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An introduction to neuroinformatics

Camille Maumet

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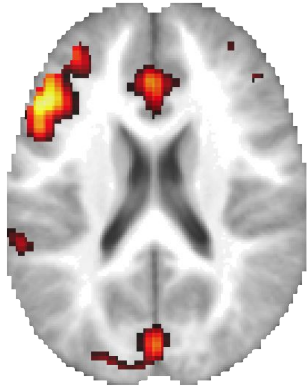
<https://inserm.hal.science/inserm-03670072v1>

Submitted on 17 May 2022

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



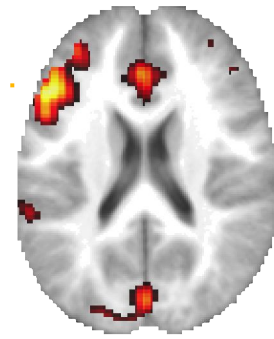
An introduction to neuroinformatics

Camille Maumet

Univ Rennes, Inria, Inserm, CNRS, IRISA



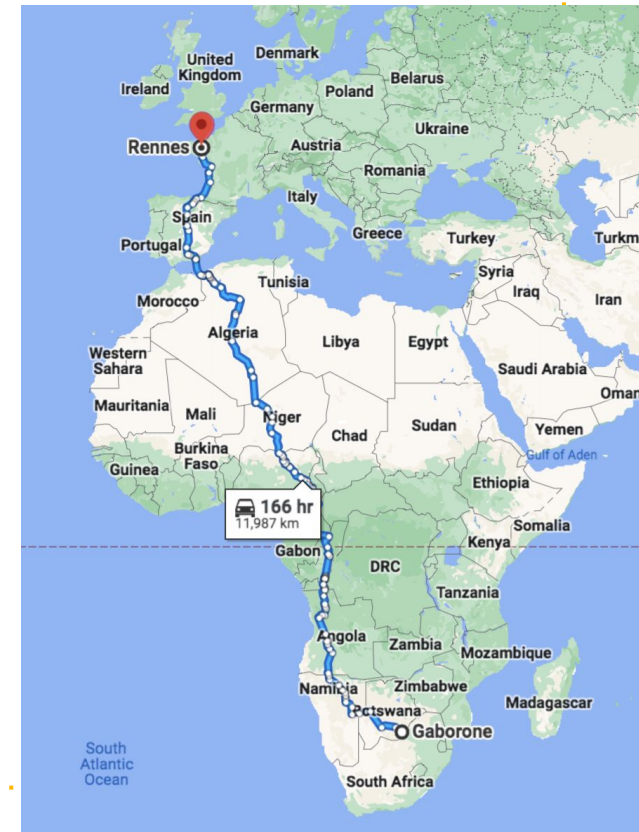
Who am I?



Neuroinformatician

Data science + brain imaging

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

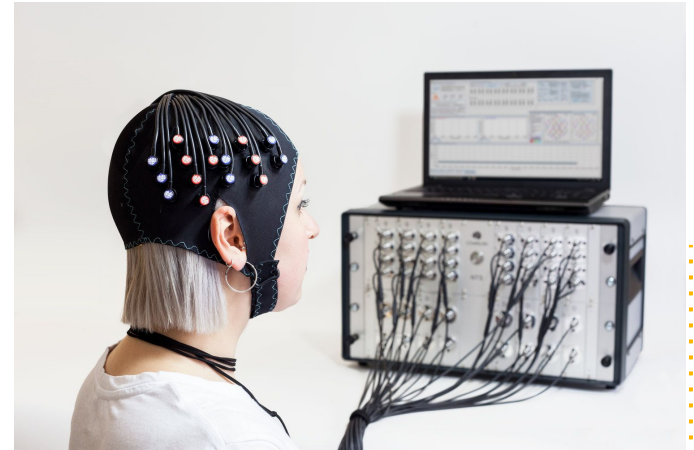


Brain imaging

Imaging the brain



Magnetic resonance imaging (MRI)



Near infrared spectroscopy (NIRS)



Electroencephalography (EEG)

Images of the brain

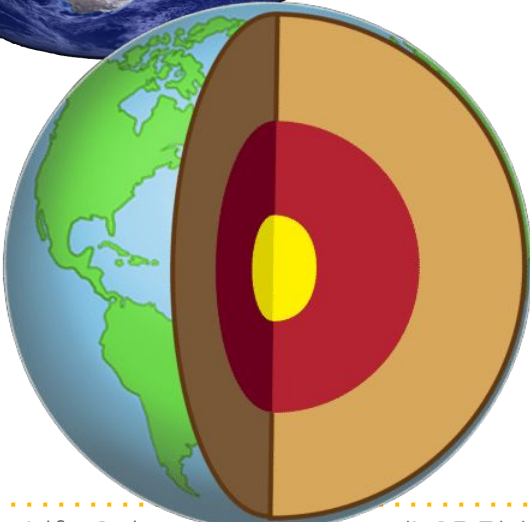
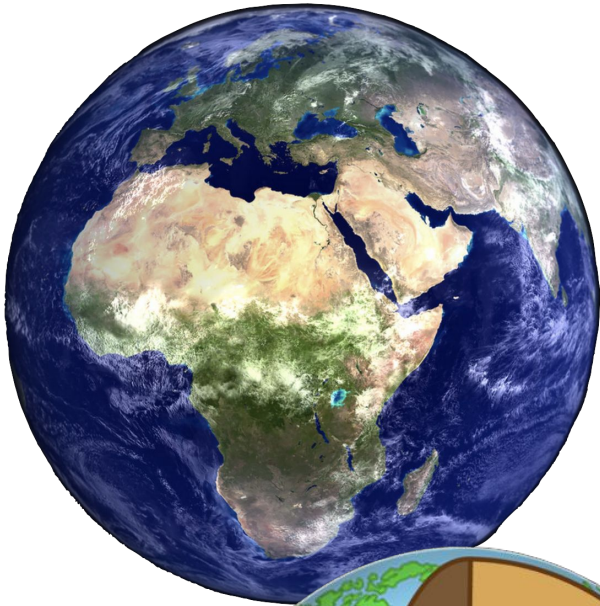


Brain images



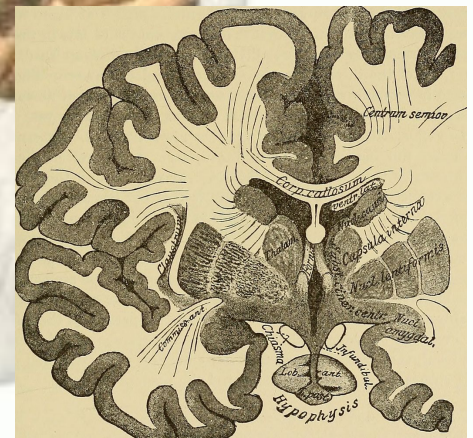
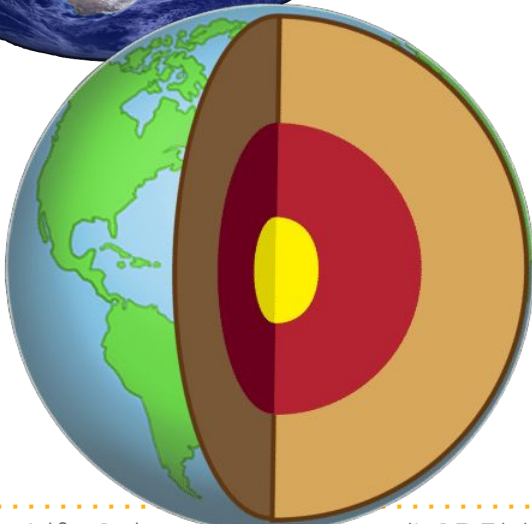
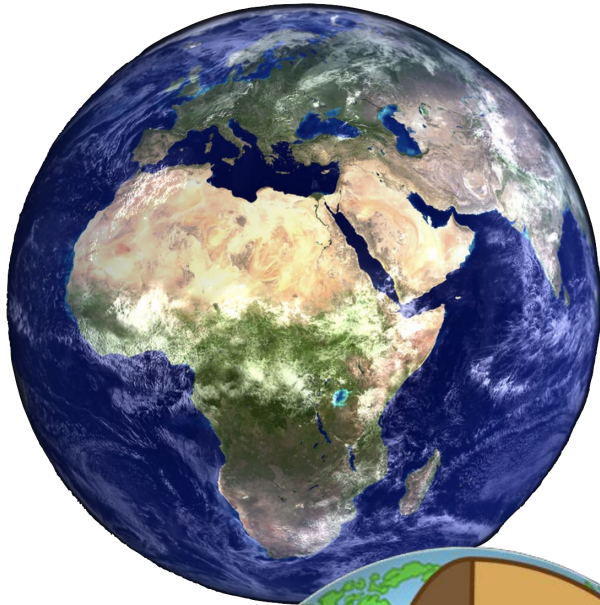
Credits: Brain, [Life Science Databases \(LSDB\)](#) (CC-BY-SA) - Globe by, Kevin Gill, [Wikipedia](#) (CC-BY-SA) - Earth layers, Domaine public / [ck12](#) - Grey and white matter, [Flickr](#), (Public Domain)

