



# An introduction to neuroinformatics

Camille Maumet

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**HAL Id: inserm-03670072**

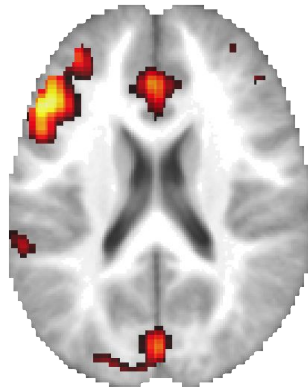
**<https://inserm.hal.science/inserm-03670072>**

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



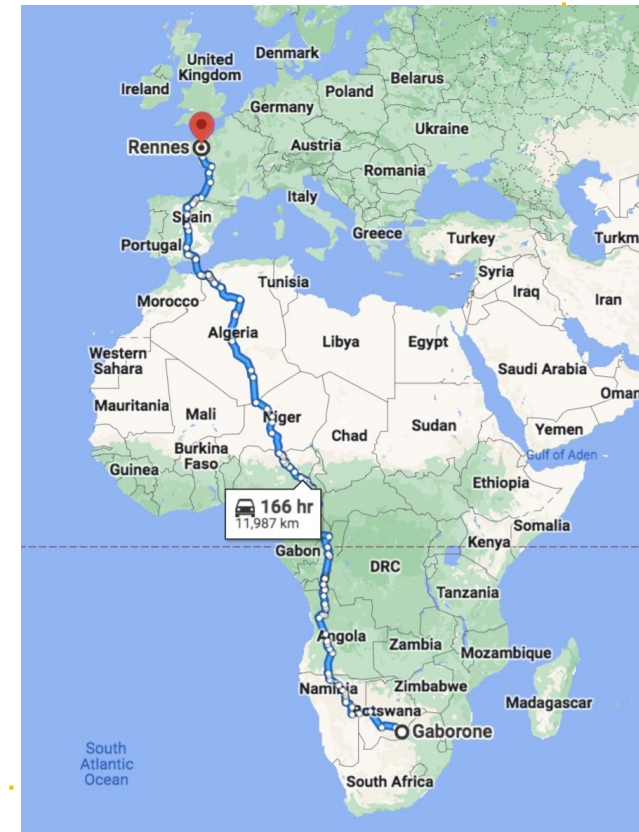
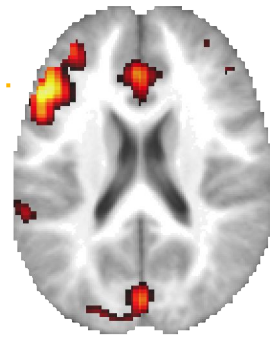
# Who am I?



## Neuroinformatician

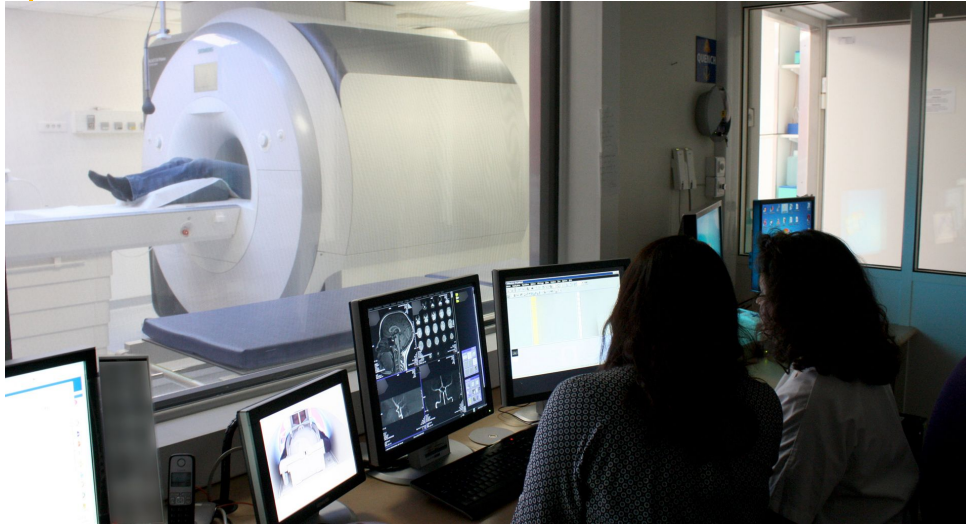
Data science + brain imaging

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

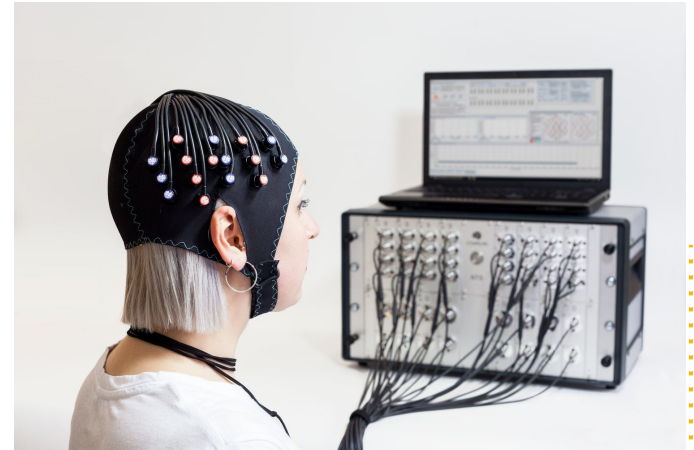


**Brain imaging**

# Imaging the brain



Magnetic resonance imaging (MRI)



Near infrared spectroscopy (NIRS)



Electroencephalography (EEG)

Credits: MRI, [Neurinfo](#) - NIRS, [Elisenicolegray](#) (CC BY-SA) - EEG, [Neurospin](#).

# Images of the brain



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)

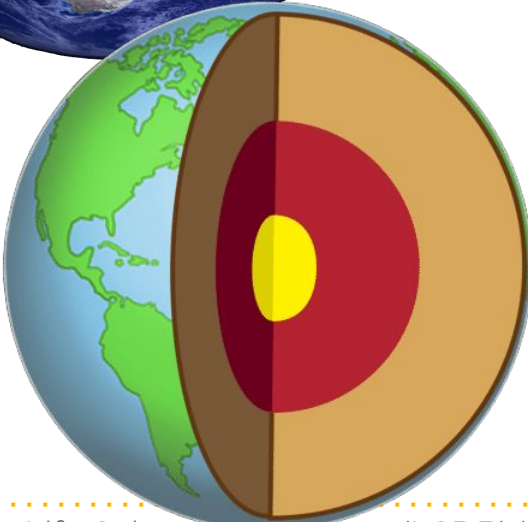
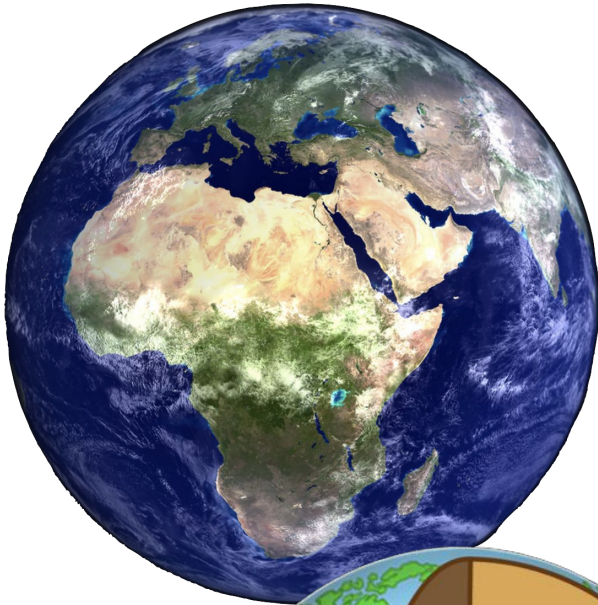


# Brain images



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)

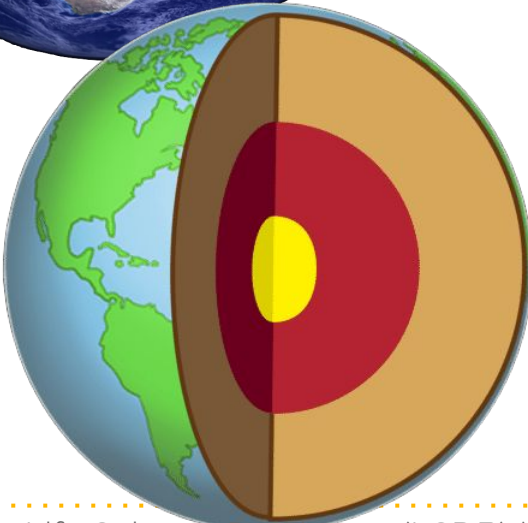
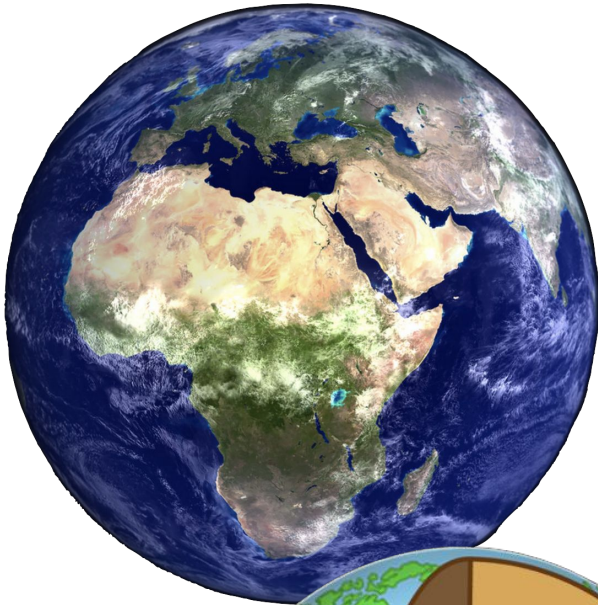
# Brain images



