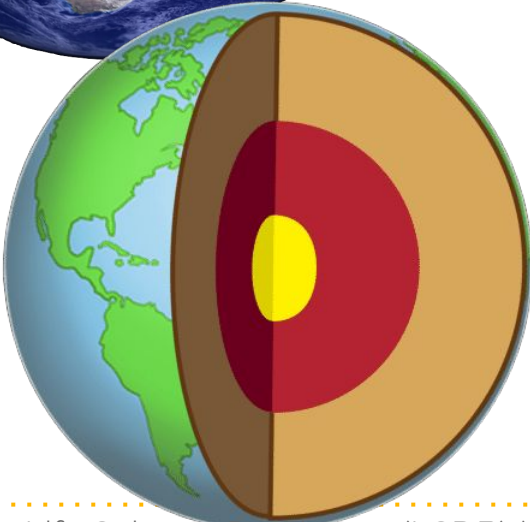
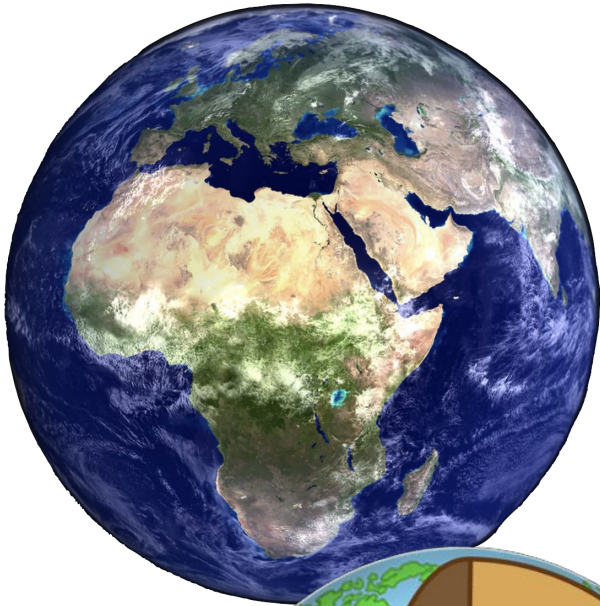


# Brain images



Credits: Brain, [Life Science Databases \(LSDB\)](#) (CC-BY-SA) - Globe by, Kevin Gill, [Wikipedia](#) (CC-BY-SA) - Earth layers, Domaine public / [ck12](#) - Grey and white matter, [Flickr](#), (Public Domain)

# Brain images

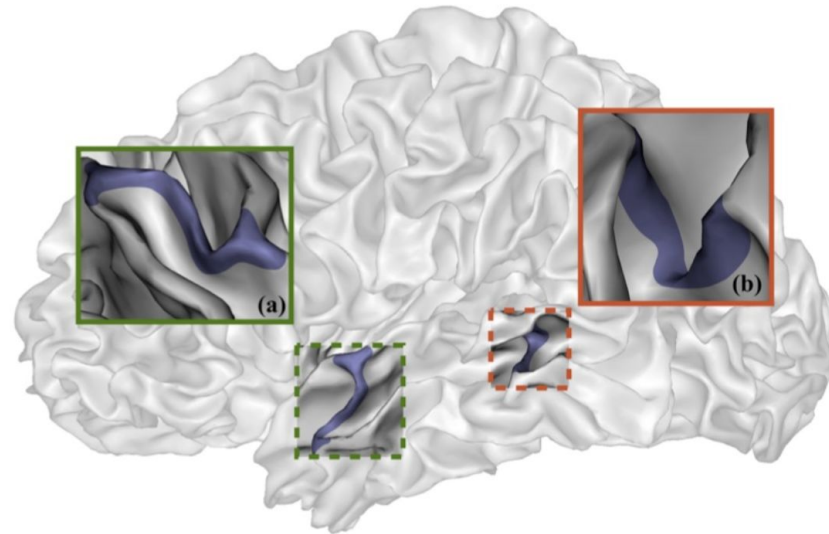


Credits: Brain, [Life Science Databases \(LSDB\)](#) (CC-BY-SA) - Globe by, Kevin Gill, [Wikipedia](#) (CC-BY-SA) - Earth layers, Domaine public / [ck12](#) - Grey and white matter, [Flickr](#), (Public Domain)





# Anatomy: cortical surfaces

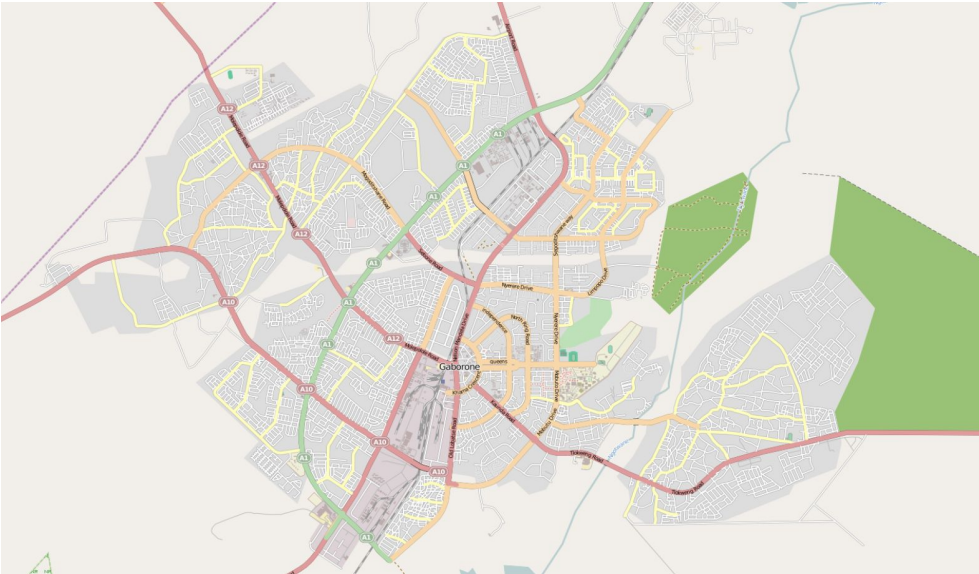
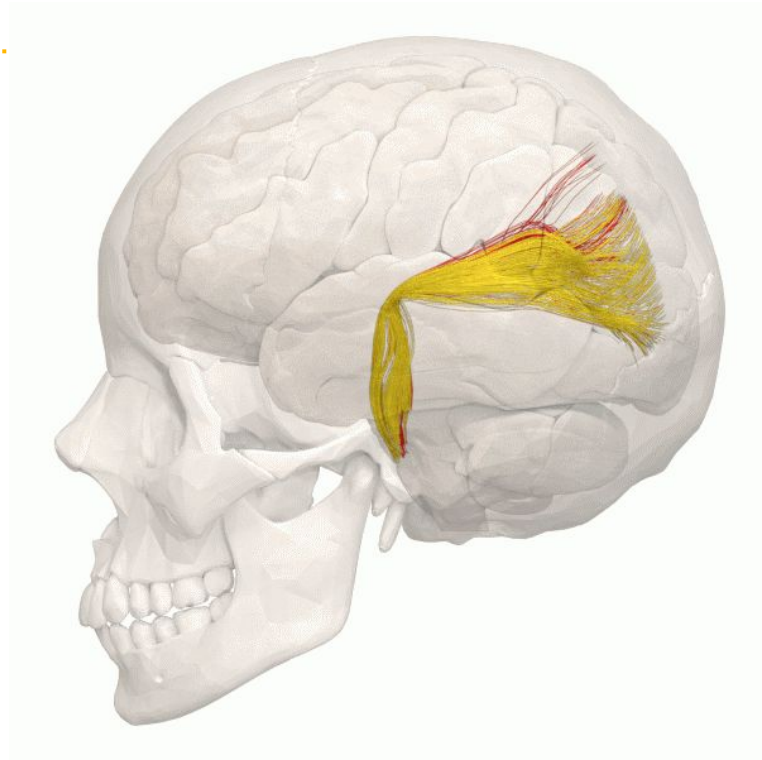


Pli de  
passage  
(Song  
et al.,  
2021)

Song et. al (2021)