Brain images



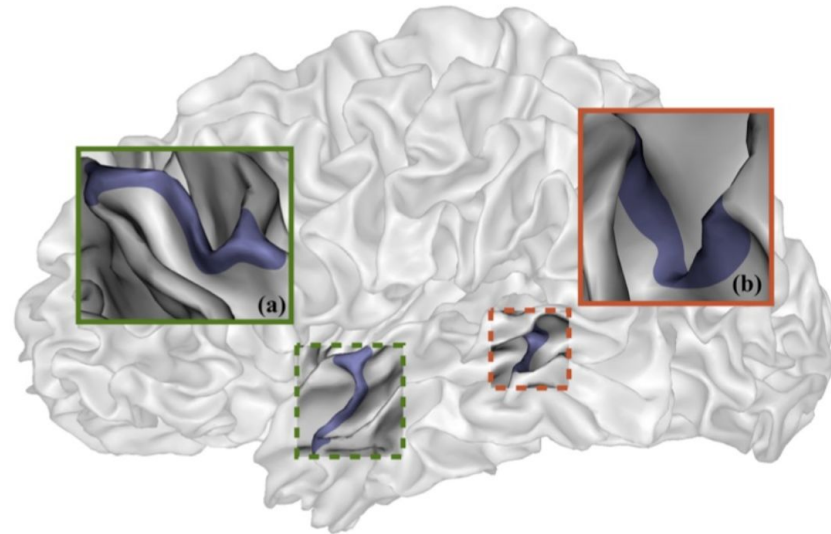
Credits: Brain, [Life Science Databases \(LSDB\)](#) (CC-BY-SA) - Globe by, Kevin Gill, [Wikipedia](#) (CC-BY-SA) - Earth layers, Domaine public / [ck12](#) - Grey and white matter, [Flickr](#), (Public Domain)

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

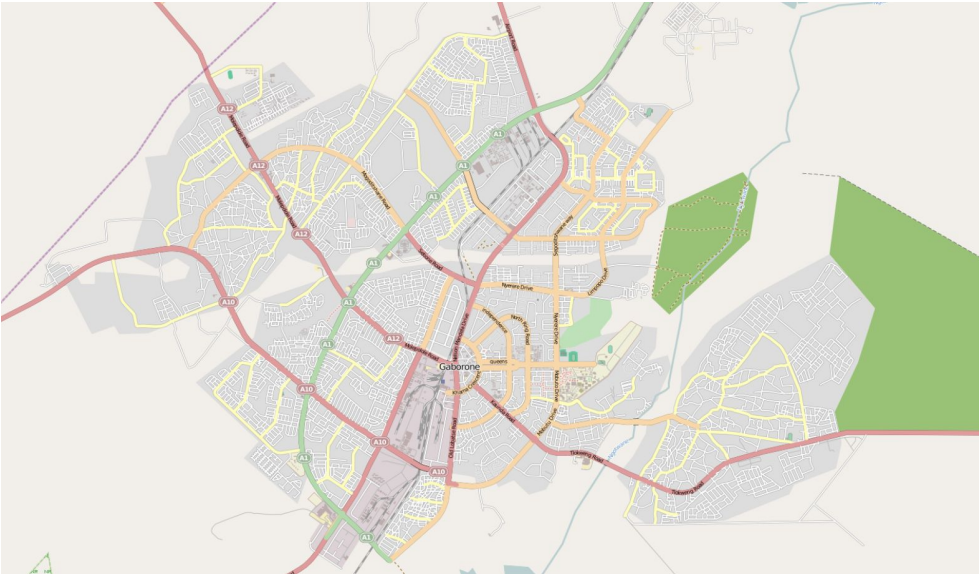
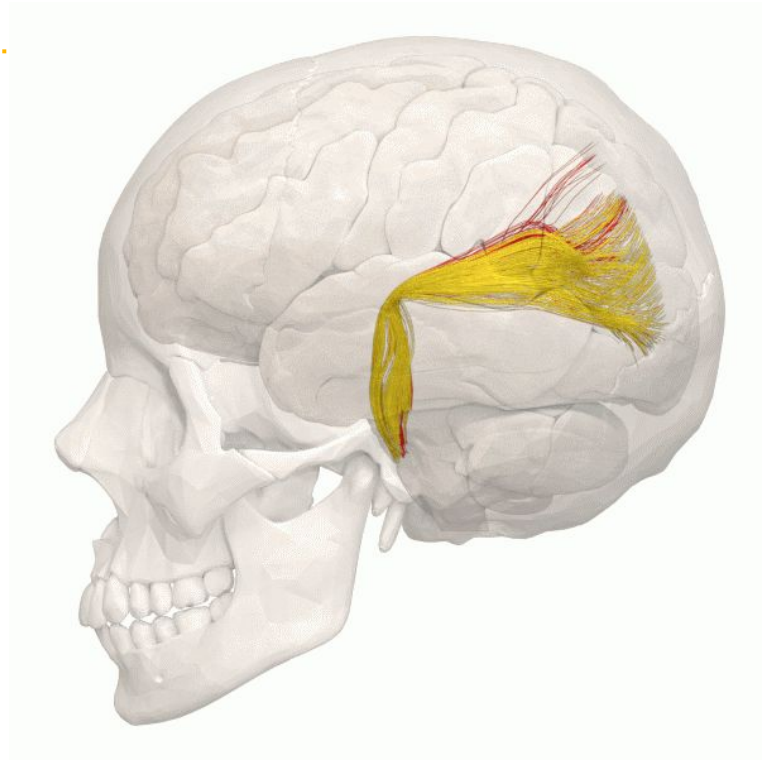


Pli de passage
(Song et al.,
2021)

Song et. al (2021)

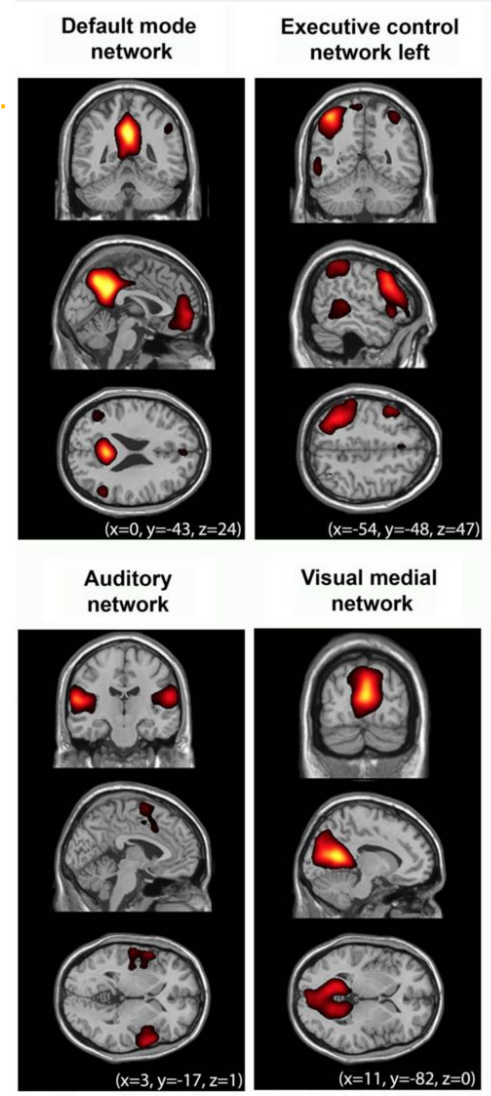
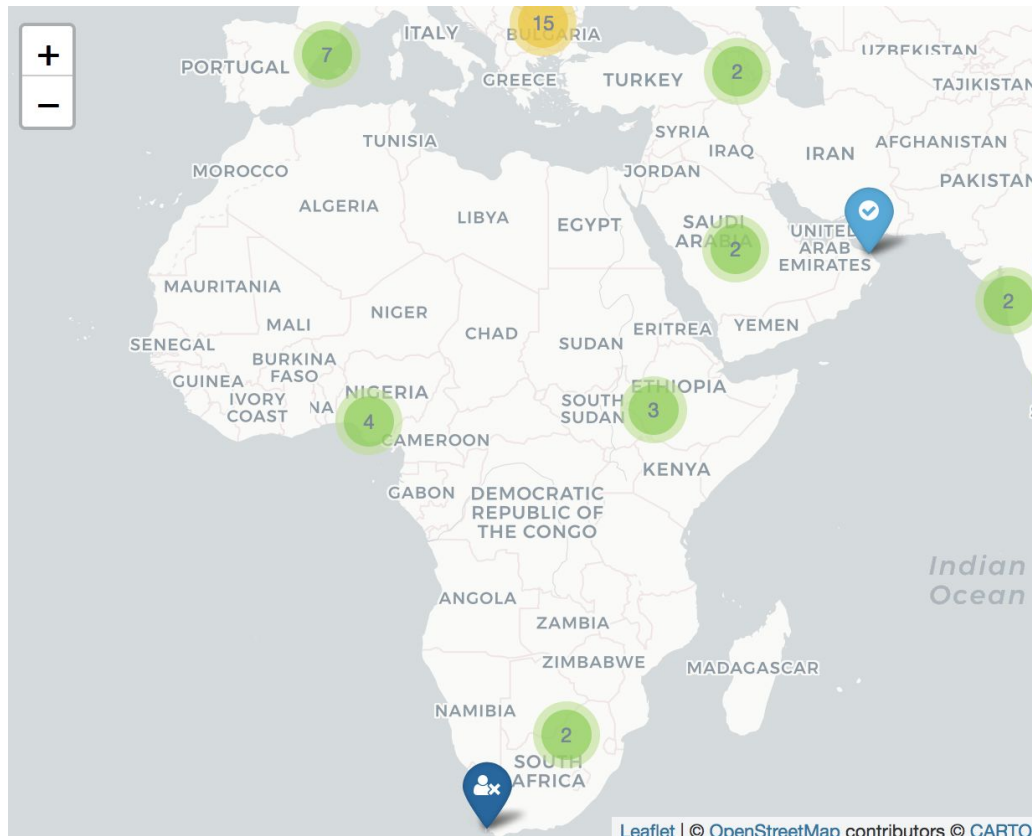


Connectivity

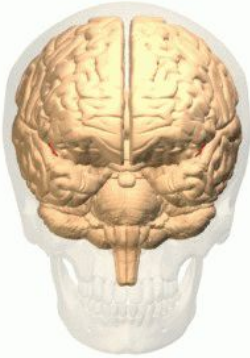


Credits: Tractography, group work [Wikipedia](#) (CC-BY-SA) - Gaborone road map by OpenStreetMap contributors, [Wikipedia](#) (CC-BY-SA).