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)

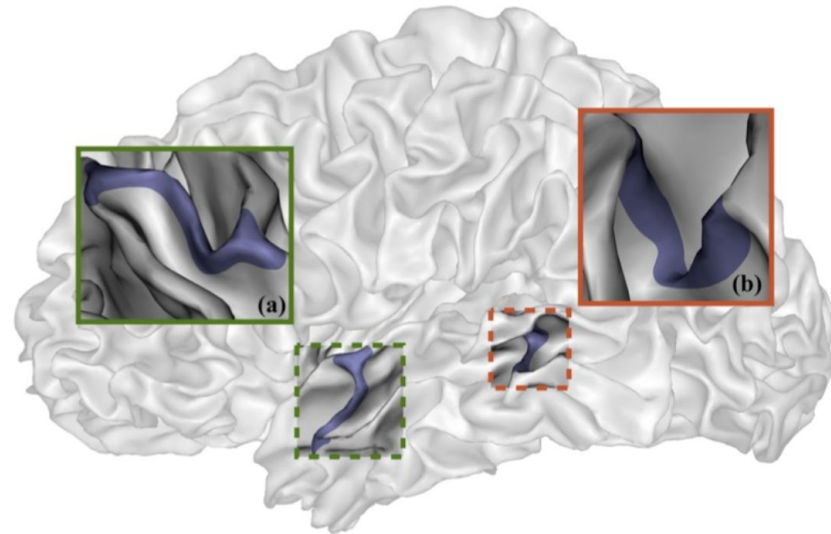


# Brain images



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

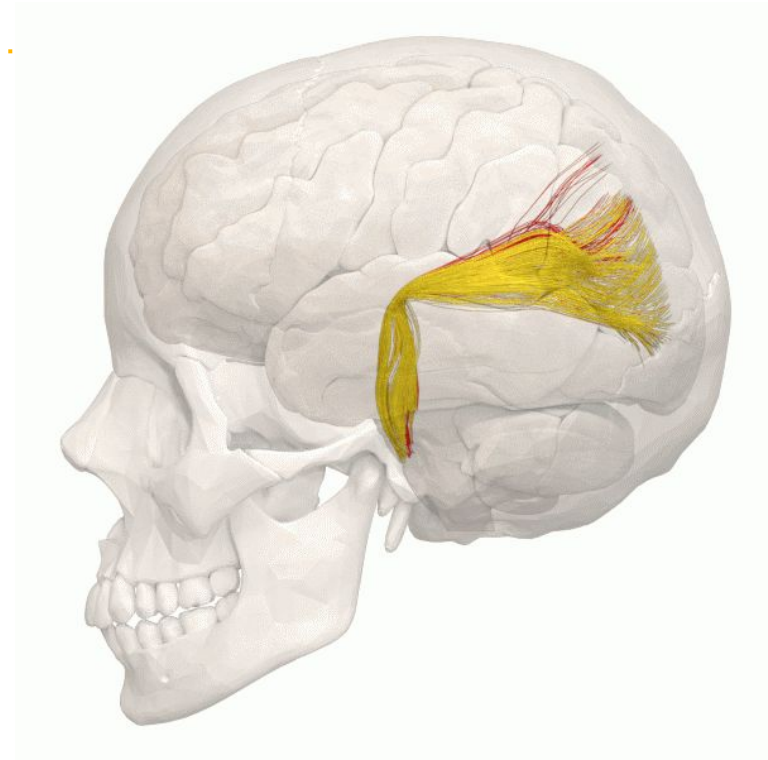
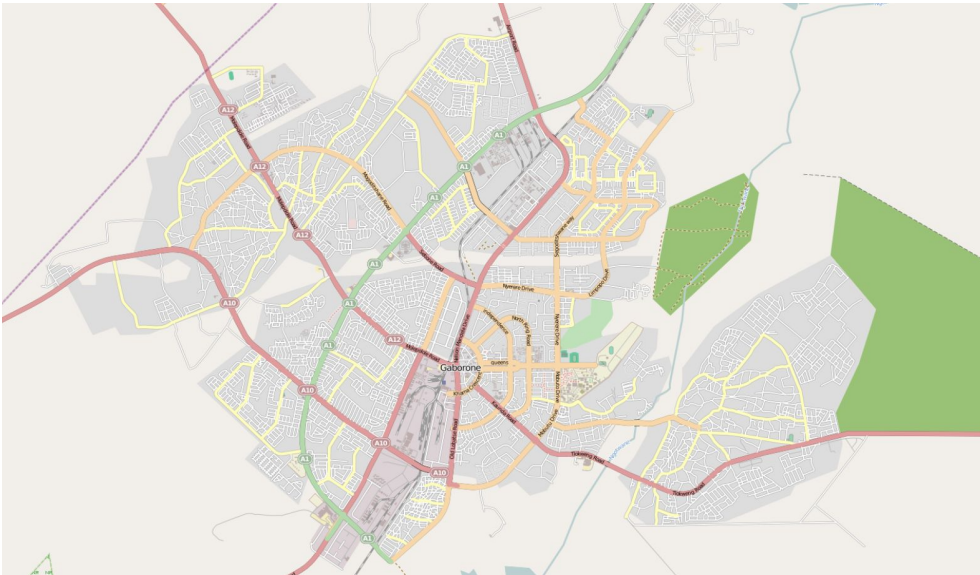


Pli de  
passage  
(Song  
et al.,  
2021)

Song et. al (2021)



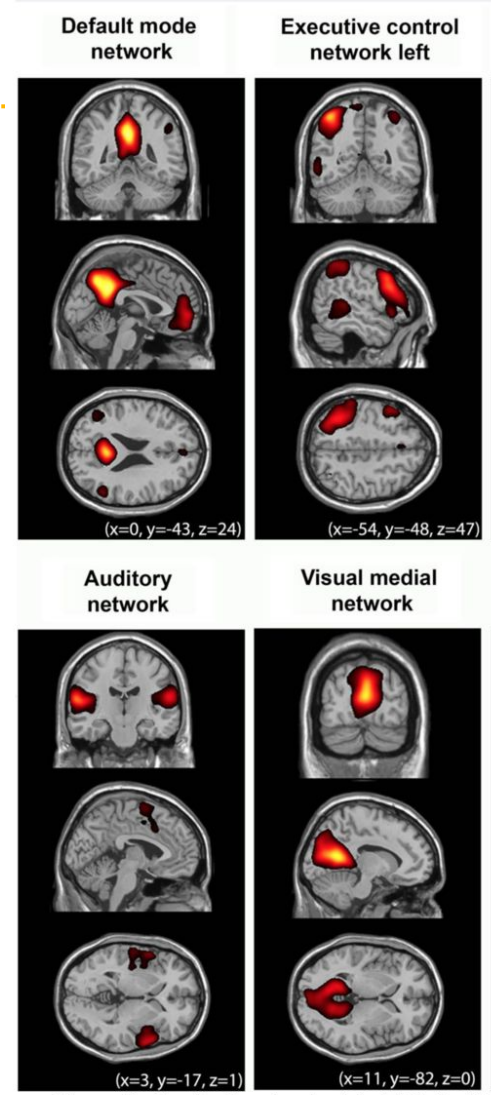
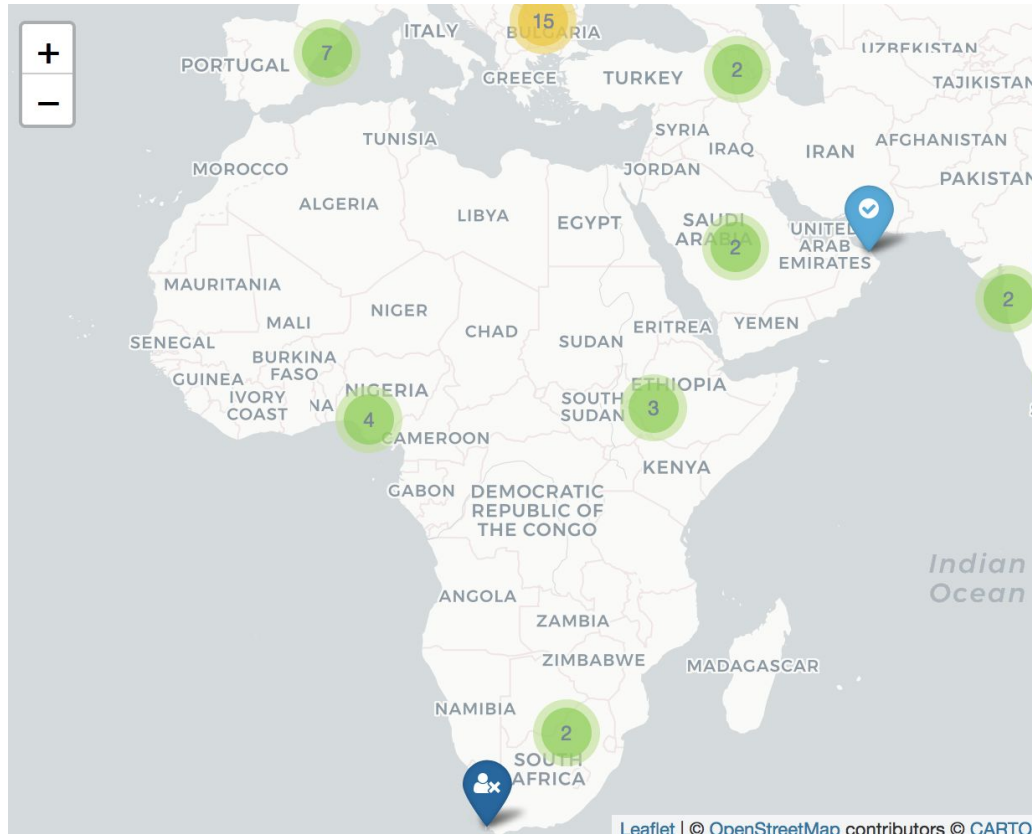
# Connectivity



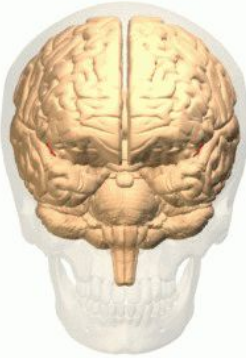
Credits: Tractography, group work [Wikipedia](#) (CC-BY-SA) - Gaborone road map by OpenStreetMap contributors, [Wikipedia](#) (CC-BY-SA).