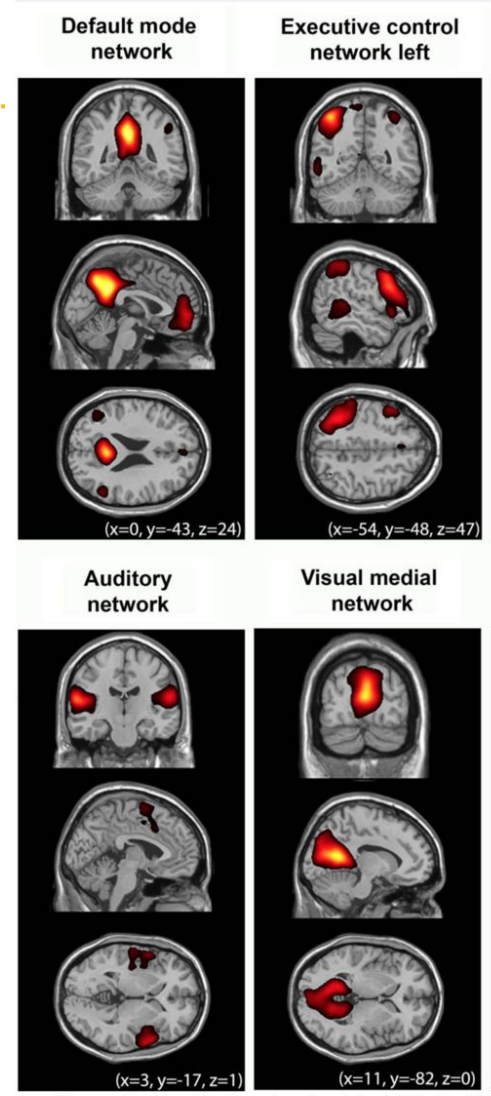
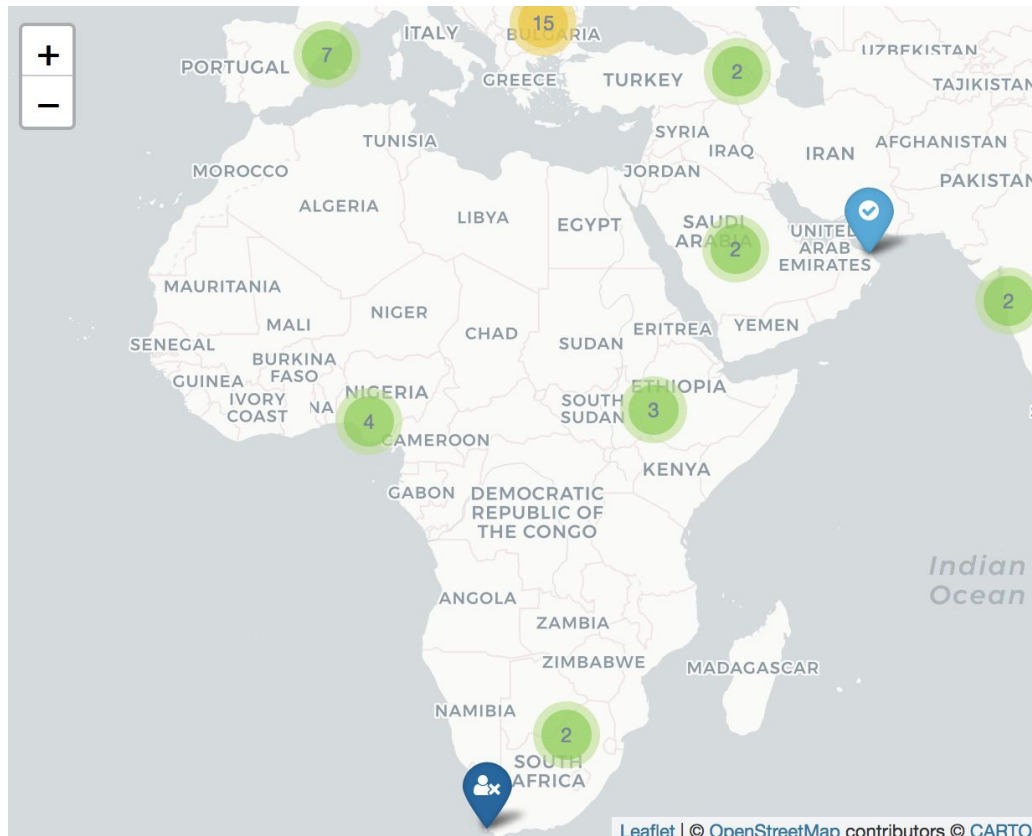
# Connectivity



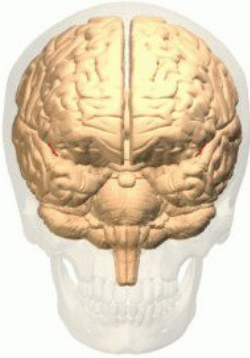
Credits: Tractography, group work [Wikipedia](#) (CC-BY-SA) - Gaborone road map by OpenStreetMap contributors, [Wikipedia](#) (CC-BY-SA).



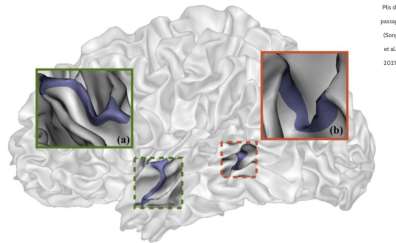
# Brain function



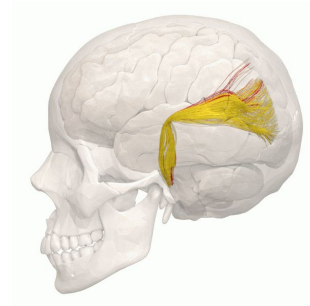
# Many types of brain maps



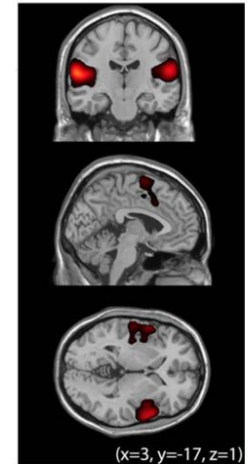
Human brain



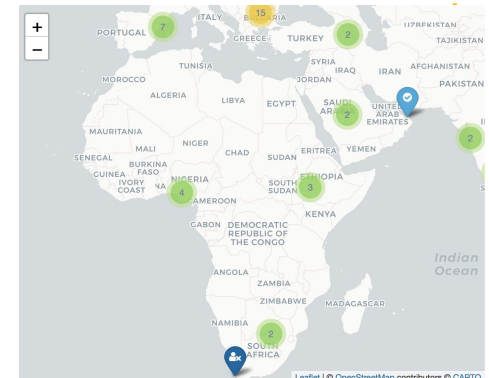
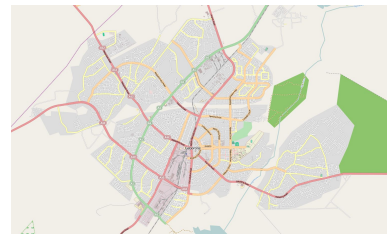
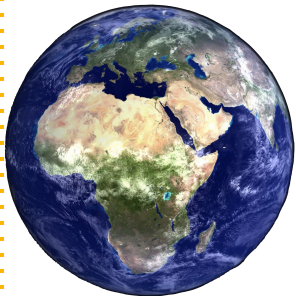
Anatomy



Connectivity



Function







# Example functional MRI study

Studying developmental Language disorder

Study started in 2005 in Rennes.

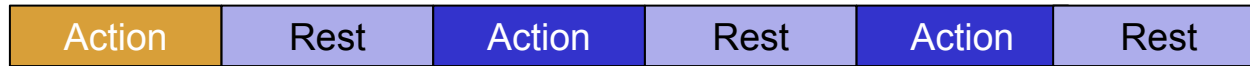
Team of clinicians and research scientists.

40 children participated.

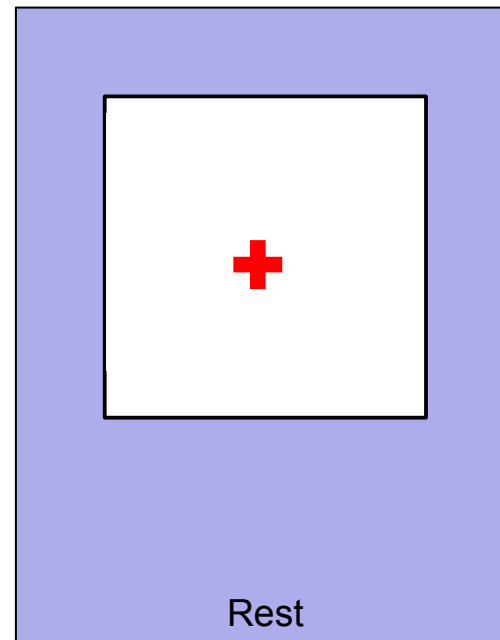
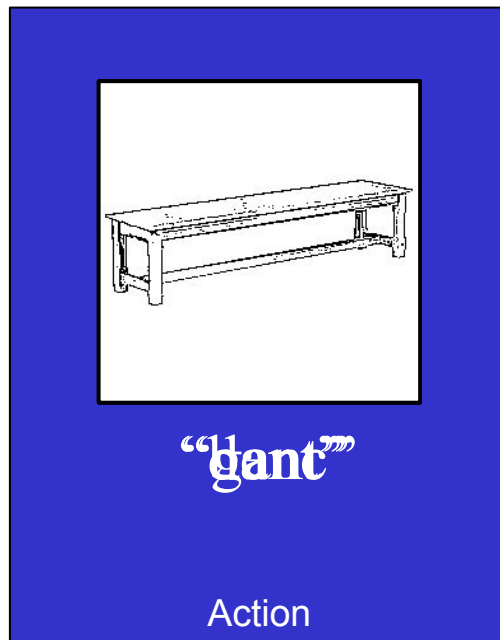
[De Guibert et. al \(2010\)](#), [De Guibert et. al \(2011\)](#)