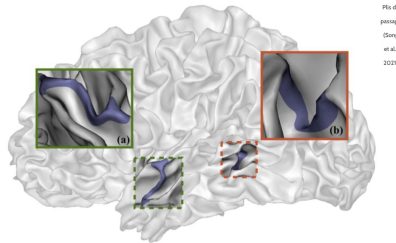
Brain function



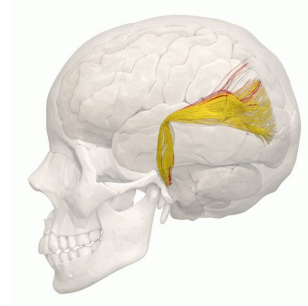
Many types of brain maps



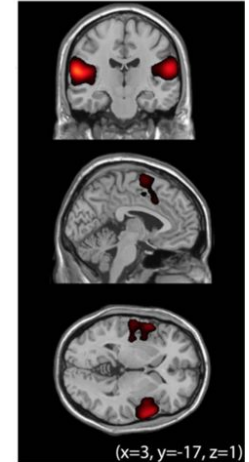
Human brain



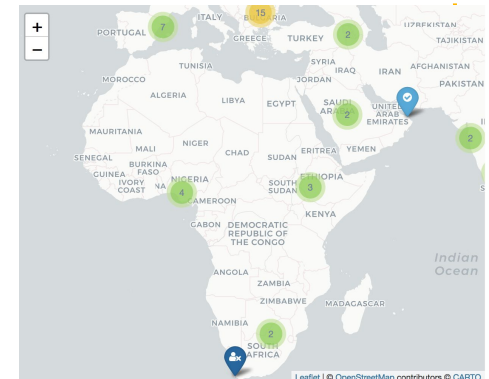
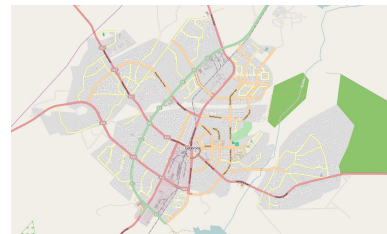
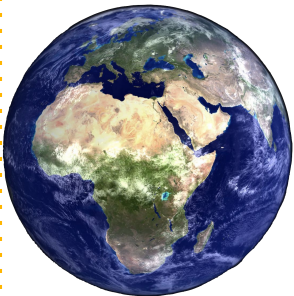
Anatomy



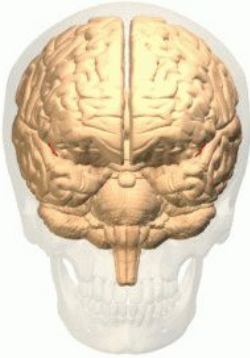
Connectivity



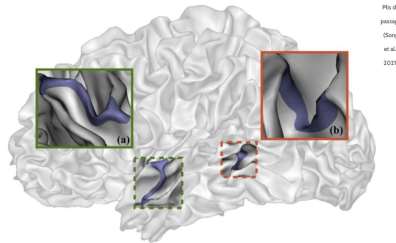
Function



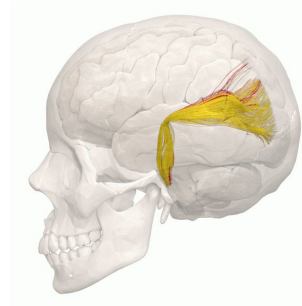
Many types of brain maps



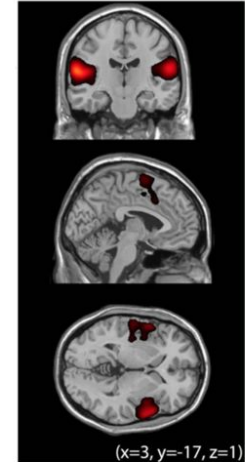
Human brain



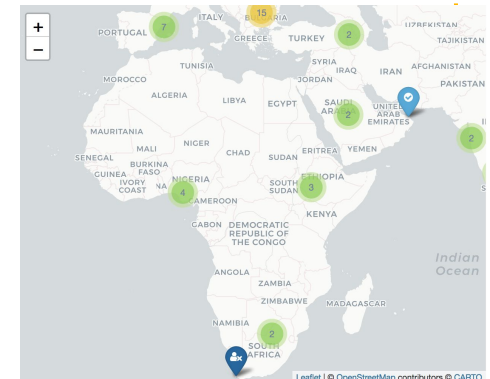
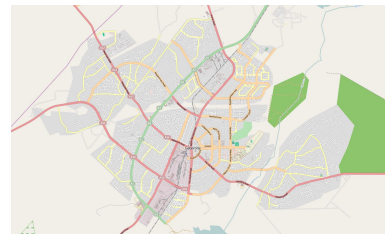
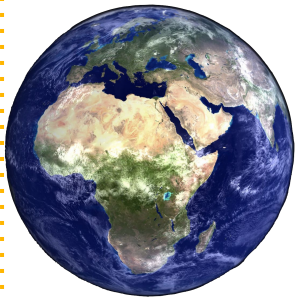
Anatomy



Connectivity



Function



Example functional MRI study

Studying developmental Language disorder

Study started in 2005 in Rennes.

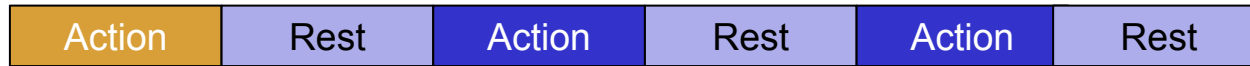
Team of clinicians and research scientists.

40 children participated.

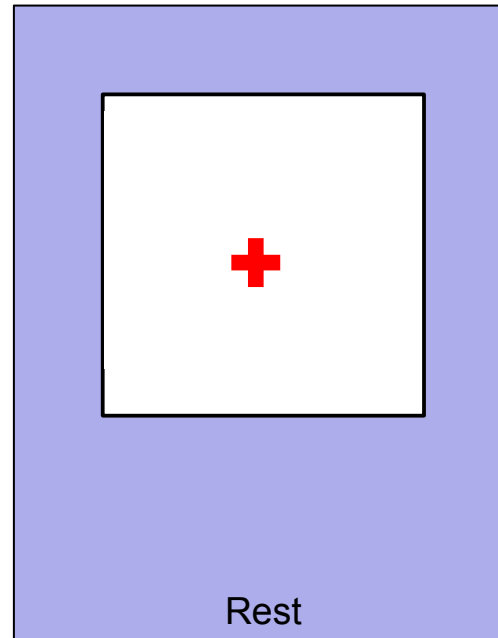
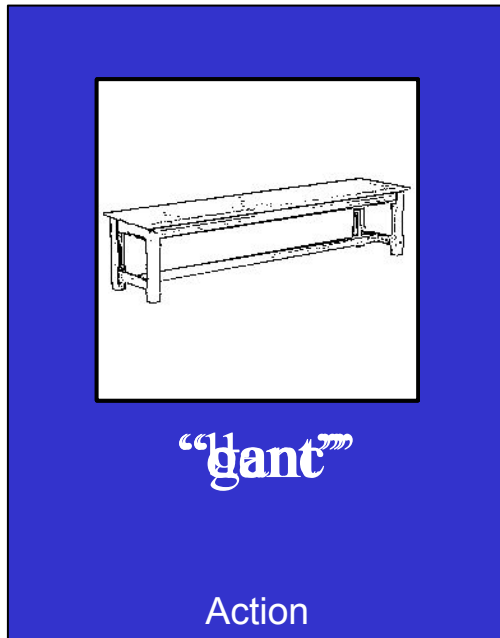
[De Guibert et. al \(2010\)](#), [De Guibert et. al \(2011\)](#)