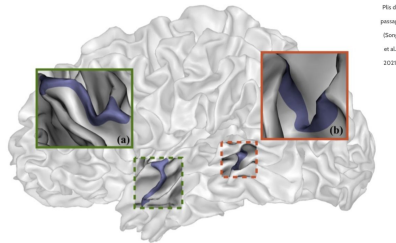
# Brain function



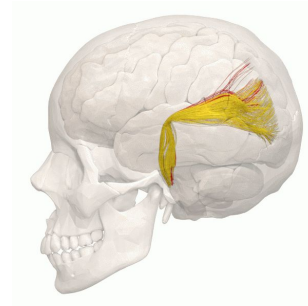
# Many types of brain maps



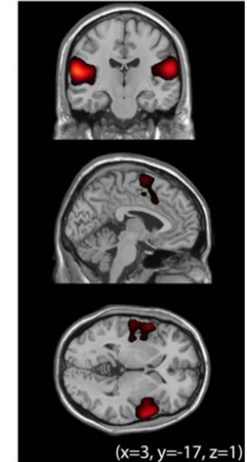
Human brain



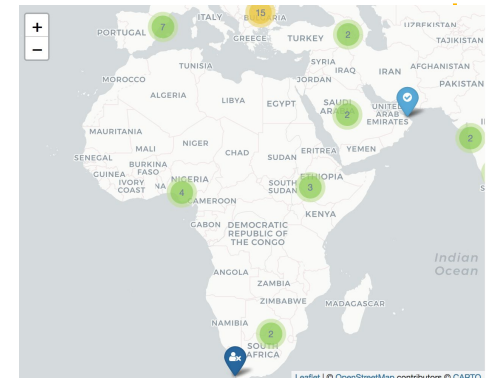
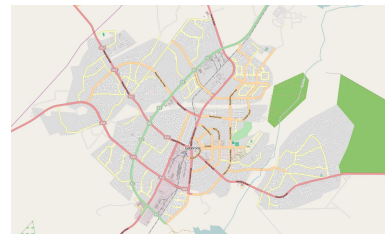
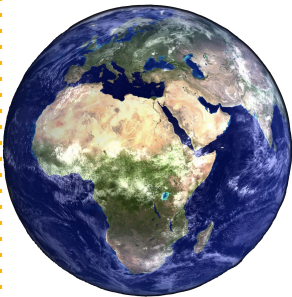
Anatomy



Connectivity

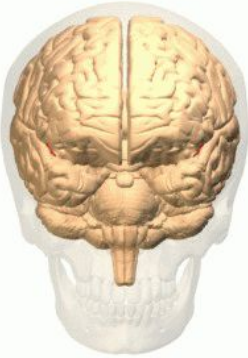


Function

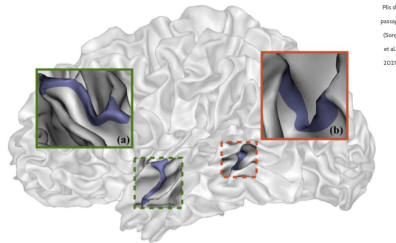




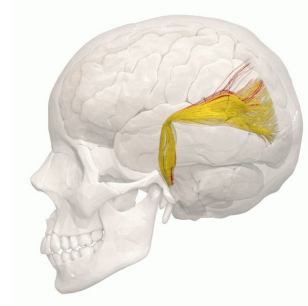
# Many types of brain maps



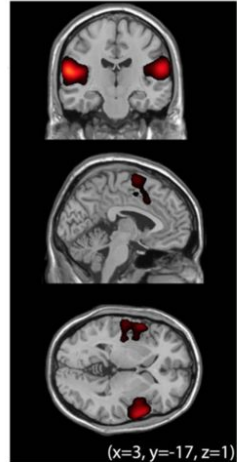
Human brain



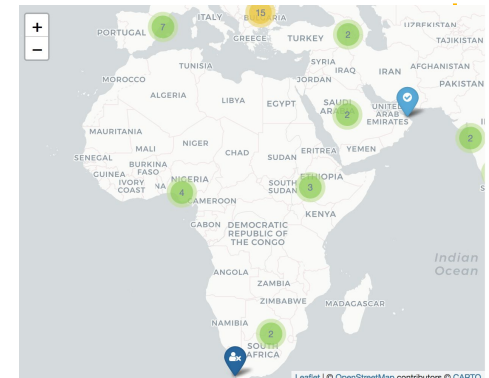
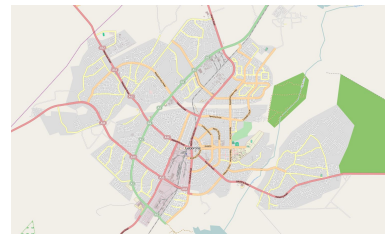
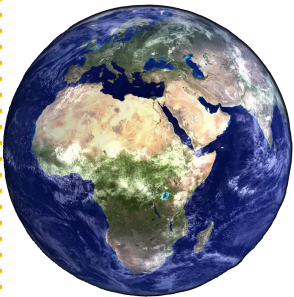
Anatomy



Connectivity



Function



# Example functional MRI study

Studying developmental Language disorder

Study started in 2005 in Rennes.

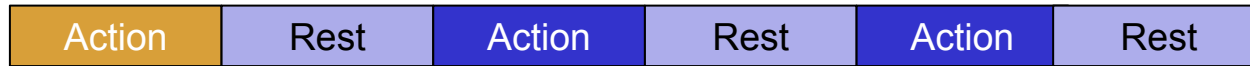
Team of clinicians and research scientists.

40 children participated.

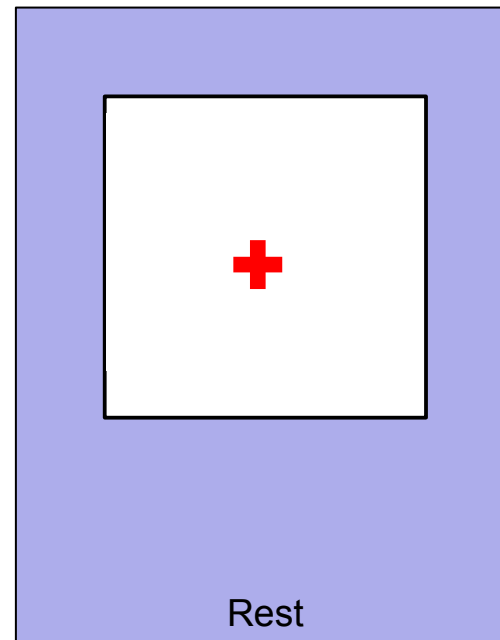
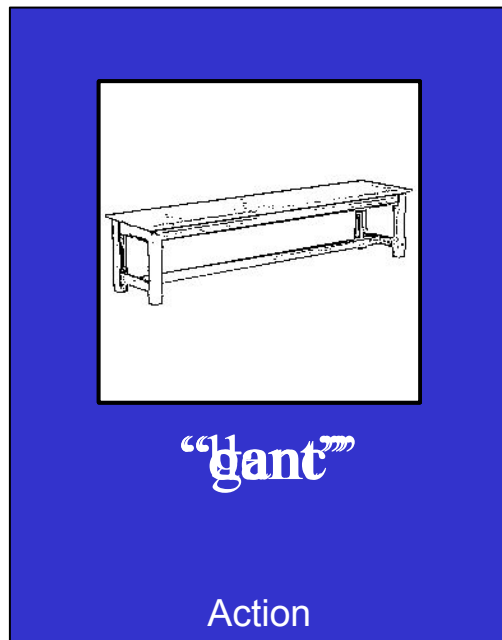
De Guibert et. al (2010), De Guibert et. al (2011)