# fMRI protocol

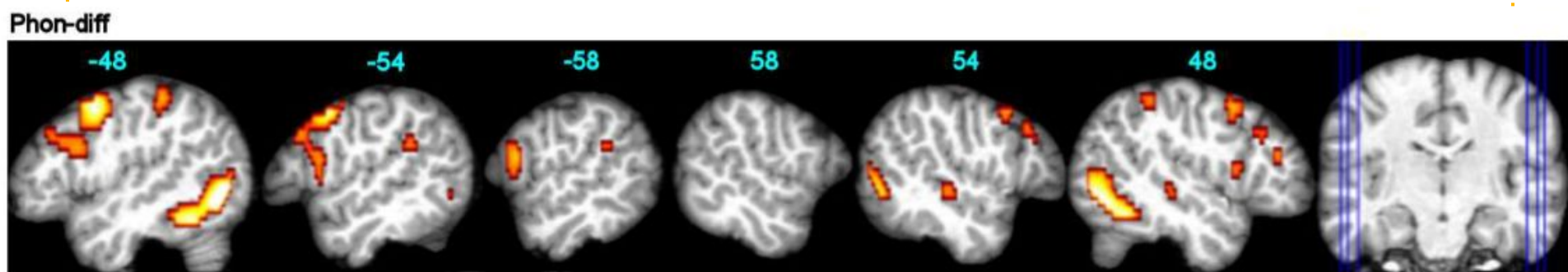


- Language paradigm using a block design

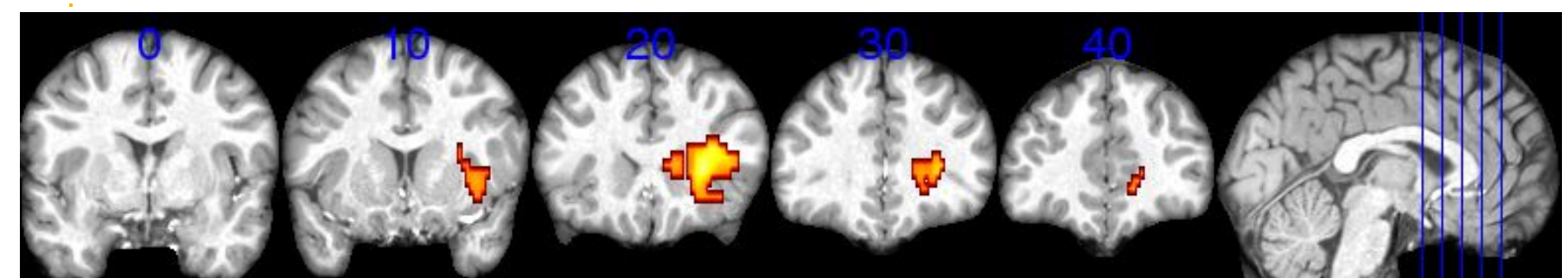


# Results

DLD Group activity during the Phon-diff task



Comparison of DLD group activity versus controls during the Phon-diff task



# Demo : exploring fMRI data



**NiBabel**

Access a cacophony of neuro-imaging file formats

<https://nipy.org/nibabel/>



ni  
*learn*

**Nilearn:**

Statistics for NeuroImaging in Python

<https://nilearn.github.io/>



**repronim/neurodocker**

By [repronim](#) • Updated a year ago

Container

<https://github.com/ReproNim/neurodocker>



# Demo : exploring fMRI data

fmRI

127.0.0.1:8888/notebooks/notebooks/SIBM/fMRI.ipynb

jupyter fmRI Last Checkpoint: Last Wednesday at 15:16 (autosaved)

File Edit View Insert Cell Kernel Widgets Help Not Trusted Python [conda env:neuro]

## Looking at fMRI data

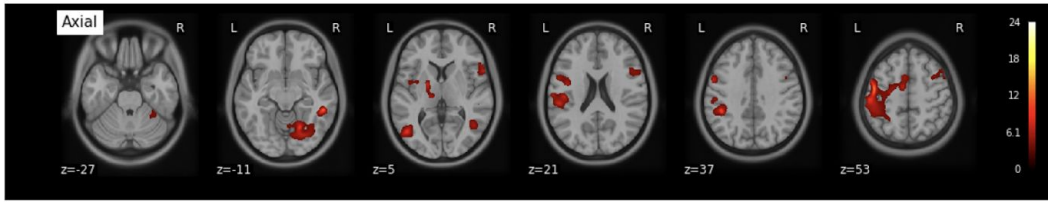
```
In [1]: from nilearn.plotting import plot_stat_map, plot_epi, plot_anat
        %matplotlib inline
```

```
In [2]: anat_img = '/data/ds000114/derivatives/fmriprep/mni_icbm152_nlin_asym_09c/1mm_T1.nii.gz'
        act_img = '/output/datasink/2ndLevel/spm_con_0002_fwhm8/spmT_0001_thr.nii'
        func_img = '/data/ds000114/sub-01/ses-test/func/sub-01_ses-test_task-fingerfootlips_bold.nii.gz'
```

## Group results

### Final figures

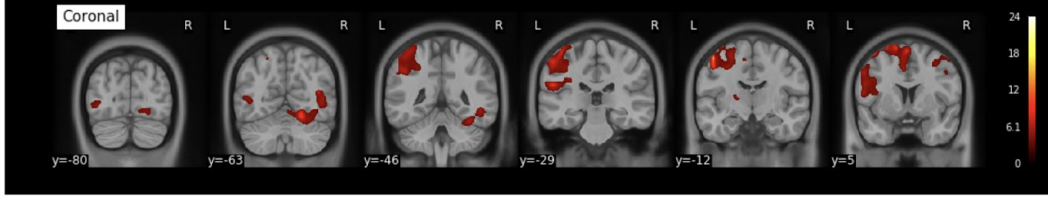
```
In [3]: plot_stat_map(act_img, title='Axial', bg_img=anat_img, display_mode='z', cut_coords=(range(-27,69,16)));
```



Axial

z=-27 z=-11 z=5 z=21 z=37 z=53

```
In [4]: plot_stat_map(act_img, title='Coronal', bg_img=anat_img, display_mode='y', cut_coords=(range(-80,21,17)));
```



Coronal

y=-80 y=-63 y=-46 y=-29 y=-12 y=5

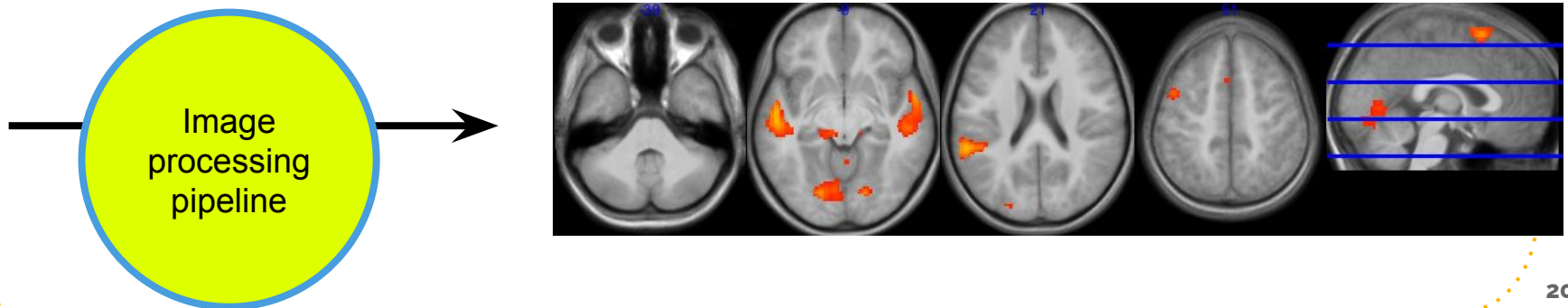
```
In [5]: plot_stat_map(act_img, title='Sagittal', bg_img=anat_img, display_mode='x', cut_coords=(range(-49,52,17)));
```