fMRI protocol

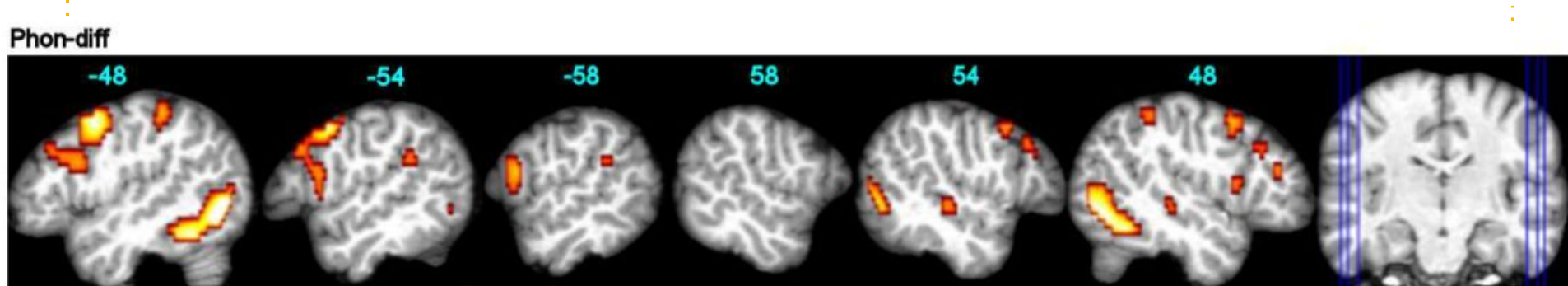


- Language paradigm using a block design

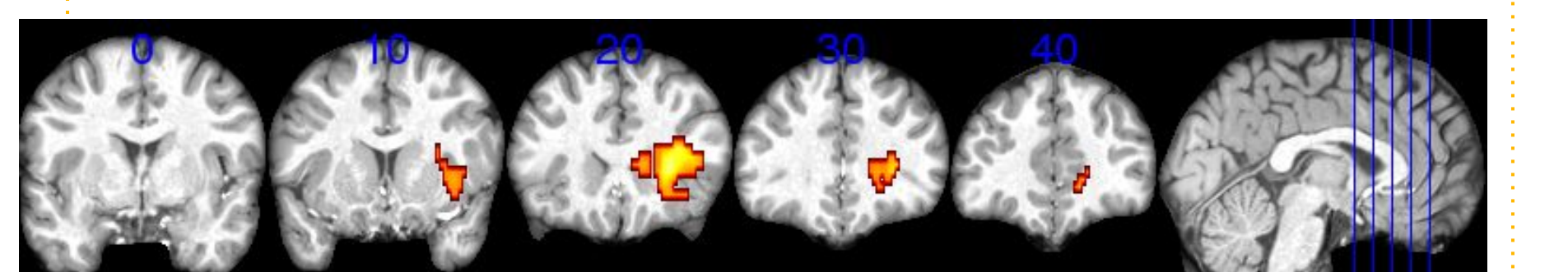


Results

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/>



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

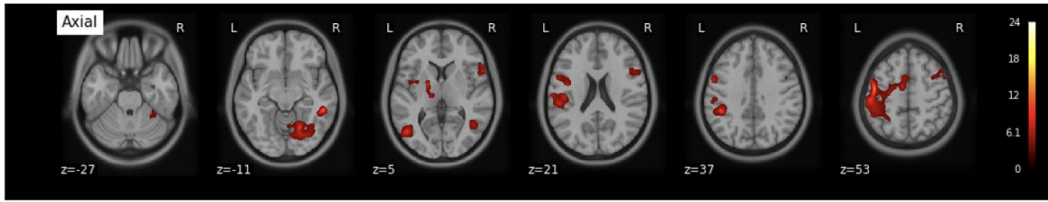
```
In [1]: from nilearn.plotting import plot_stat_map, plot_epi, plot_anat
        %matplotlib inline
```

```
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

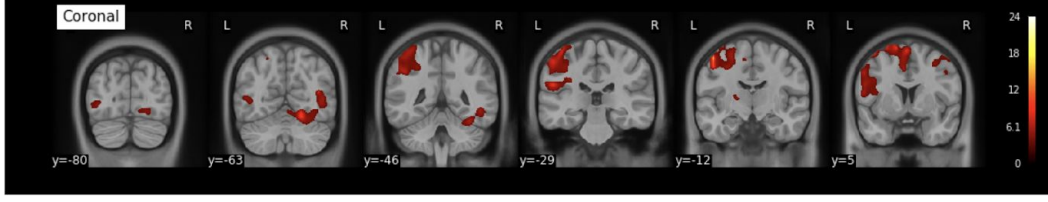
```
In [3]: plot_stat_map(act_img, title='Axial', bg_img=anat_img, display_mode='z', cut_coords=(range(-27,69,16)));
```



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

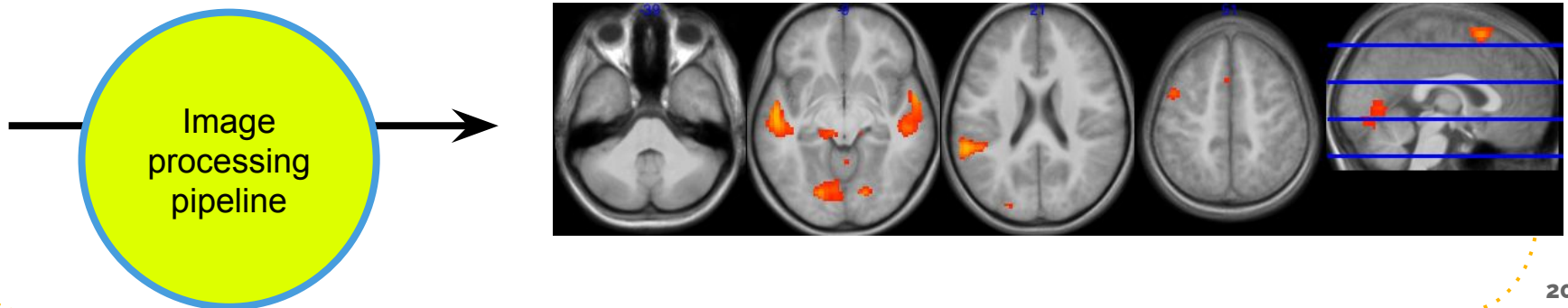
```
In [5]: plot_stat_map(act_img, title='Sagittal', bg_img=anat_img, display_mode='x', cut_coords=(range(-49,52,17)));
```

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

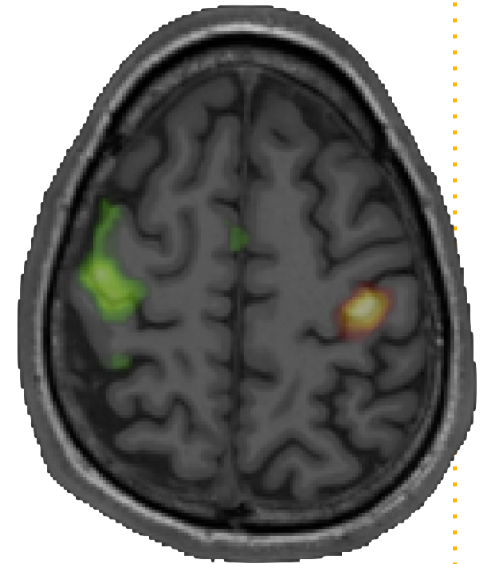
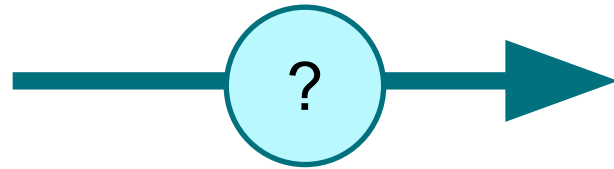
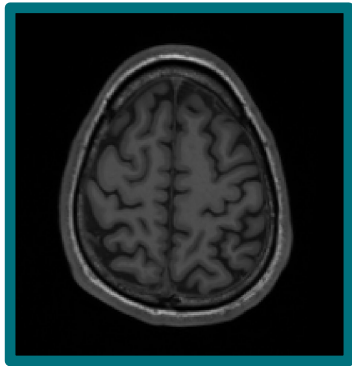
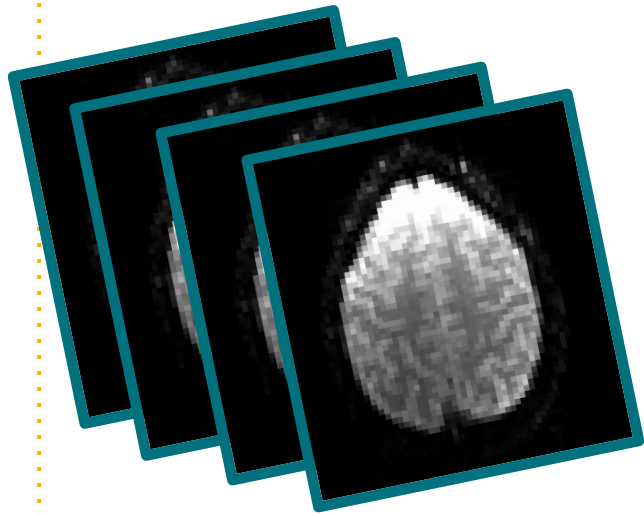
Functional MRI: raw data



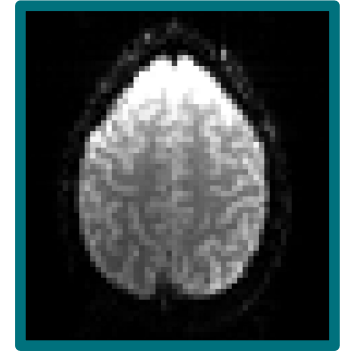
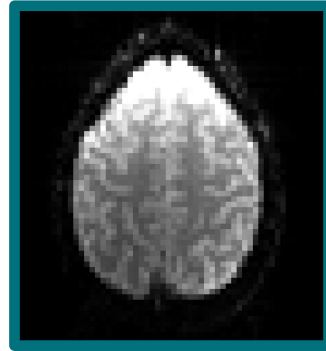
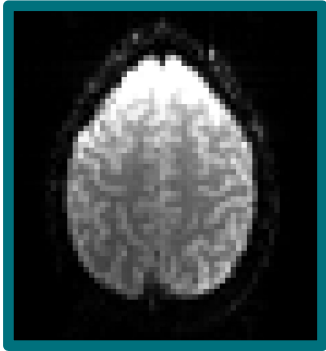