# fMRI protocol

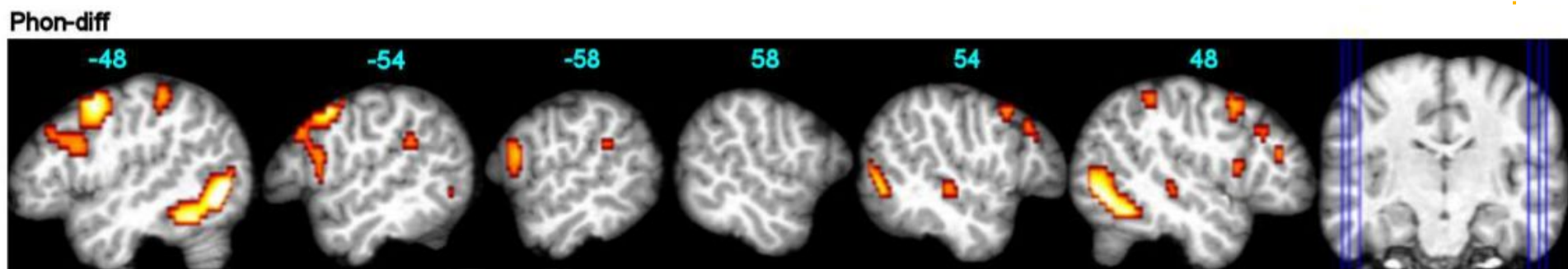


- Language paradigm using a block design

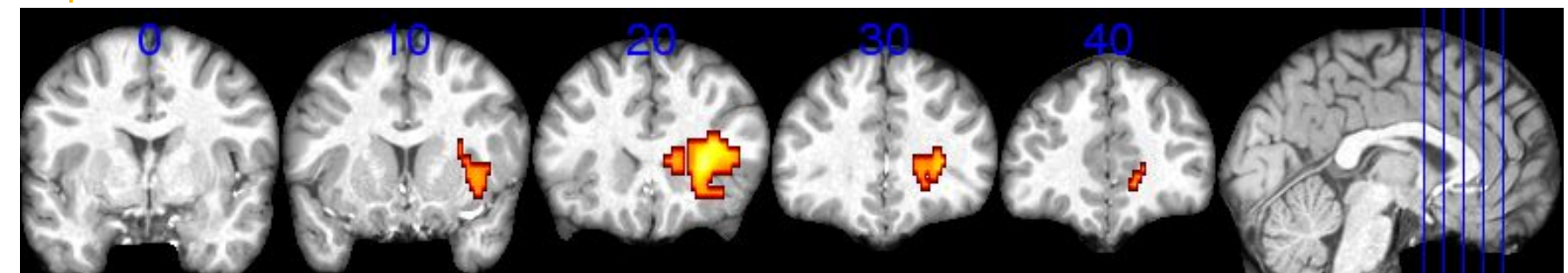


# Results

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/>



**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

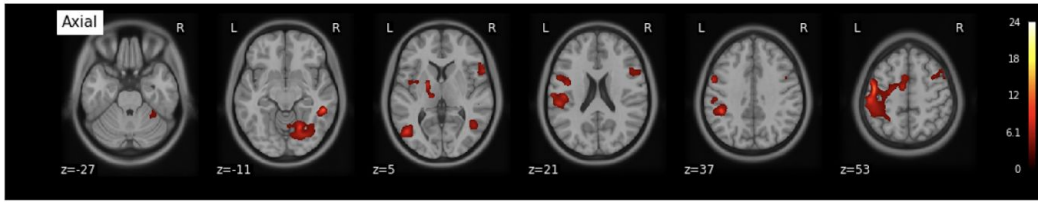
```
In [1]: from nilearn.plotting import plot_stat_map, plot_epi, plot_anat
        %matplotlib inline
```

```
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

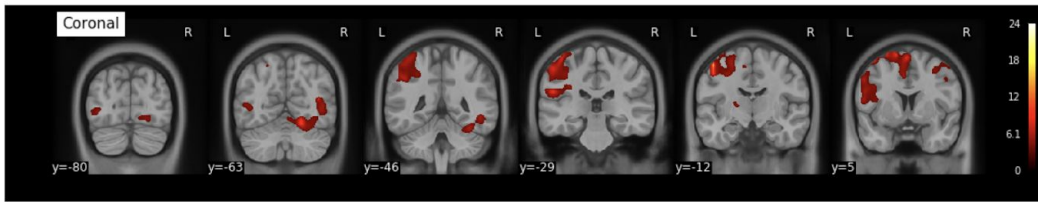
Final figures

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



Axial

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



Coronal

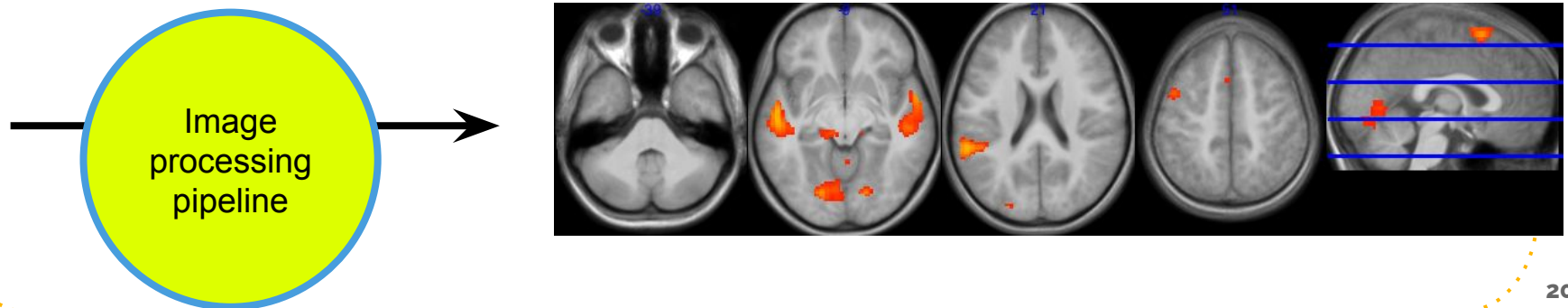
```
In [5]: plot_stat_map(act_img, title='Sagittal', bg_img=anat_img, display_mode='x', cut_coords=(range(-49,52,17)));
```

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

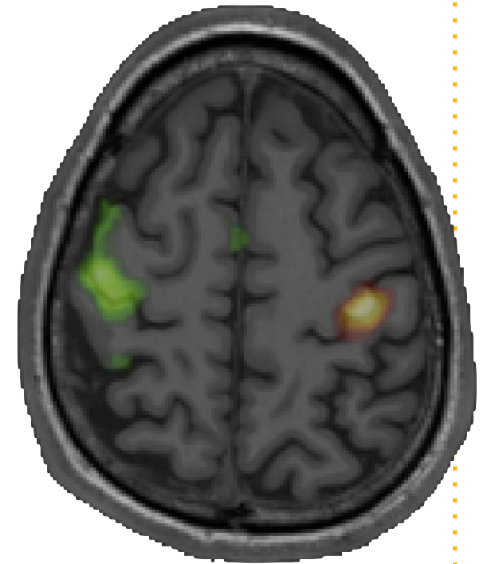
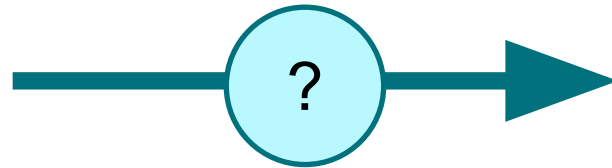
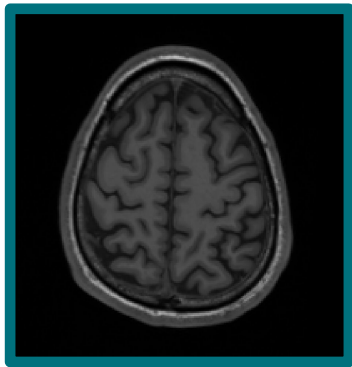
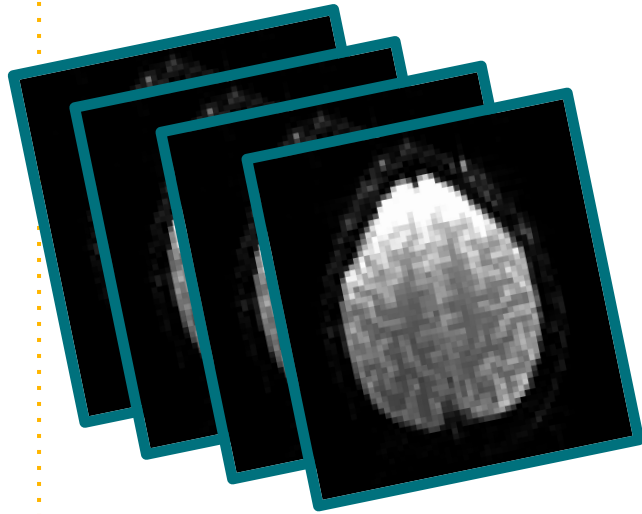
# Functional MRI: raw data



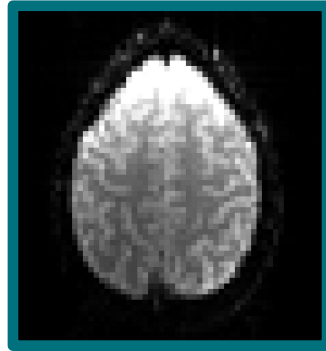
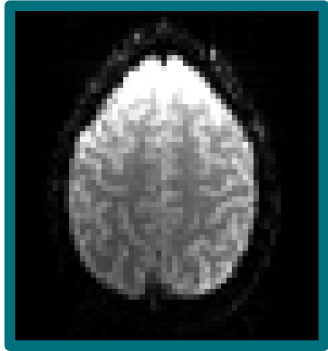
- 64 brain volumes / subject / paradigm



# Data analysis

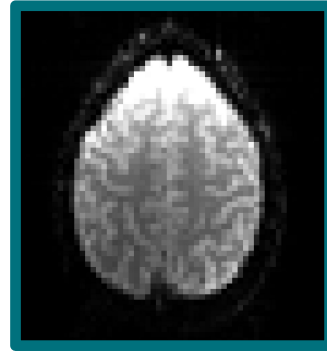
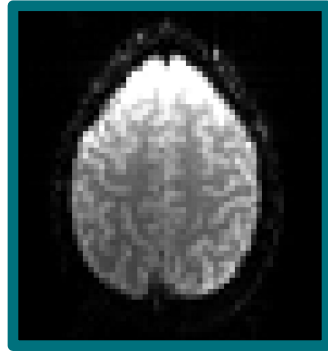


# Motion correction





# Motion correction



# Motion correction



# Motion correction



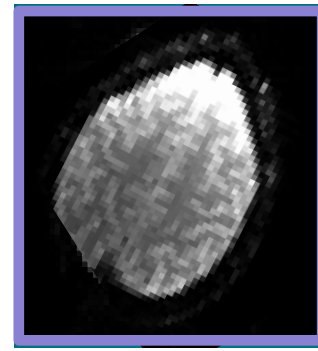
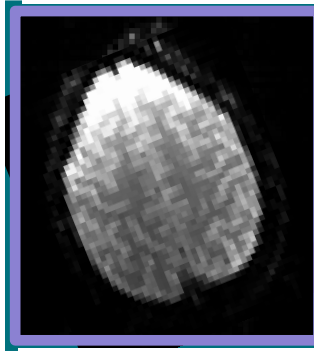
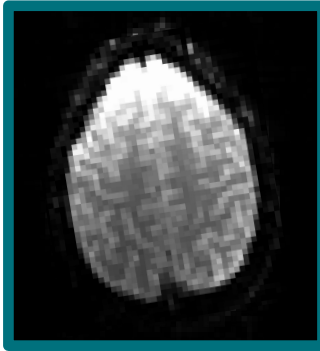
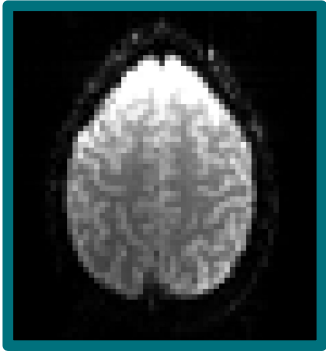