From **brain data** to  
**findings** about the  
brain

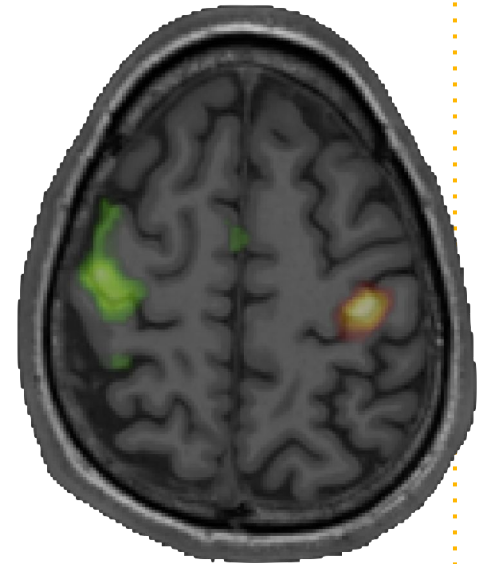
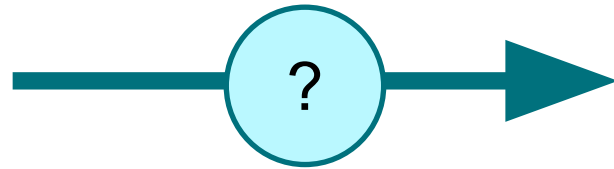
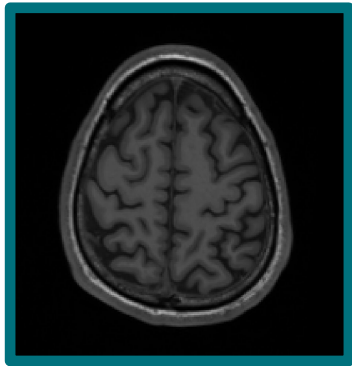
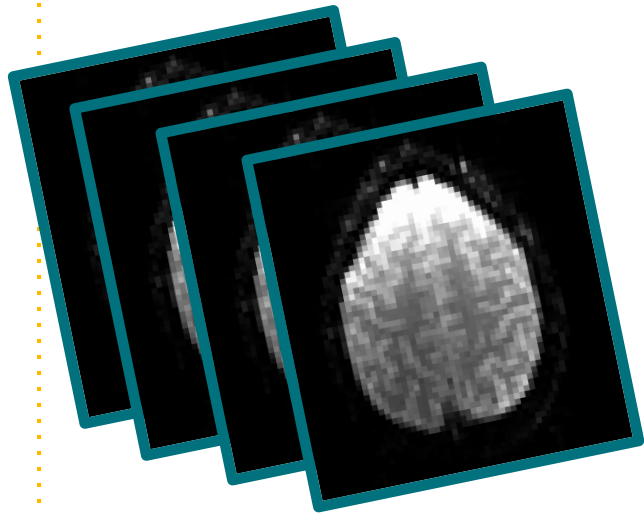
# Functional MRI: raw data



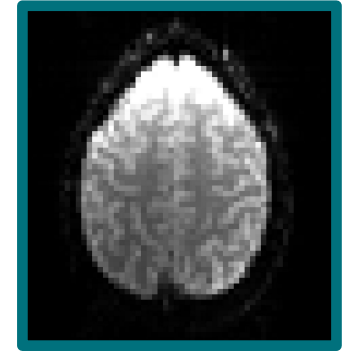
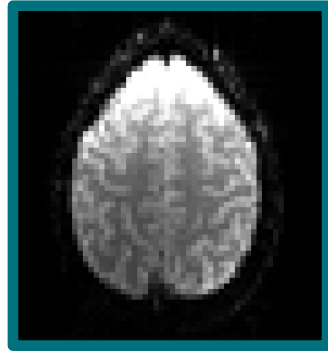
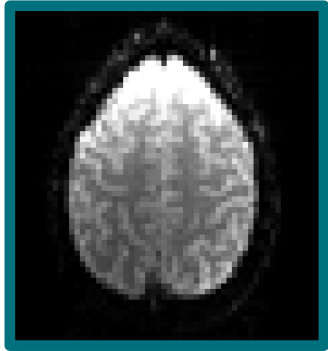
- 64 brain volumes / subject / paradigm



# Data analysis

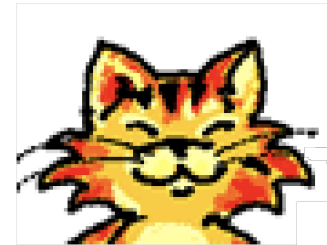
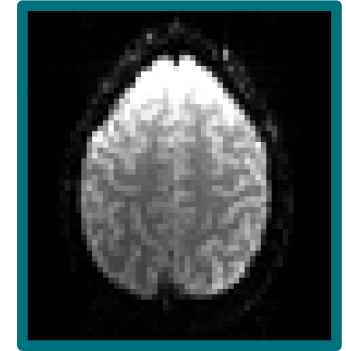


# Motion correction

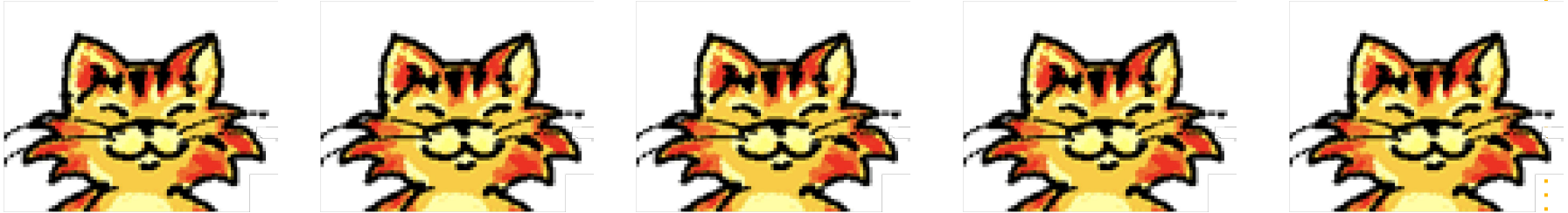




# Motion correction



# Motion correction



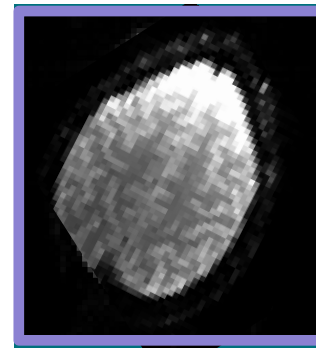
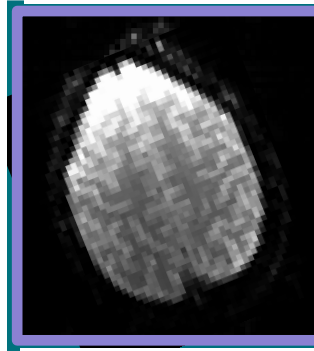
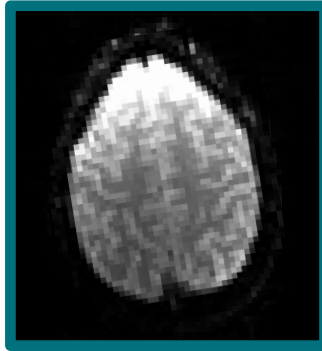
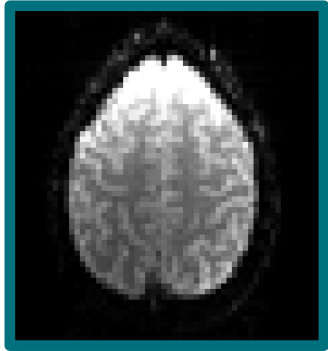
# Motion correction