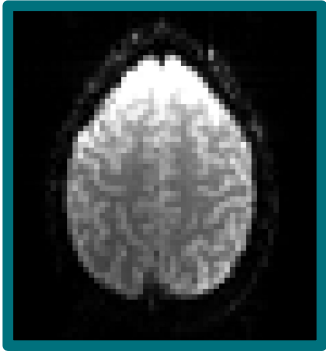
- 64 brain volumes / subject / paradigm



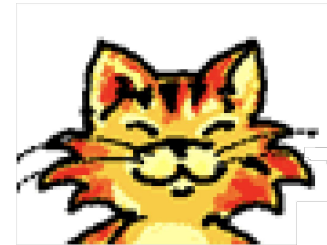
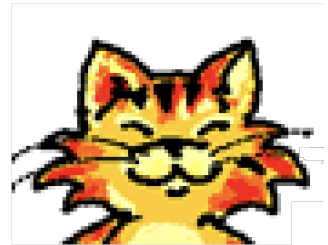
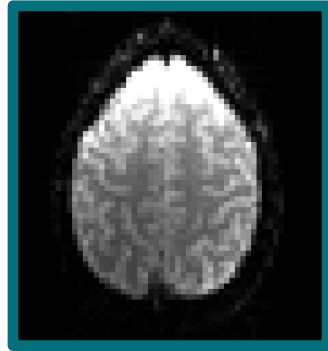
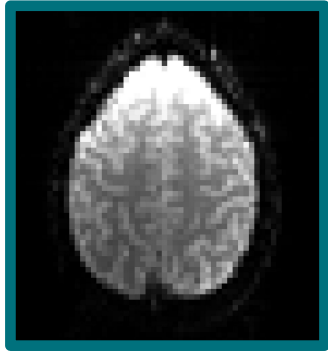
Data analysis



Motion correction



Motion correction



Motion correction



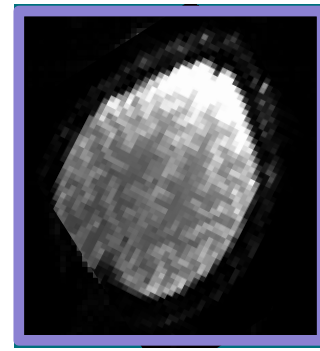
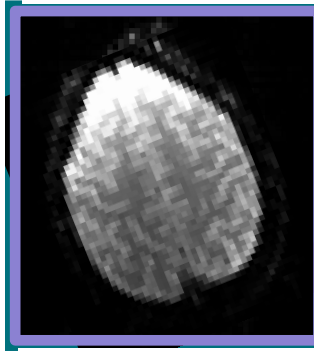
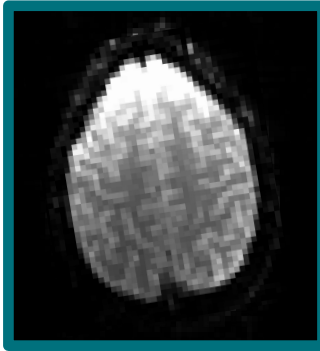
Motion correction



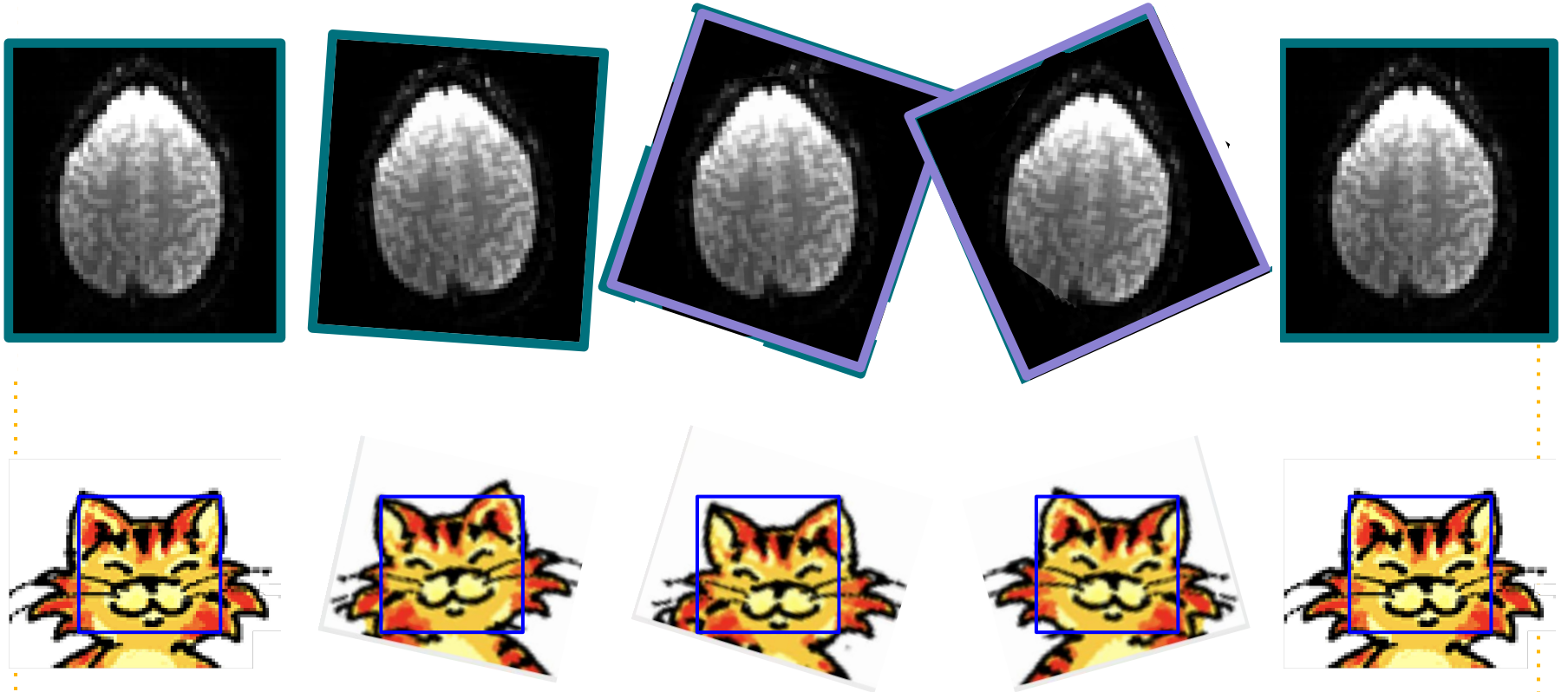
Motion correction



Motion correction



Motion correction



Motion correction

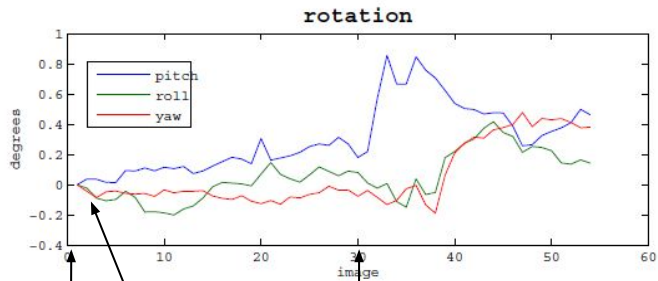
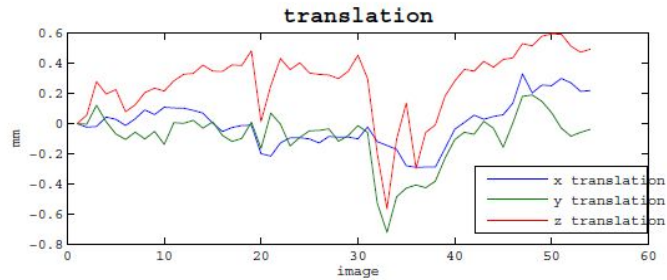
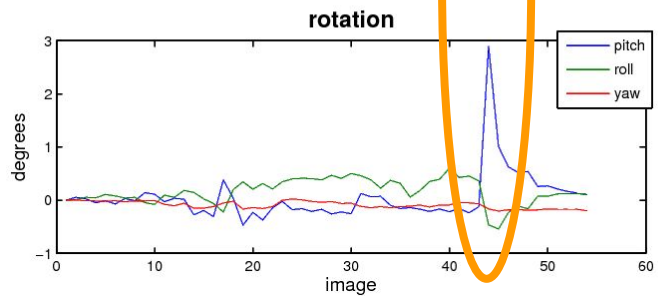
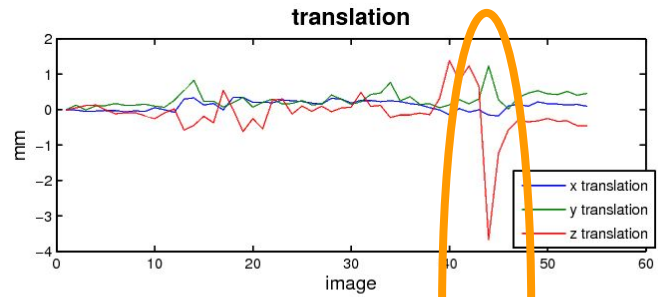


Image 1
Image 2

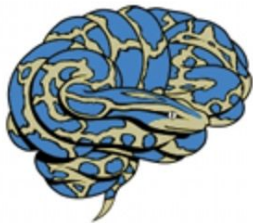
Image 30



Demo : motion correction

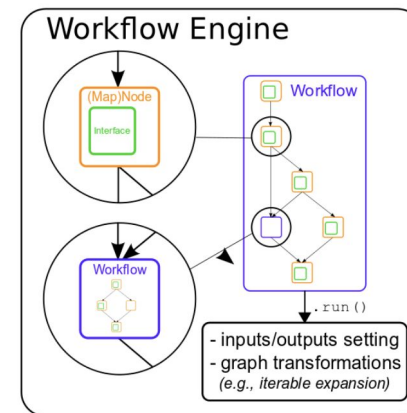
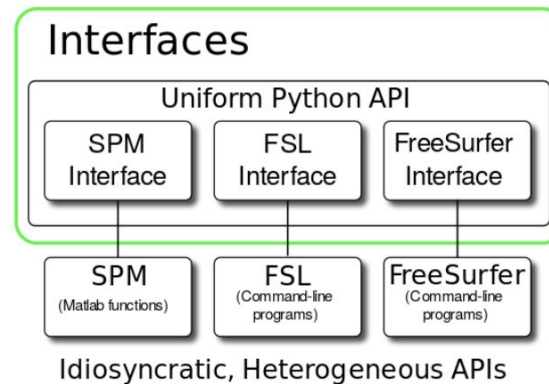


<https://www.fil.ion.ucl.ac.uk/spm/>



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_re...`. The Jupyter interface includes a menu bar (File, Edit, View, Insert, Cell, Kernel, Widgets, Help), a toolbar with icons for file operations and execution, and a code editor. The code editor contains the following Python code:

```
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"

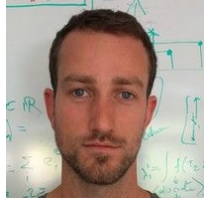
In [7]: os.listdir(raw_dir)

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

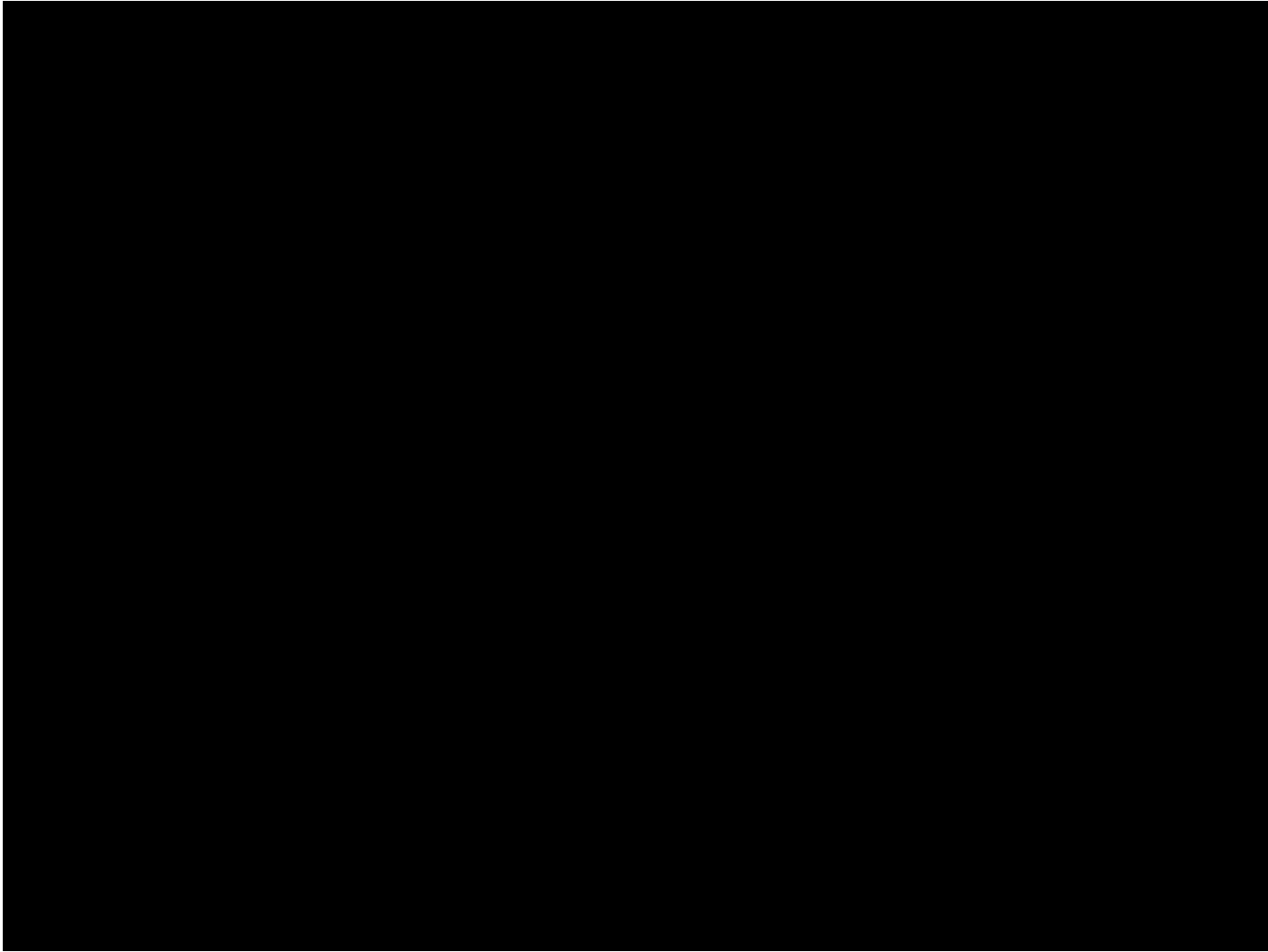
In [8]: # NODE AND TEMPLATE FOR SELECTING FILES
        anat_file = os.path.join('Structural', 'sM03953_0007.img')
        func_file = os.path.join('RawEPI', 'sM03953_0005_*.img')

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


Motion correction

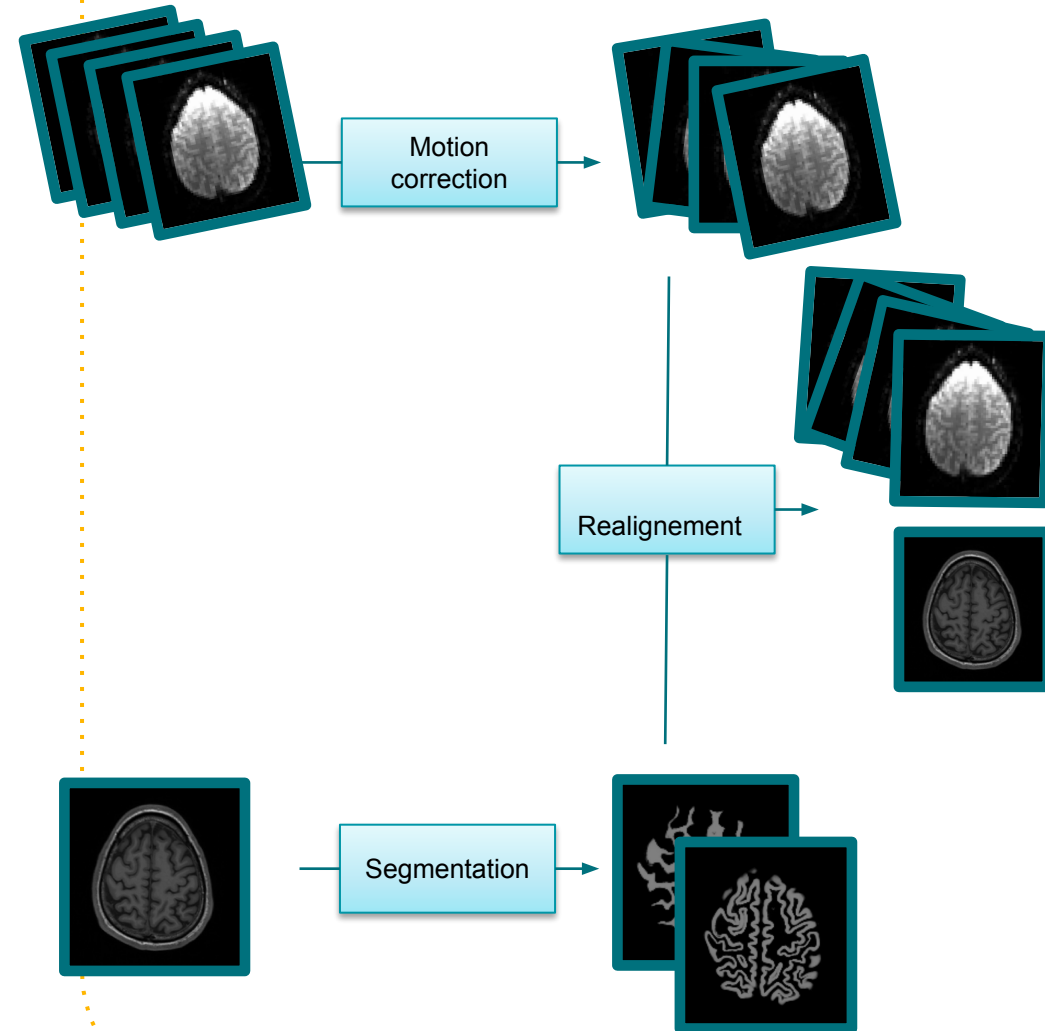


Quentin
Duché



Credits: Video by Quentin Duché, Empenn.

More preparation steps...