Credits: cat by Sheilagraber, [Wikimedia commons](#) (CC-BY)

# Motion correction



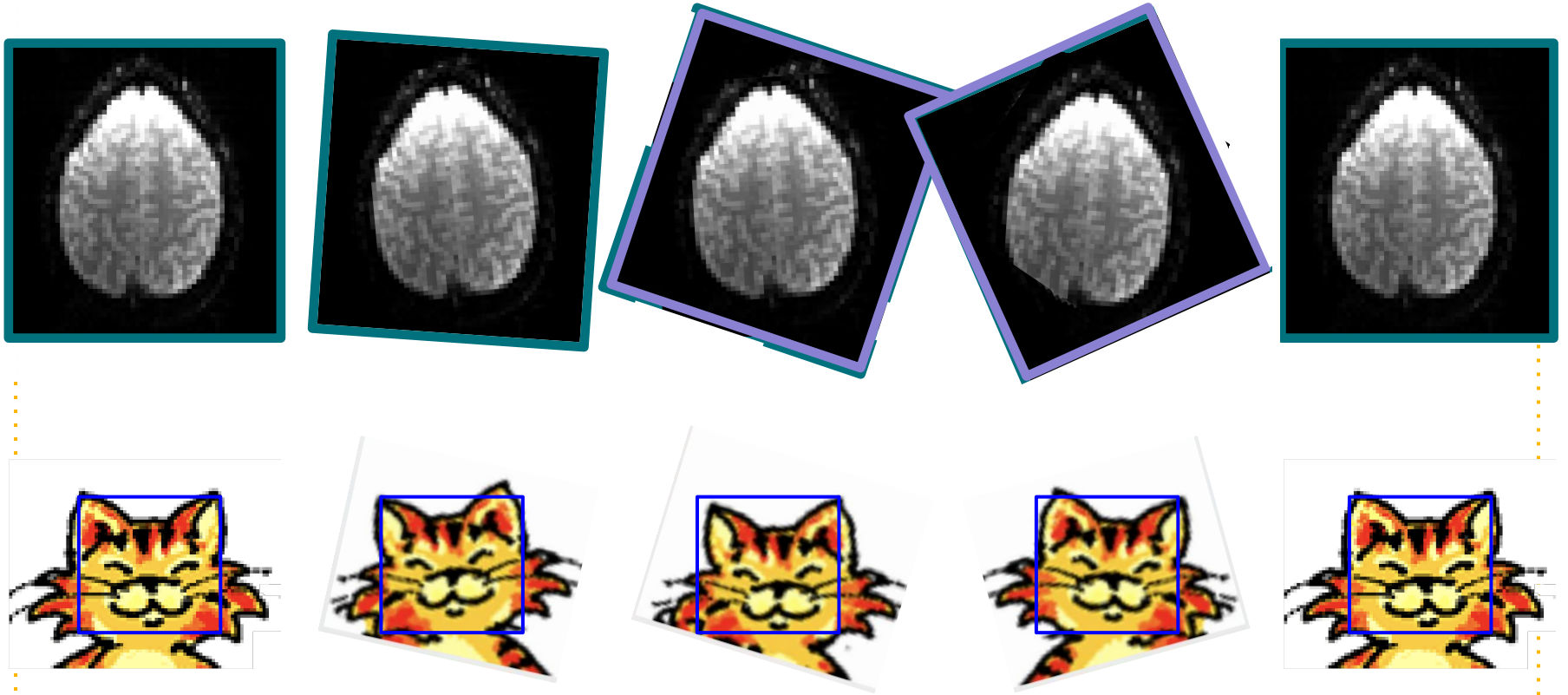
Credits: cat by Sheilagraber, [Wikimedia commons](#) (CC-BY)

# Motion correction





# Motion correction



# Motion correction

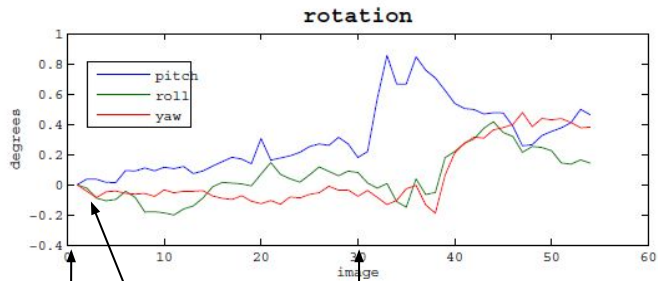
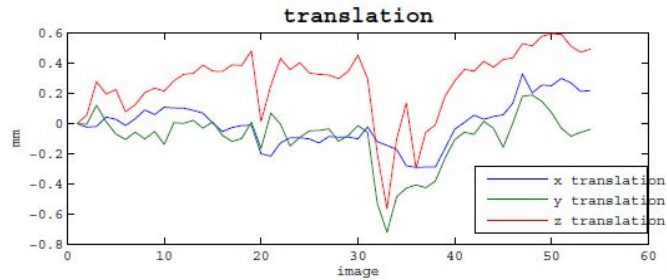
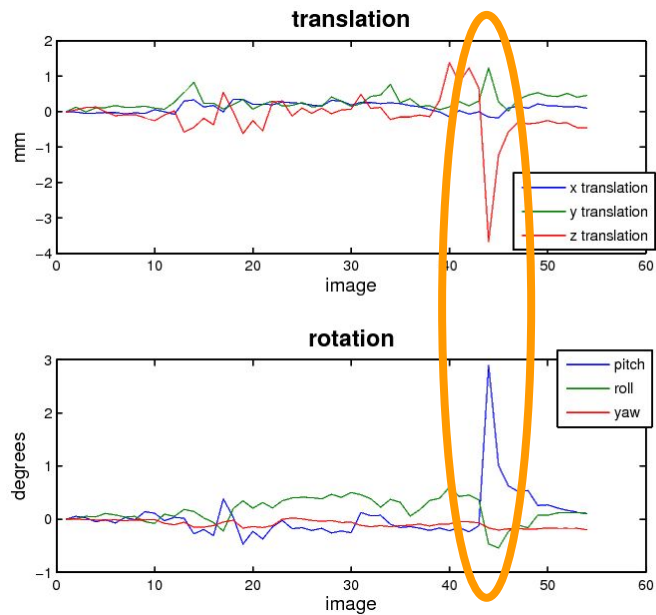
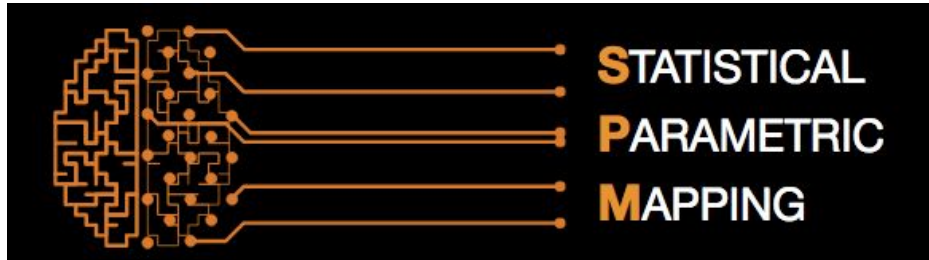


Image 1  
Image 2

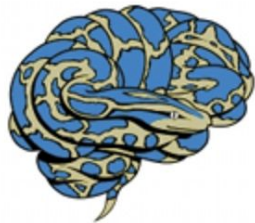
Image 30



# Demo : motion correction

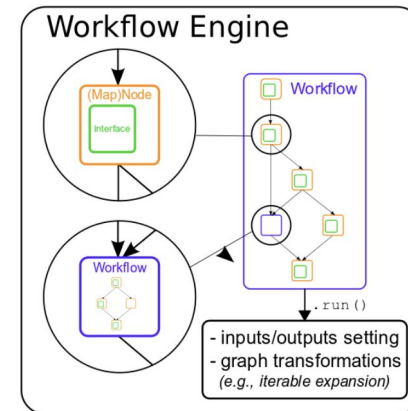
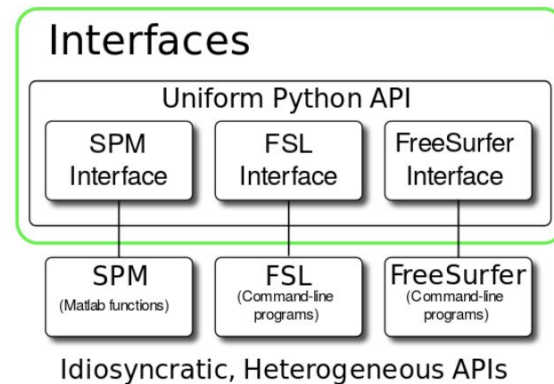


<https://www.fil.ion.ucl.ac.uk/spm/>



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

<https://nipype.readthedocs.io>



# Demo : motion correction



Elodie Germani

The screenshot shows a Jupyter Notebook titled "face\_rep\_example" running on a local server at 127.0.0.1:8888. The notebook has a menu bar with File, Edit, View, Insert, Cell, Kernel, Widgets, and Help. Below the menu is a toolbar with icons for saving, running, and other actions. 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"

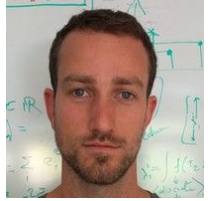
In [7]: os.listdir(raw_dir)

Out[7]: ['RawEPI', 'Structural', 'all_conditions.mat', 'sots.mat', 'workingdir_moco']

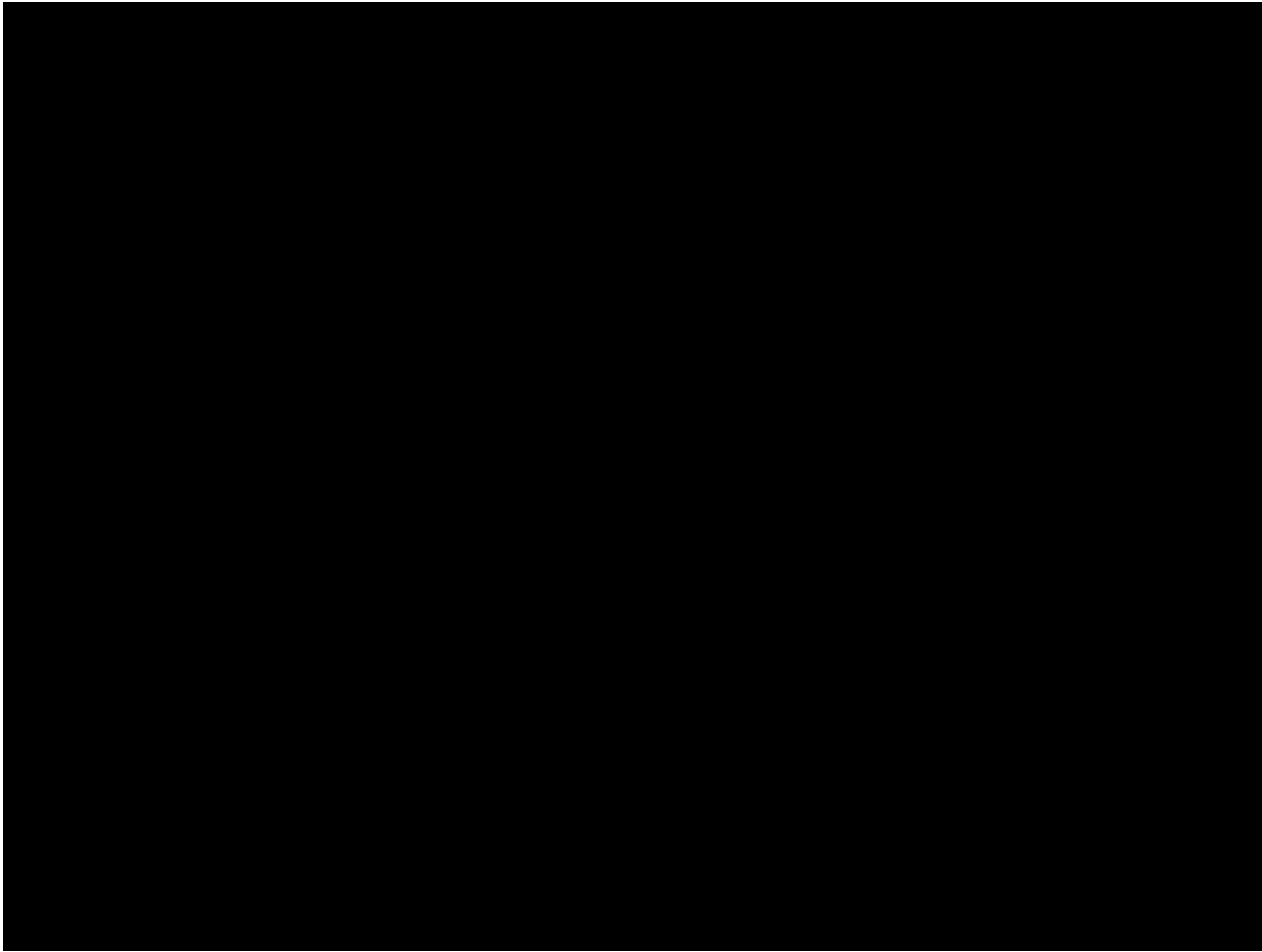
In [8]: # NODE AND TEMPLATE FOR SELECTING FILES
        anat_file = os.path.join('Structural', 'sM03953_0007.img')
        func_file = os.path.join('RawEPI', 'sM03953_0005_*.img')

        templates = {'anat': anat_file,
```