# Motion correction

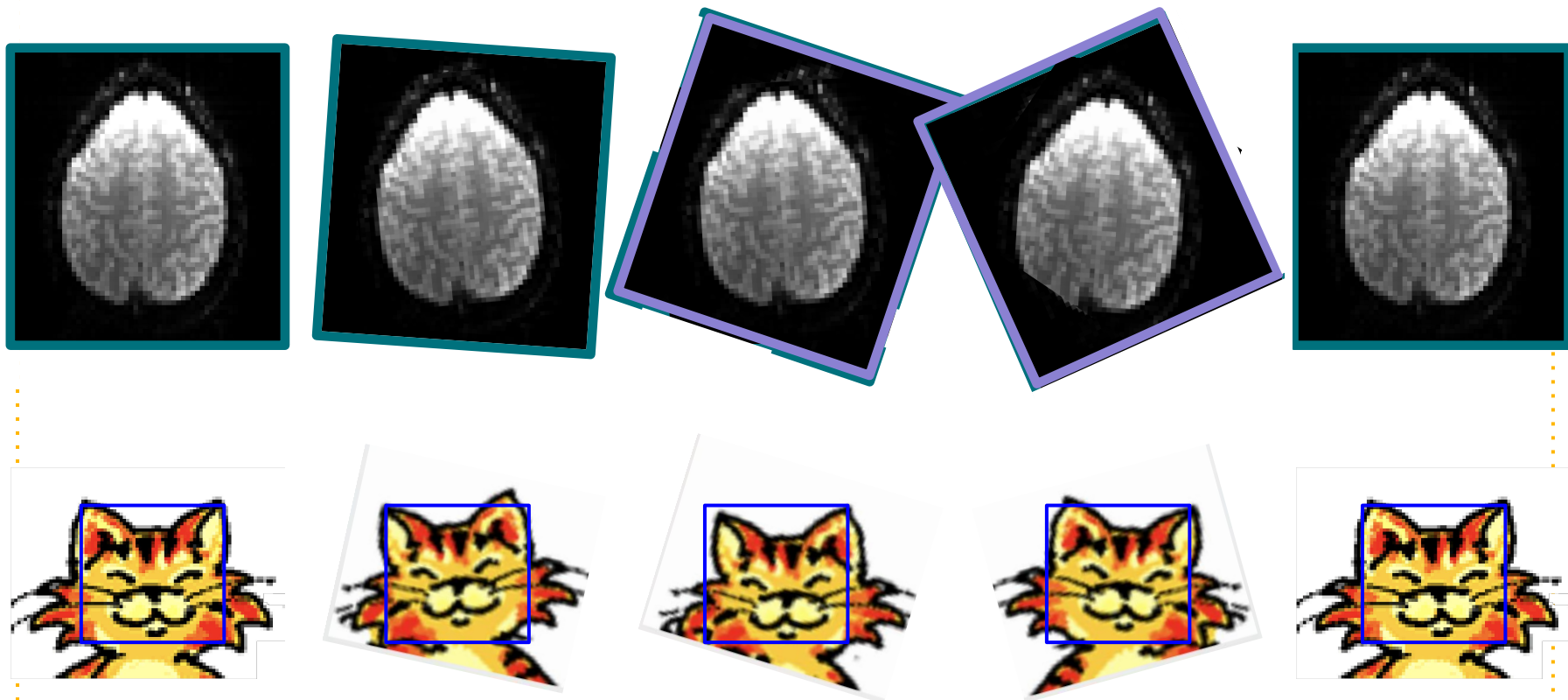


# Motion correction





# Motion correction



# Motion correction

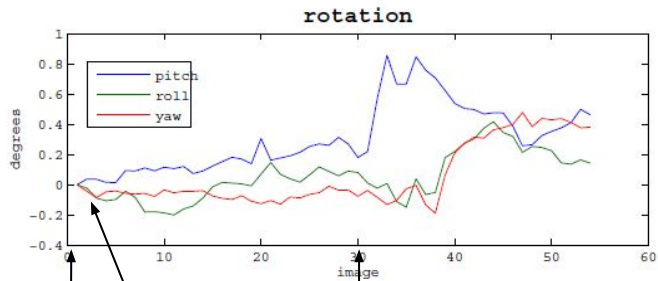
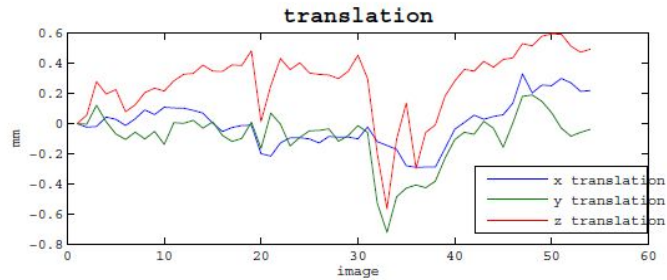
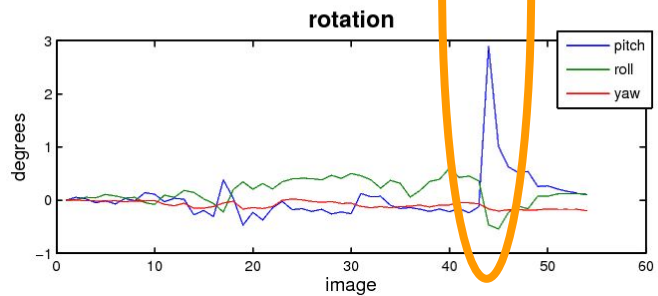
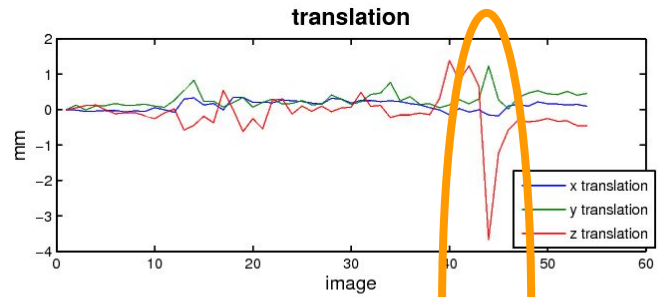


Image 1  
Image 2

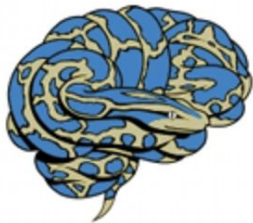
Image 30



# Demo : motion correction

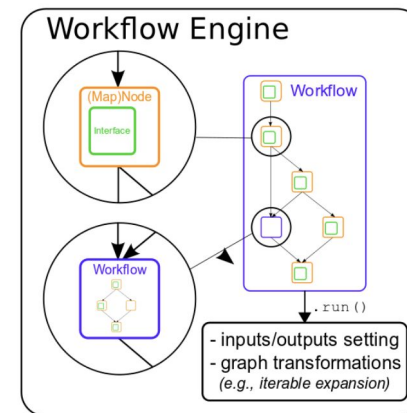
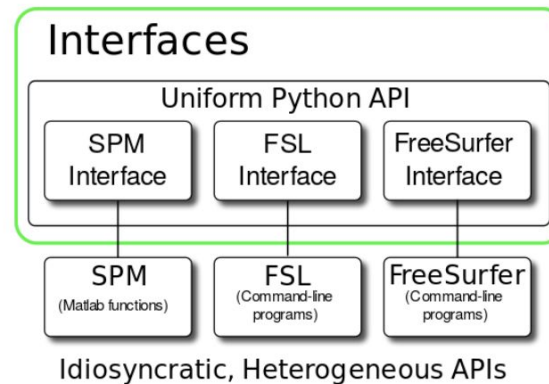


<https://www.fil.ion.ucl.ac.uk/spm/>



**Nipype:**  
**Neuroimaging in Python**  
**Pipelines and Interfaces**

<https://nipype.readthedocs.io>



# Demo : motion correction

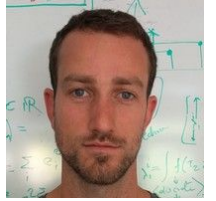


Elodie Germani

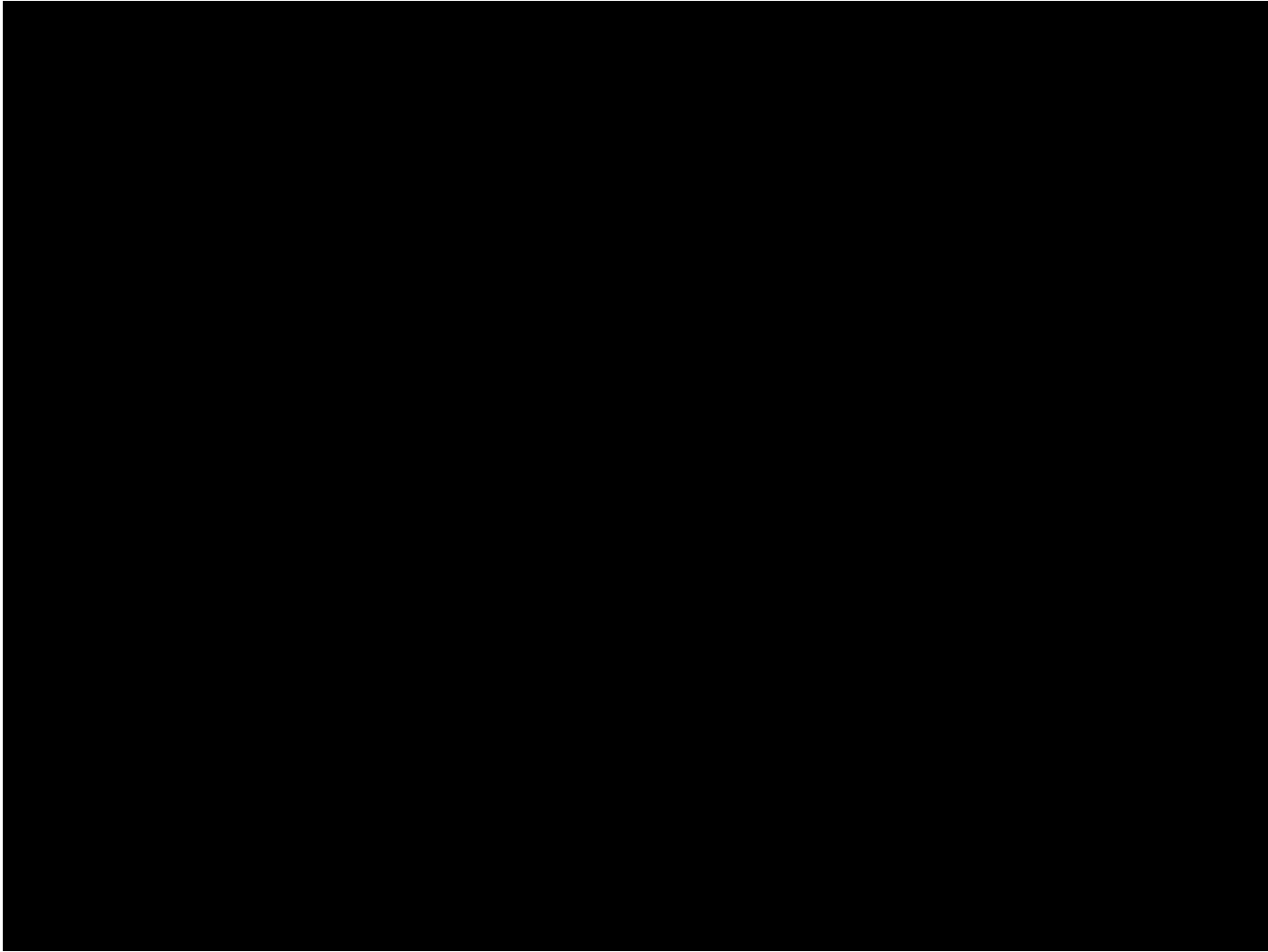
The screenshot shows a Jupyter Notebook interface in a browser. The browser address bar shows the URL `127.0.0.1:8888/notebooks/Softs/reproduced_tutorial/face_rep_example`. The notebook title is `face_rep_example` and it indicates the last checkpoint was 9 minutes ago. The interface includes a menu bar (File, Edit, View, Insert, Cell, Kernel, Widgets, Help) and a toolbar with icons for file operations and execution. The notebook content is as follows:

```
Apply motion correction  
  
In [5]: from nipy.interfaces.spm import RealignUnwarp  
        from nipy.interfaces.utility import Function  
        from nipy.interfaces.io import SelectFiles, DataSink  
        from nipy import Workflow, Node, MapNode  
        import os  
  
In [6]: # folders TO STORE FILES  
        exp_dir = "/home/Softs/reproduced_tutorial/data/face_rep/"  
        raw_dir = os.path.join(exp_dir, "raw")  
        working_dir = "workingdir_moco"  
  
In [7]: os.listdir(raw_dir)  
Out[7]: ['RawEPI', 'Structural', 'all_conditions.mat', 'sots.mat', 'workingdir_moco']  
  
In [8]: # NODE AND TEMPLATE FOR SELECTING FILES  
        anat_file = os.path.join('Structural', 'sM03953_0007.img')  
        func_file = os.path.join('RawEPI', 'sM03953_0005_*.img')  
  
        templates = {'anat': anat_file,  
                    'func': func_file}
```