Demo : Preprocessing



Elodie Germani

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



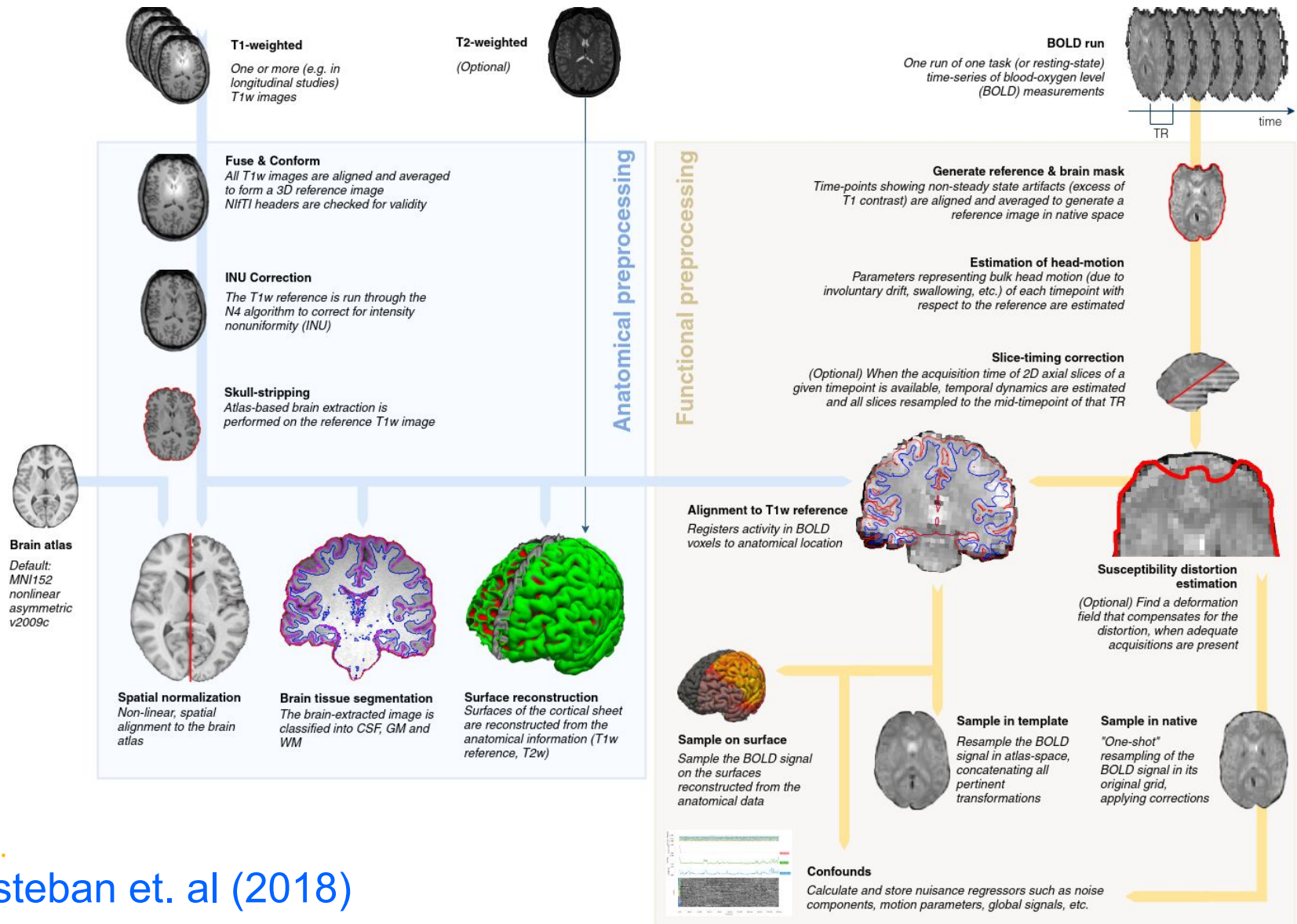
<https://www.fil.ion.ucl.ac.uk/spm/>



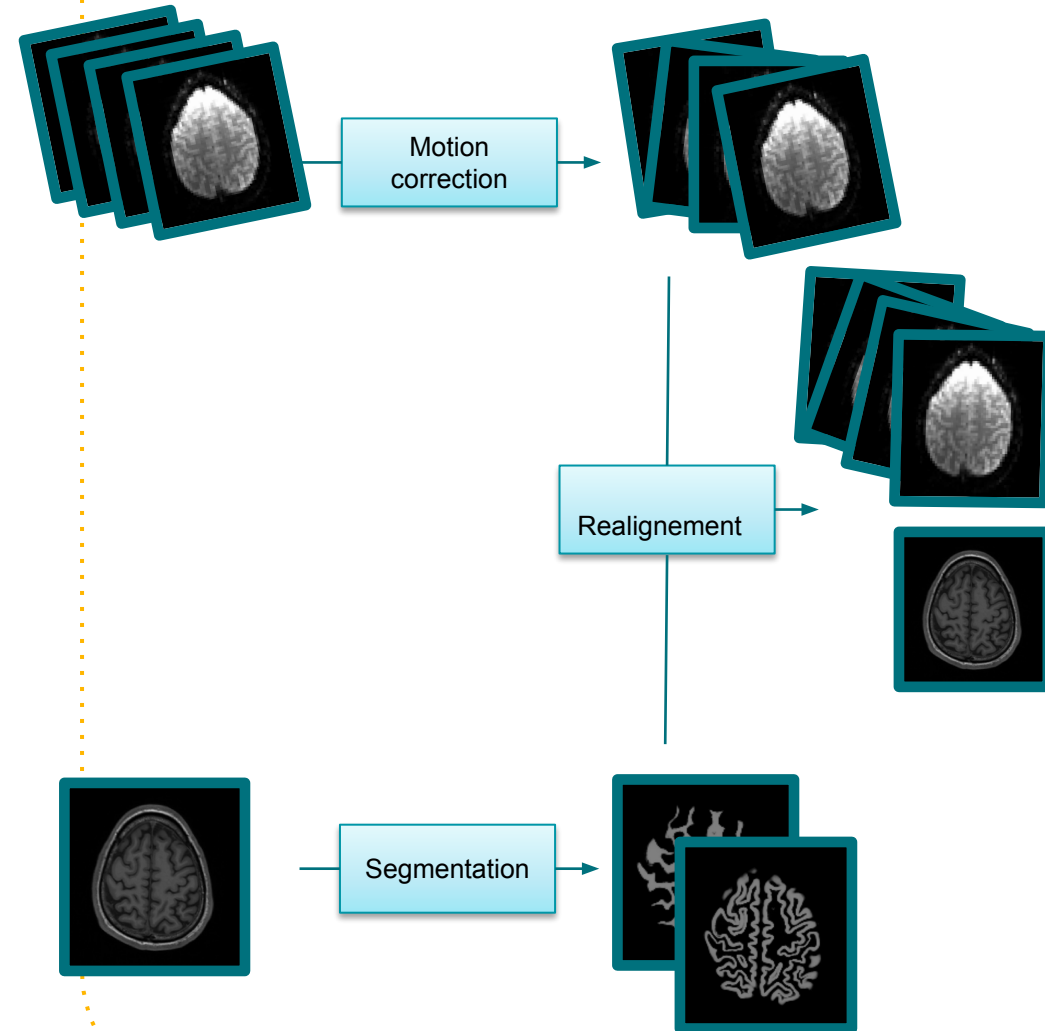
Nipype:
Neuroimaging in Python
Pipelines and Interfaces

<https://nipype.readthedocs.io>

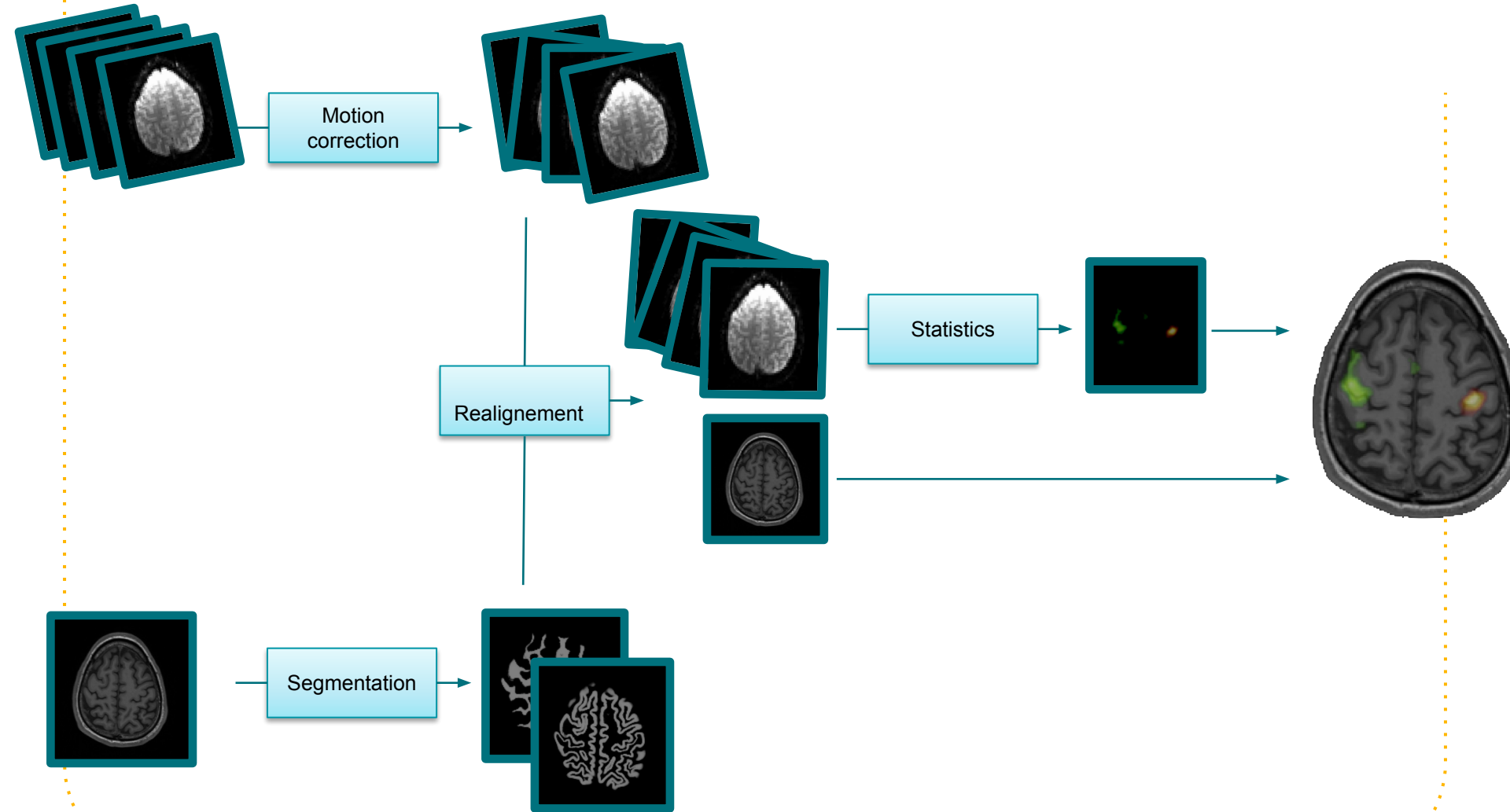
And even more preparation...