# Motion correction

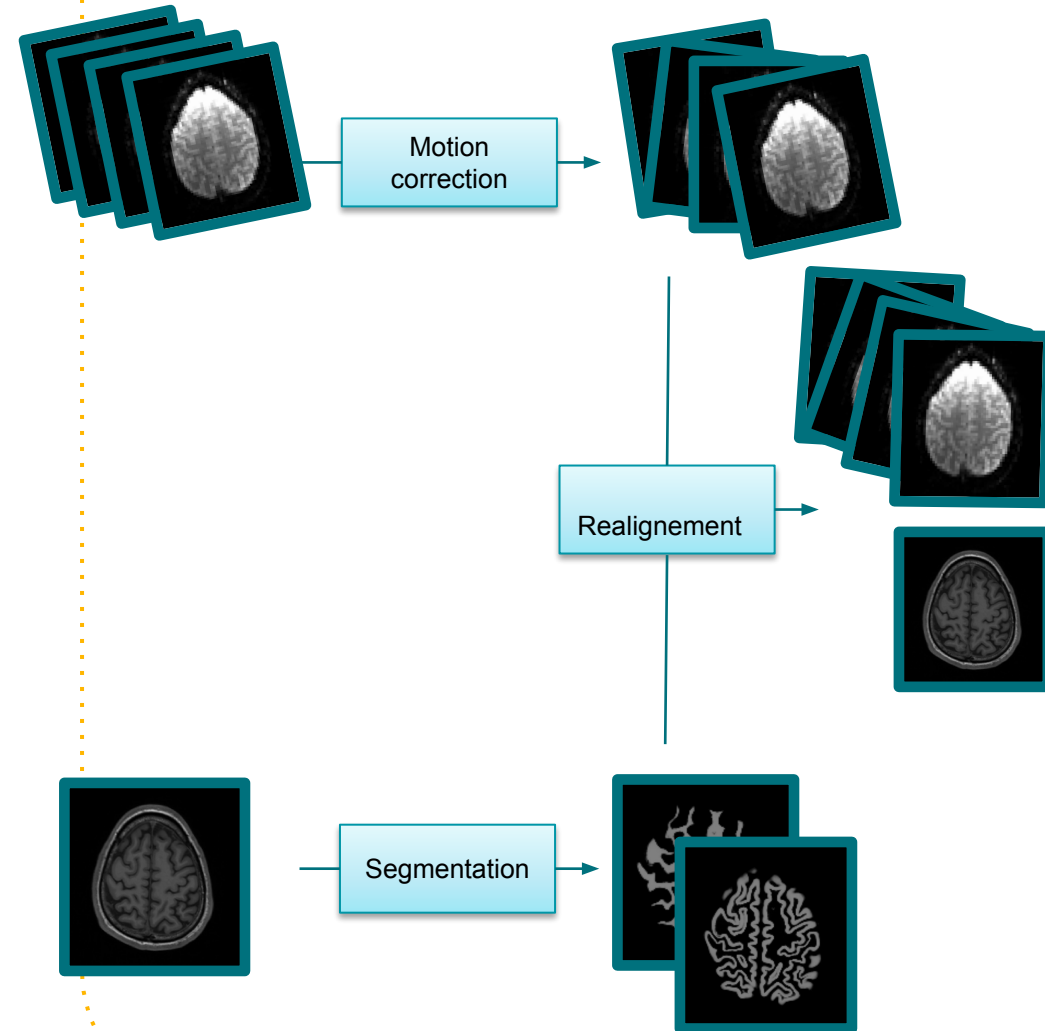


Quentin  
Duché



Credits: Video by Quentin Duché, Empenn.