# Motion correction



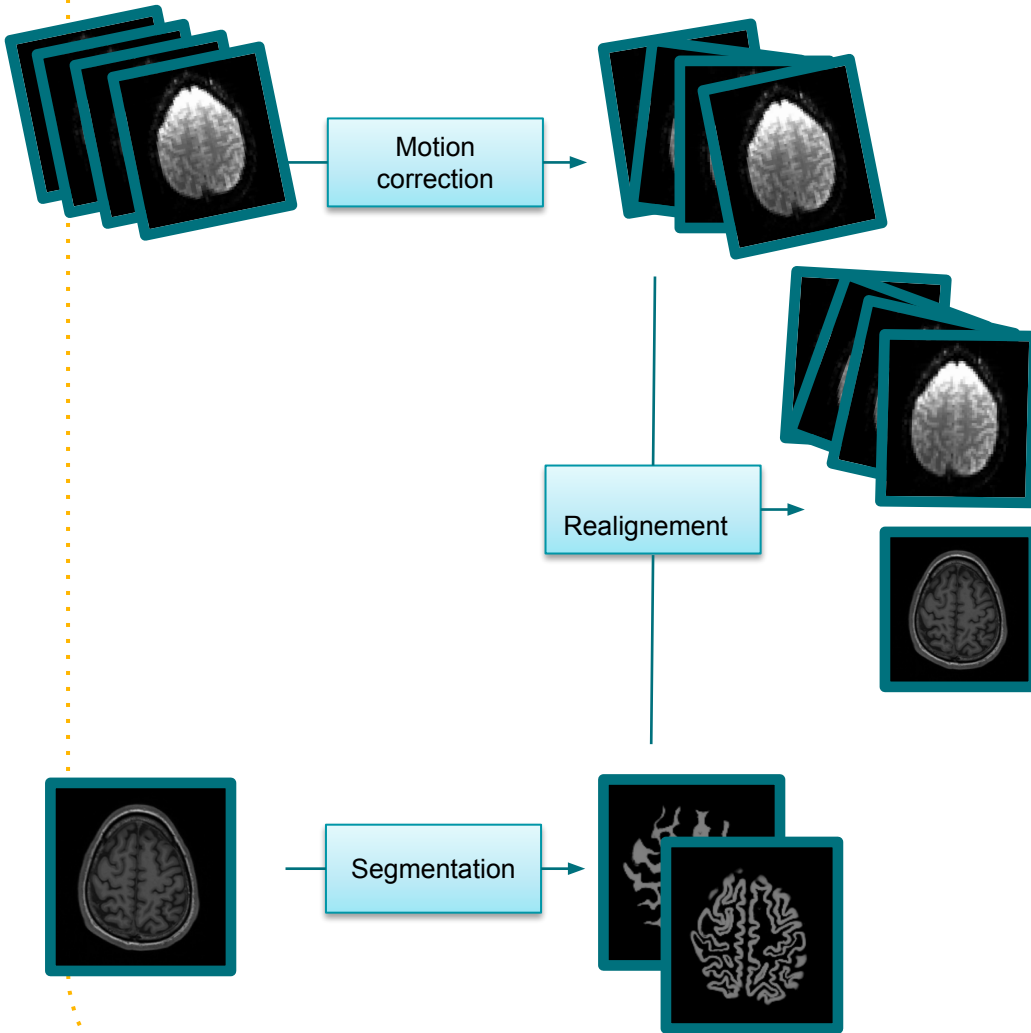
Quentin  
Duché



Credits: Video by Quentin Duché, Empenn.



# More preparation steps...

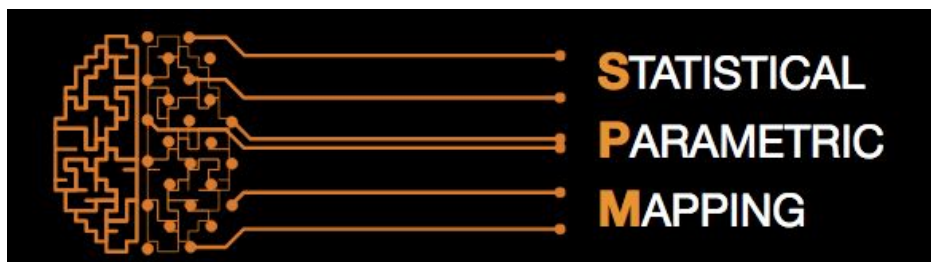


# Demo : Preprocessing



Elodie Germani

Reproduction of [SPM tutorial](#) using Nipype: [https://gitlab.inria.fr/egermani/reproduced\\_tutorial](https://gitlab.inria.fr/egermani/reproduced_tutorial)