More preparation steps...

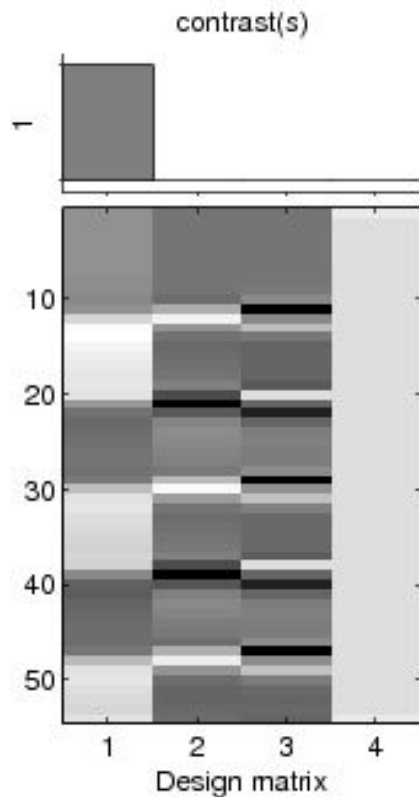


More preparation steps...

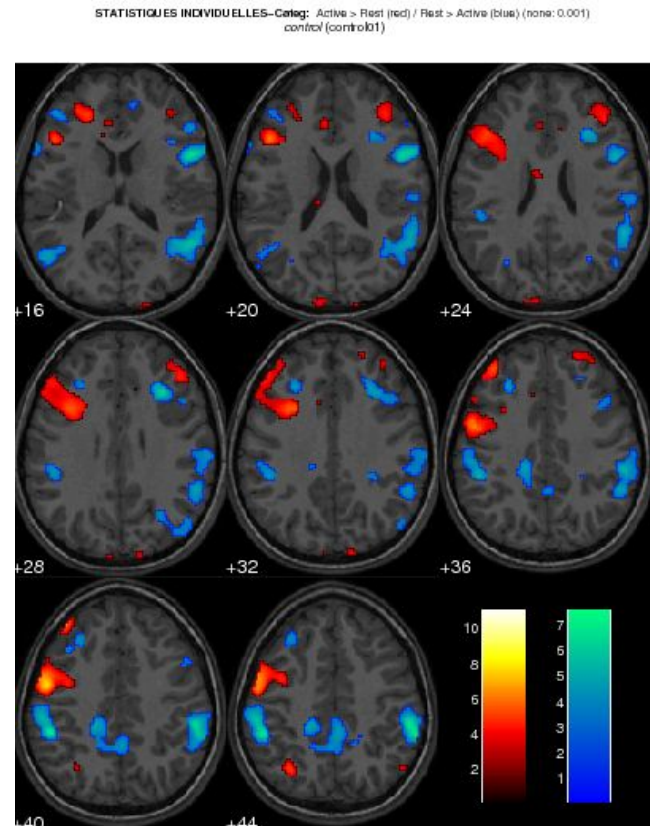
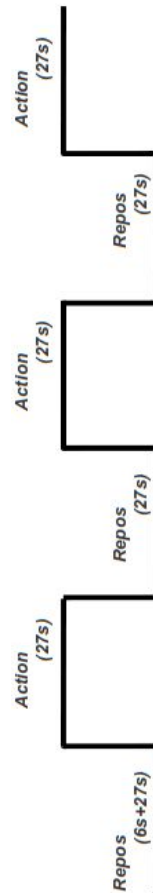


Statistical analysis

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



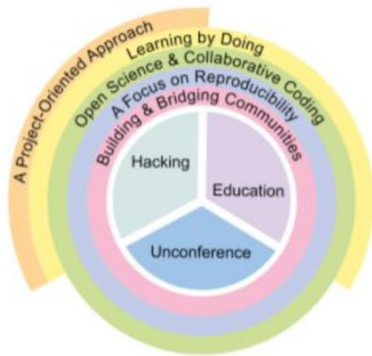
Design matrix



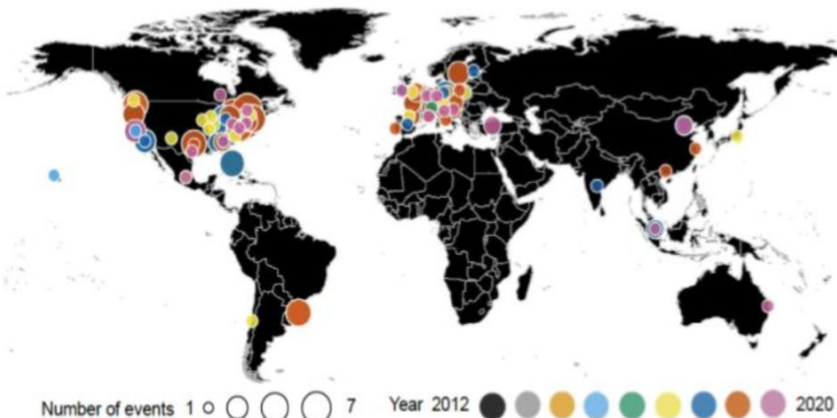
**Collaborative and
community-driven
research**

Brainhack: project-based community science

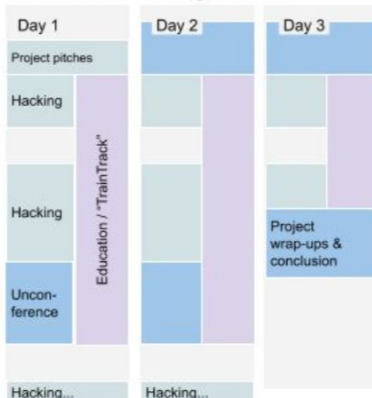
A. Anatomy of a Brainhack



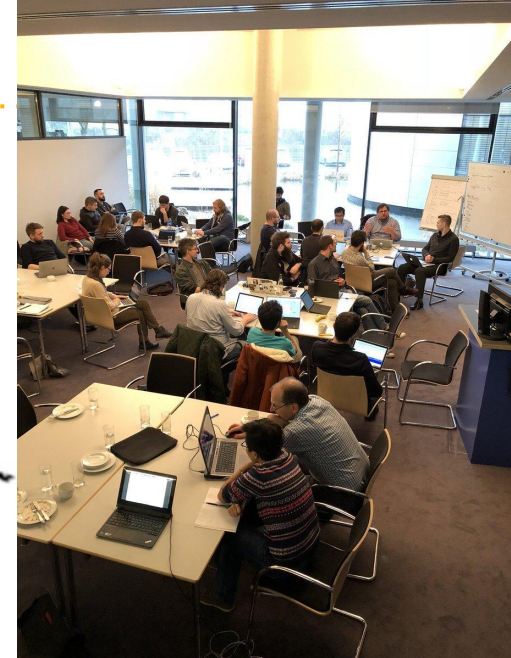
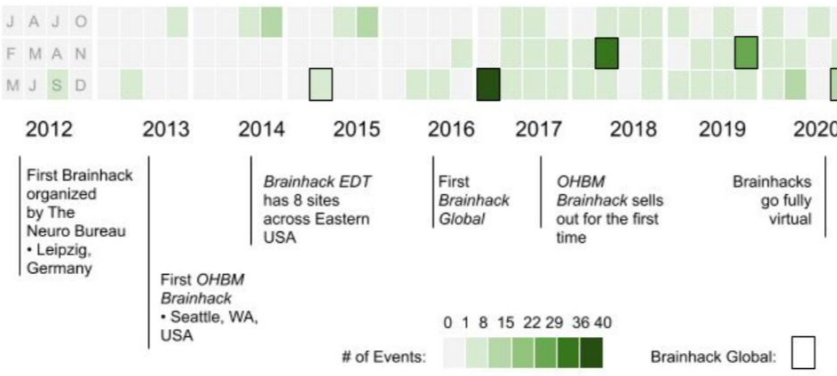
C. Brainhack Cartography



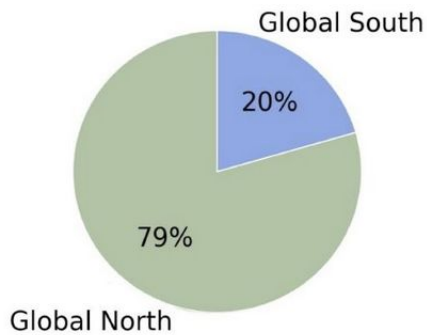
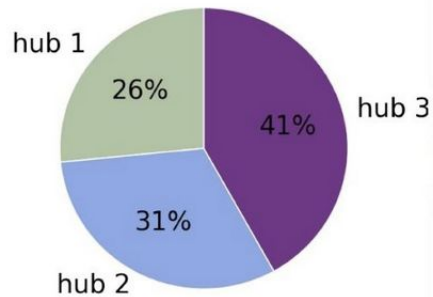
B. Timeline of a Single Event



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

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May 13, 2022



An introduction to neuroinformatics

Camille Maumet

Thank you!