# More preparation steps...





# Demo : Preprocessing



Elodie Germani

Reproduction of [SPM tutorial](https://www.fil.ion.ucl.ac.uk/spm/) using Nipype: [https://gitlab.inria.fr/egermani/reproduced\\_tutorial](https://gitlab.inria.fr/egermani/reproduced_tutorial)



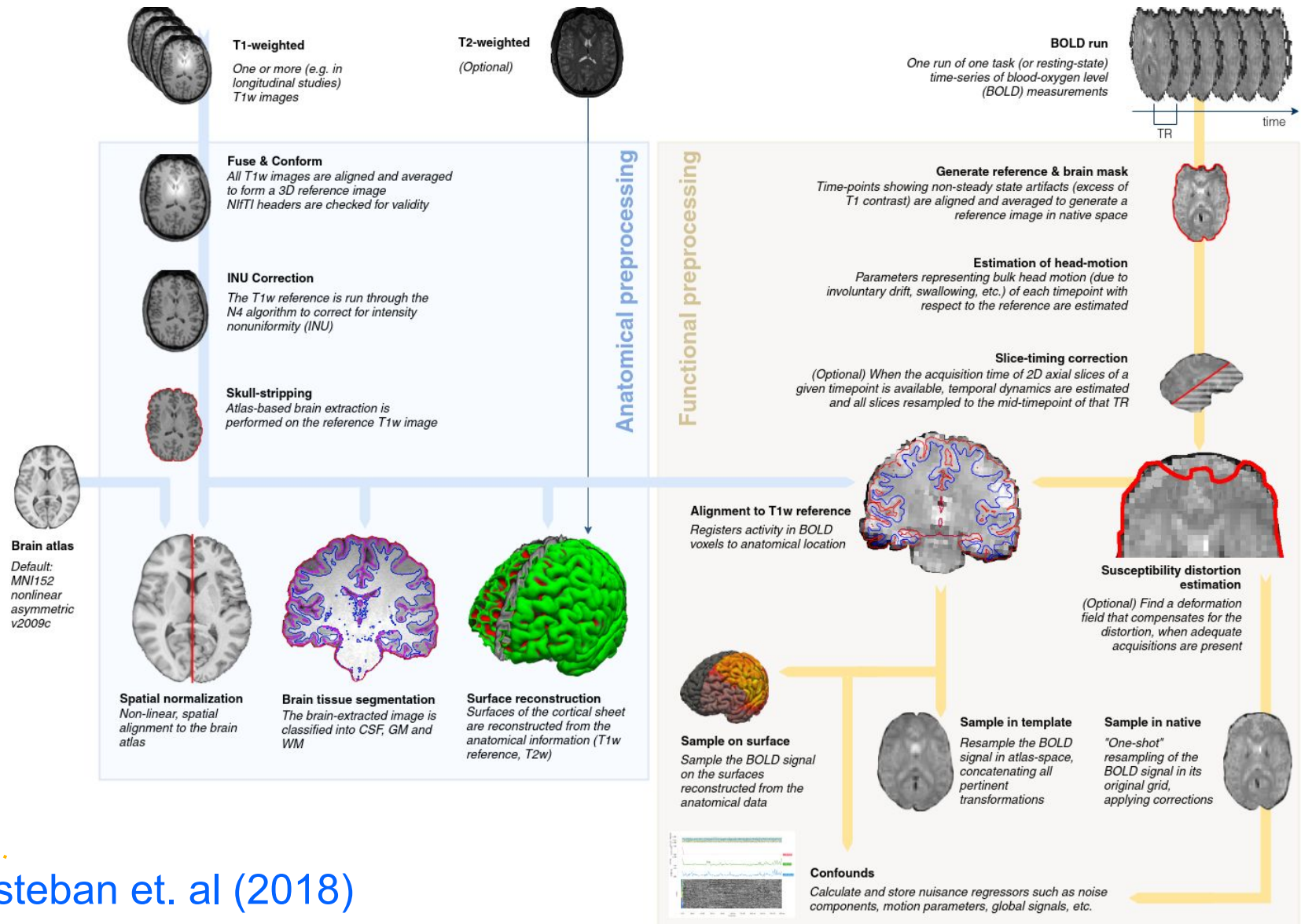
<https://www.fil.ion.ucl.ac.uk/spm/>



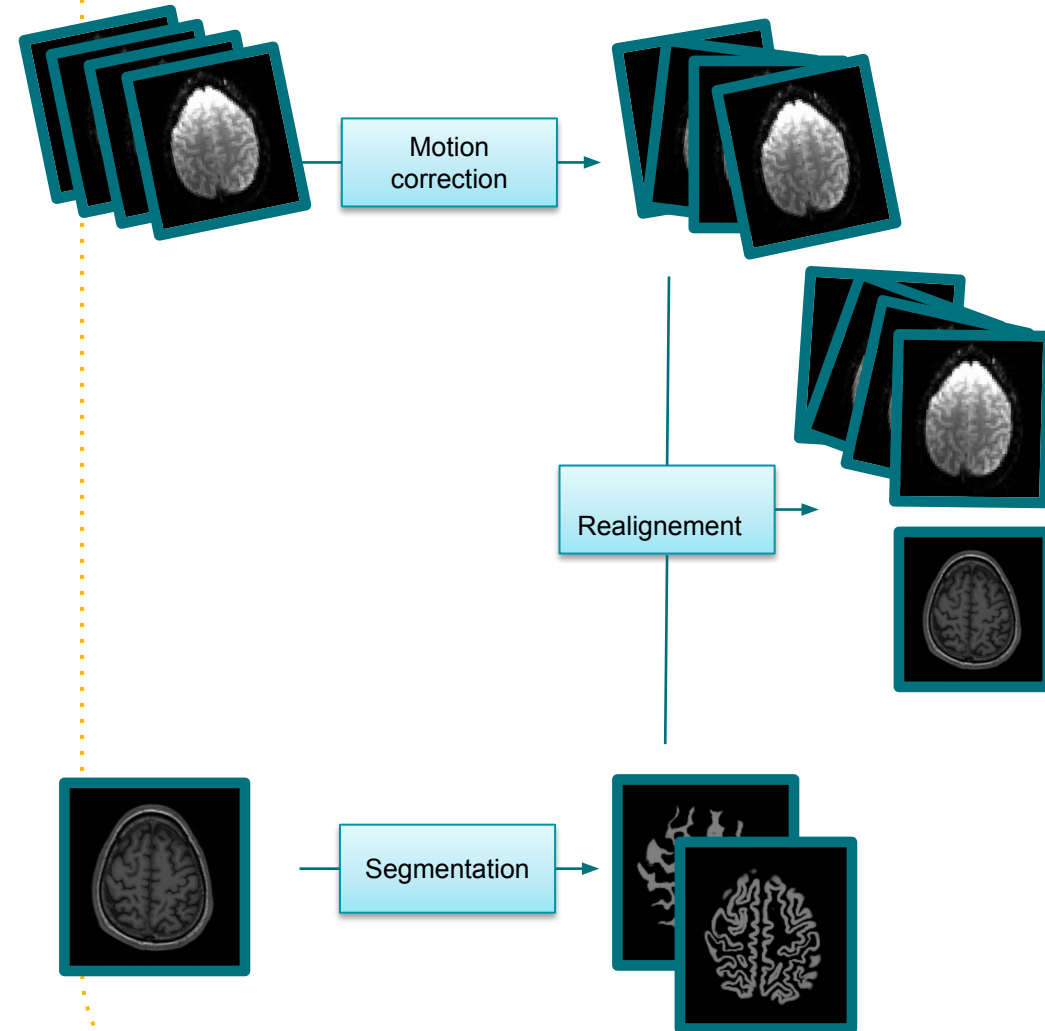
**Nipype:**  
**Neuroimaging in Python**  
**Pipelines and Interfaces**

<https://nipype.readthedocs.io>

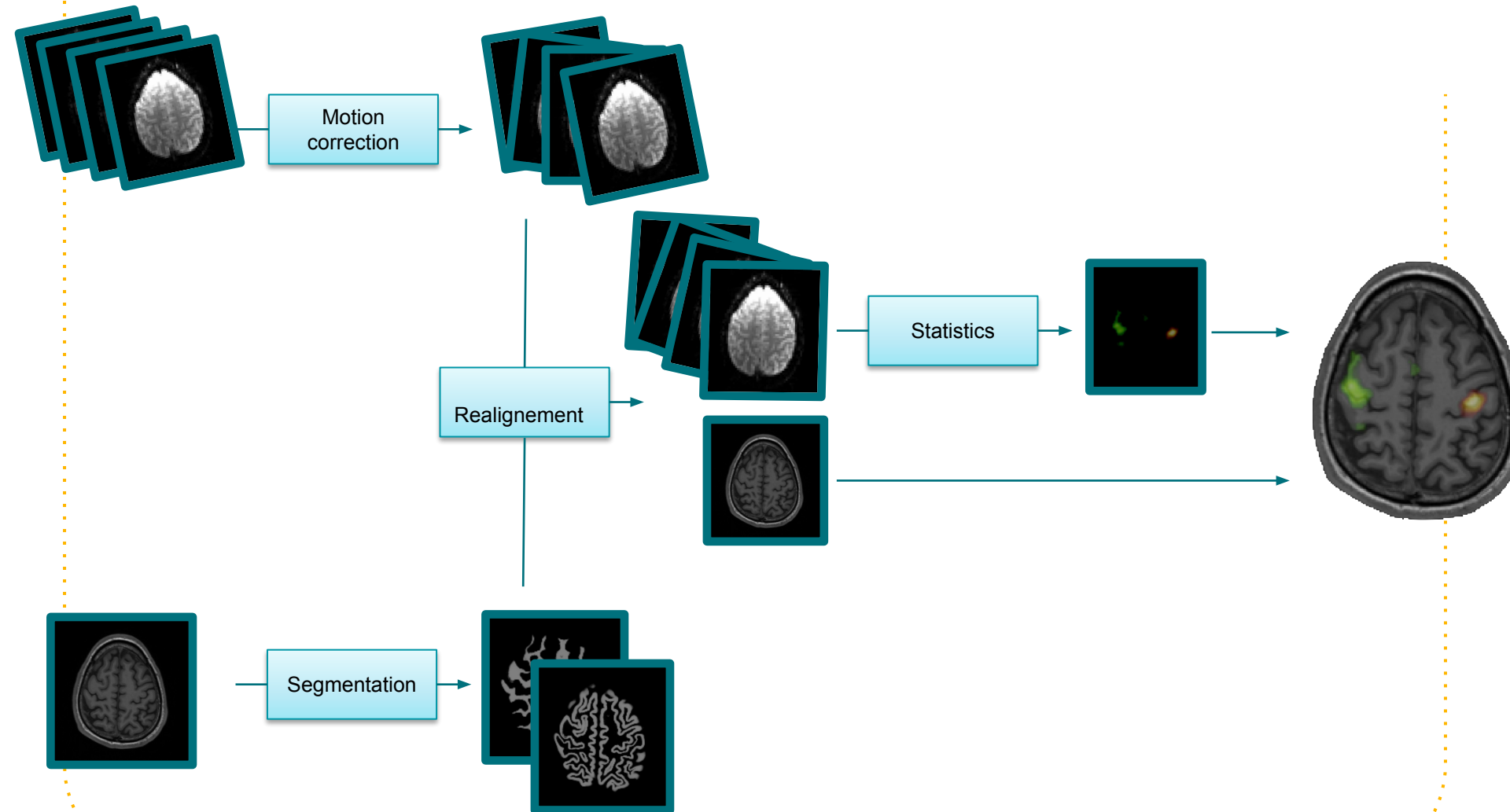
# And even more preparation...