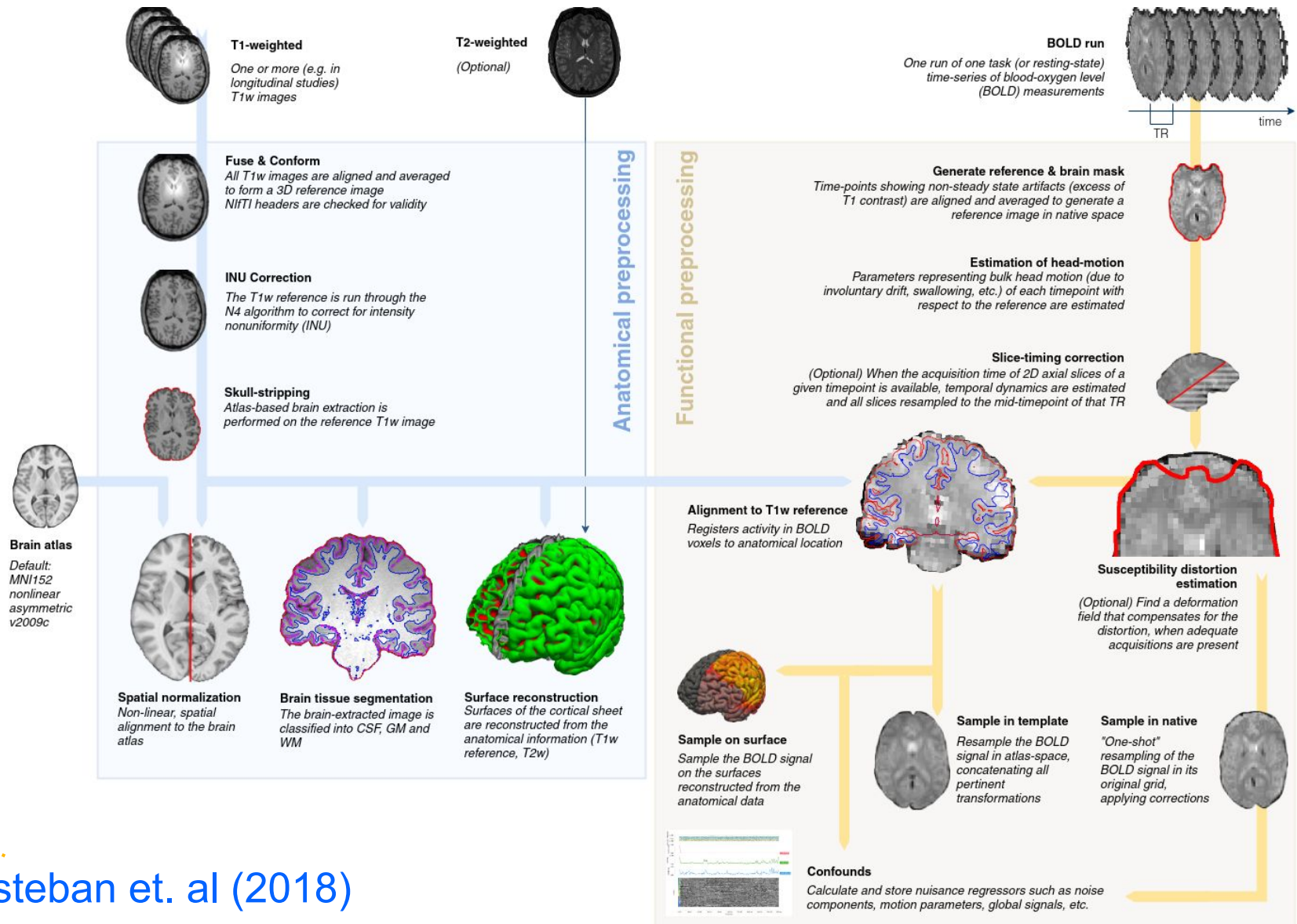
<https://www.fil.ion.ucl.ac.uk/spm/>



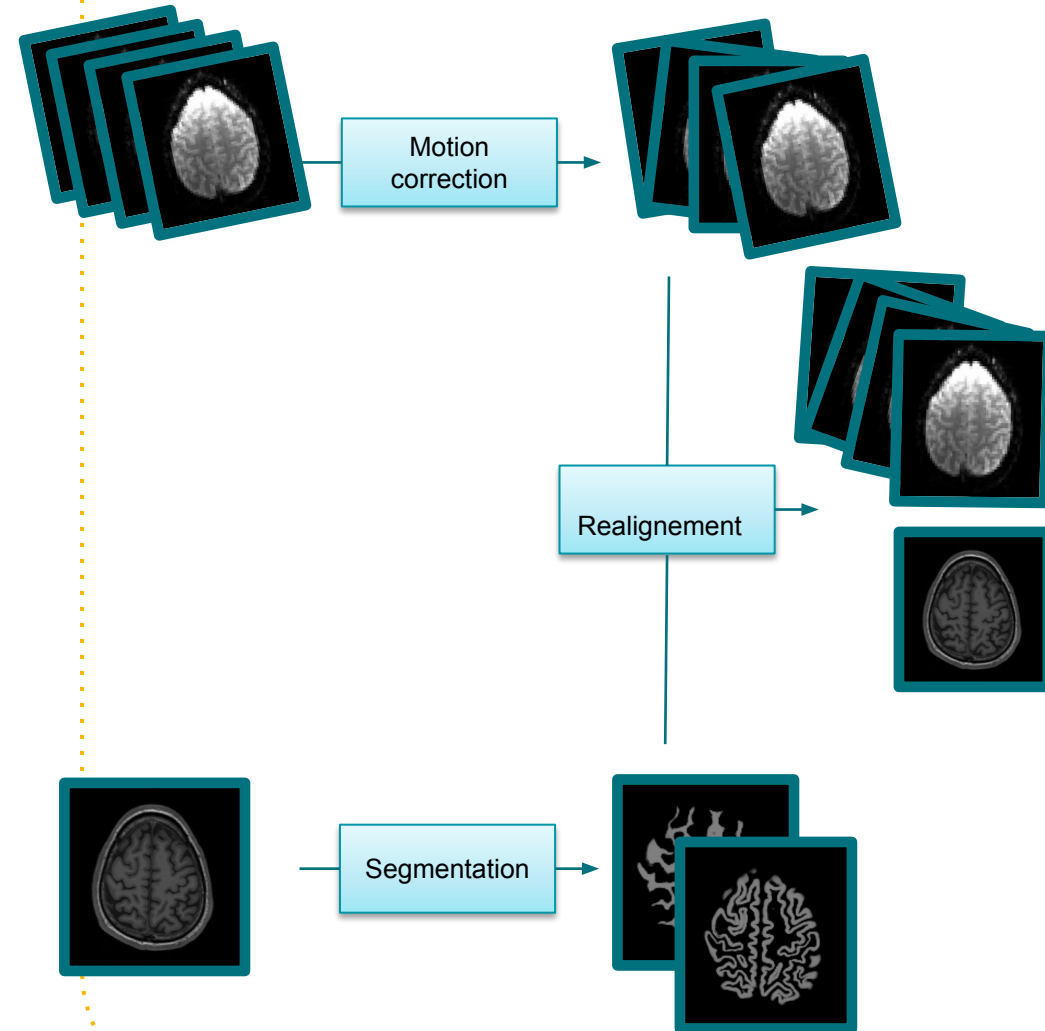
**Nipype:**  
**Neuroimaging in Python**  
**Pipelines and Interfaces**

<https://nipype.readthedocs.io>

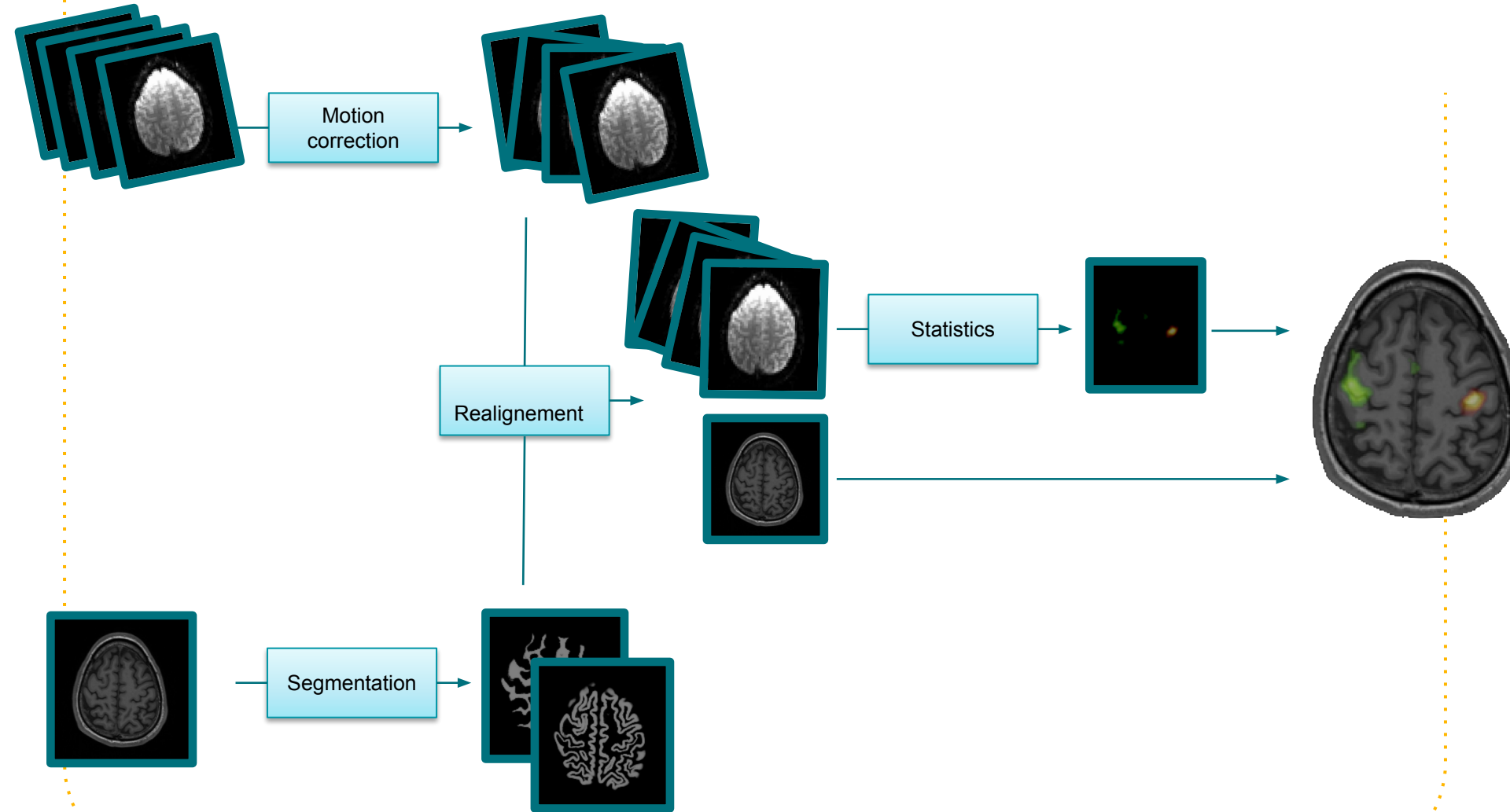
# And even more preparation...



# More preparation steps...



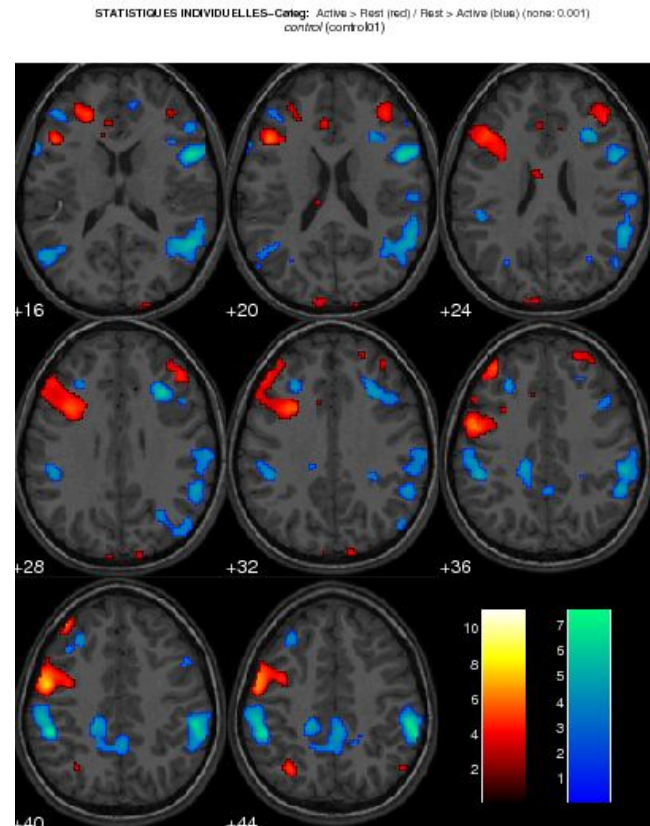
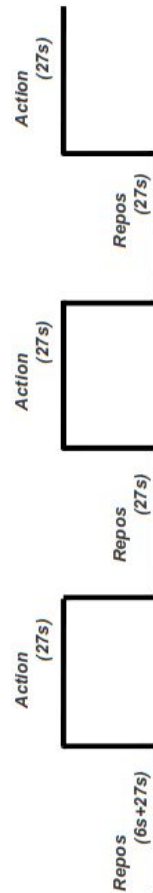
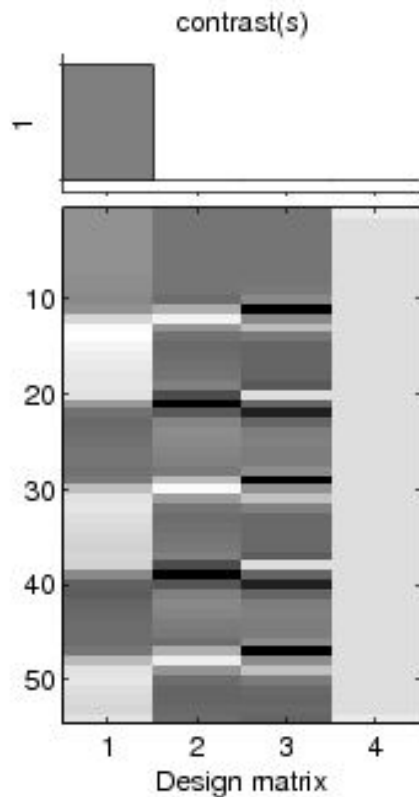
# More preparation steps...





# Statistical analysis

Goal: Get areas of activations and deactivations for a given participant or for a group of participants.

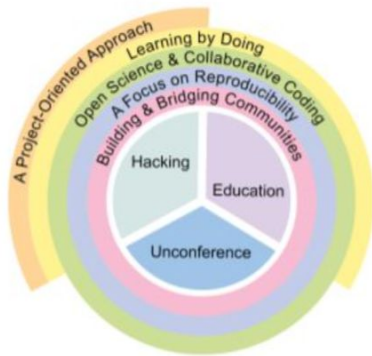


Design matrix

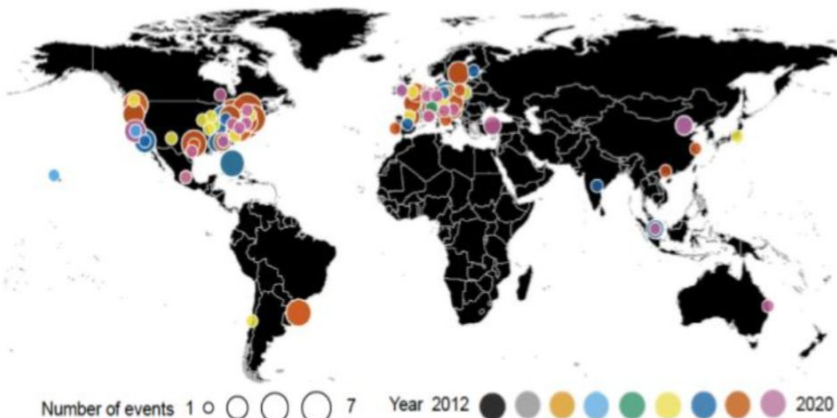
**Collaborative and  
community-driven  
research**

# Brainhack: project-based community science

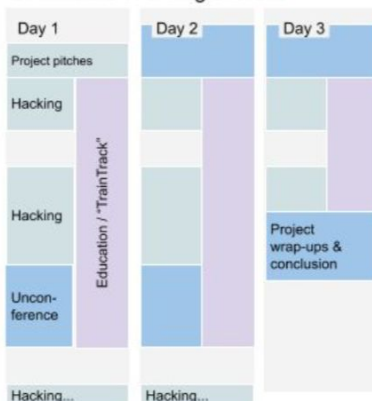
A. Anatomy of a Brainhack



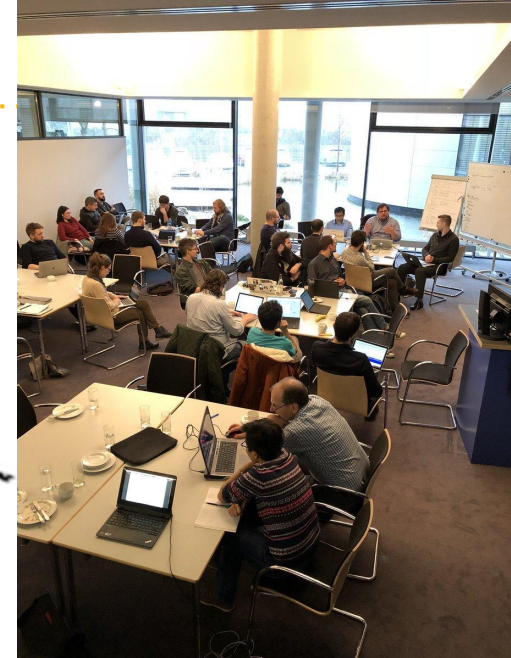
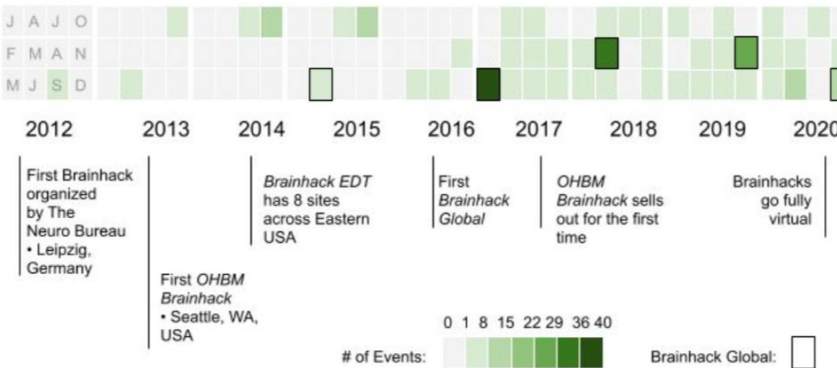
C. Brainhack Cartography



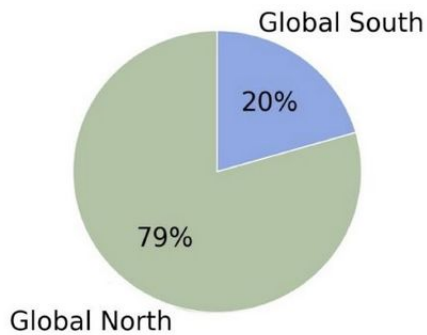
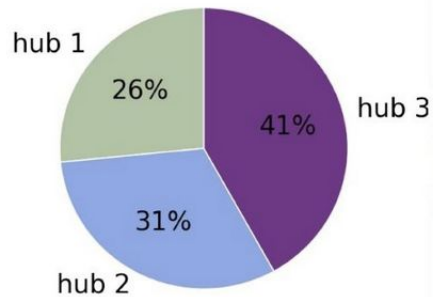
B. Timeline of a Single Event



D. Brainhack Timeline



# OHBM Brainhack - hybrid!



Locations of the 2020 OHBM Brainhack attendees

# Coming soon!

## OHBM Brainhack June 16-18, 2022



<https://ohbm.github.io/hackathon2022/>

Registration: [here](#) (fee waiver available)





**Neuroinformatics  
Assembly 2022**  
Virtual | September 12-16

Advances in FAIR data management and sharing practices  
for neuroscience research, infrastructures, and tools

Abstract submission open until **MAY 23**

[neuroinformatics.incf.org](https://neuroinformatics.incf.org)



May 13, 2022



# An introduction to neuroinformatics

Camille Maumet

# Thank you!