# More preparation steps...

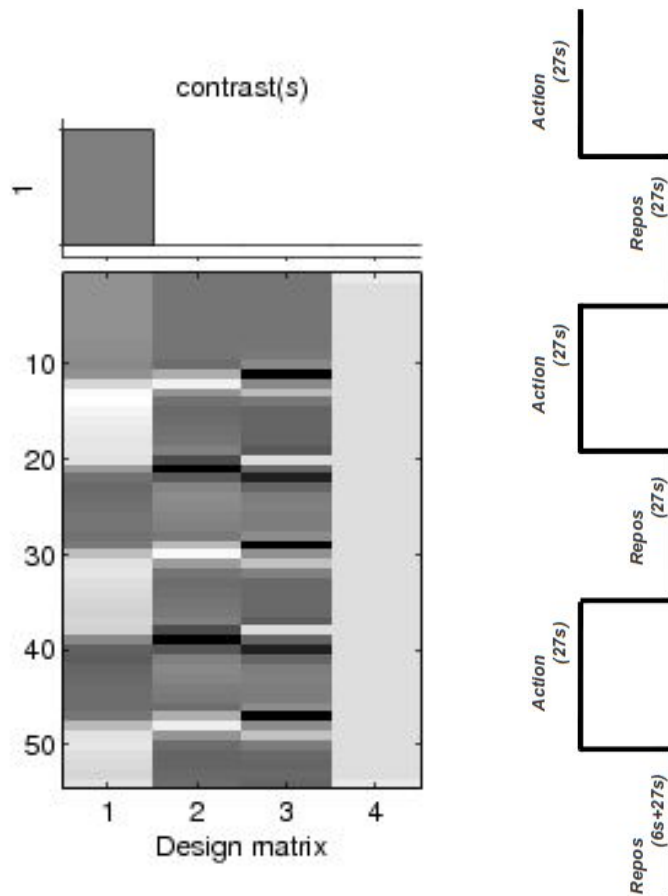


# More preparation steps...

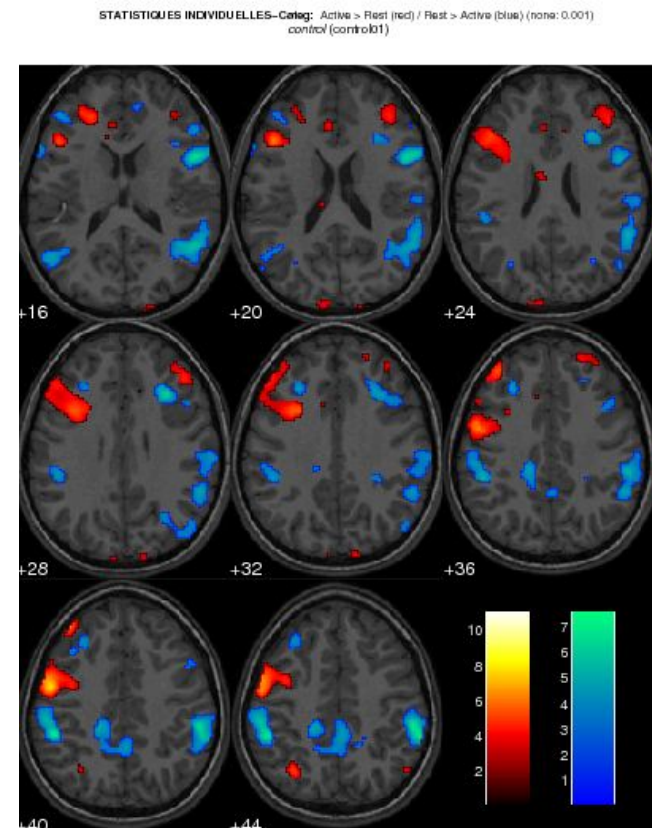


## Statistical analysis

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



Design matrix

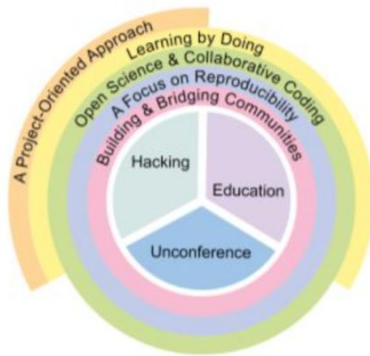




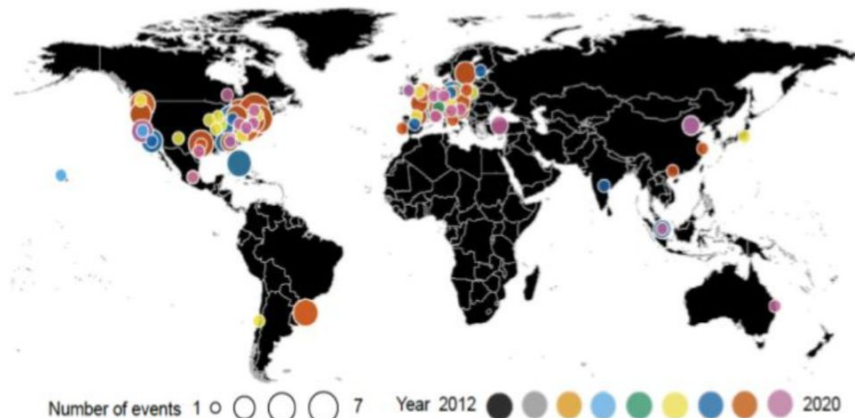
# **Collaborative and community-driven research**

# Brainhack: project-based community science

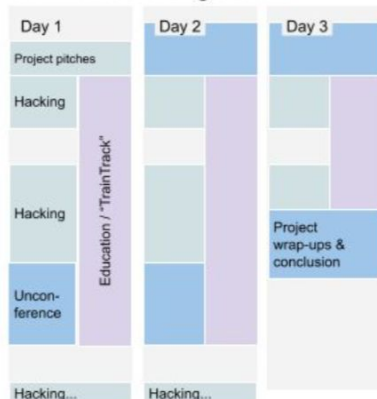
A. Anatomy of a Brainhack



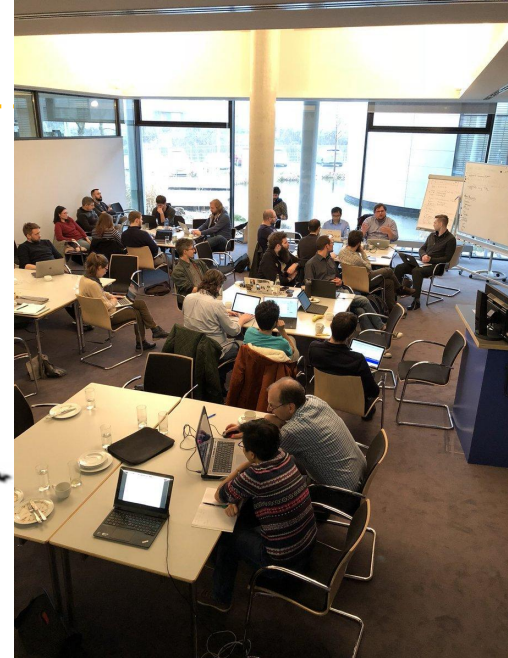
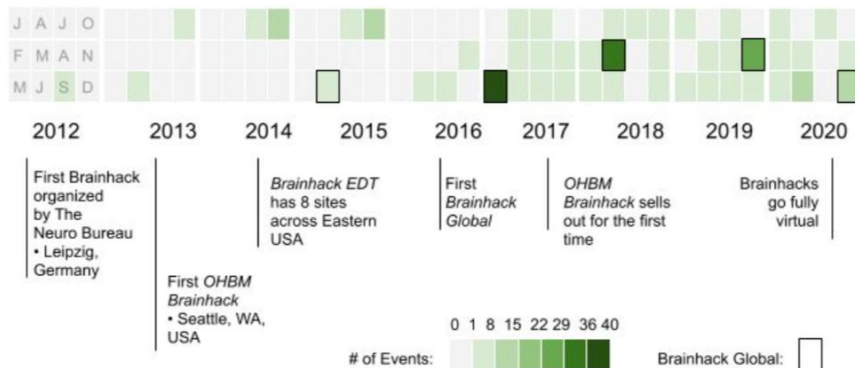
C. Brainhack Cartography



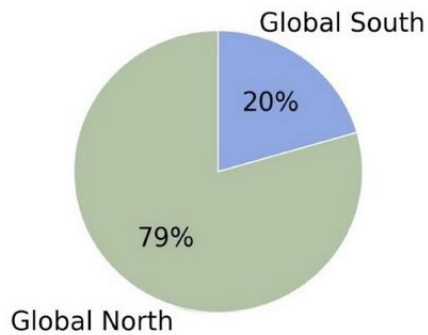
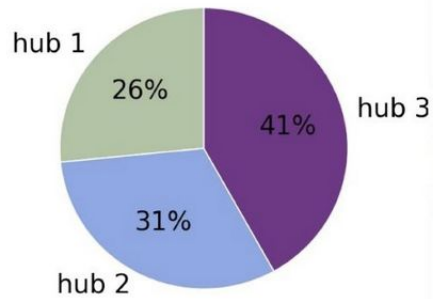
B. Timeline of a Single Event



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  
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Abstract submission open until **MAY 23**

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May 13, 2022



# An introduction to neuroinformatics

Camille Maumet

# Thank you!

