



## An introduction to neuroinformatics

Camille Maumet

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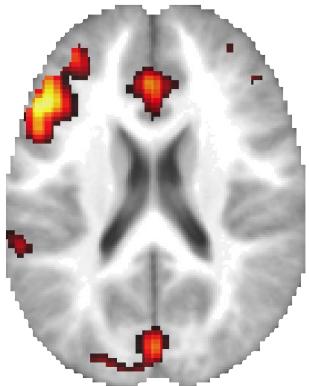
HAL Id: inserm-03670072

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Submitted on 17 May 2022

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# An introduction to neuroinformatics

Camille Maumet

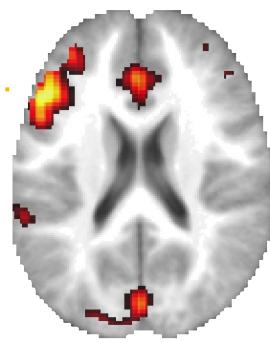
Univ Rennes, Inria, Inserm, CNRS, IRISA

# Who am I?

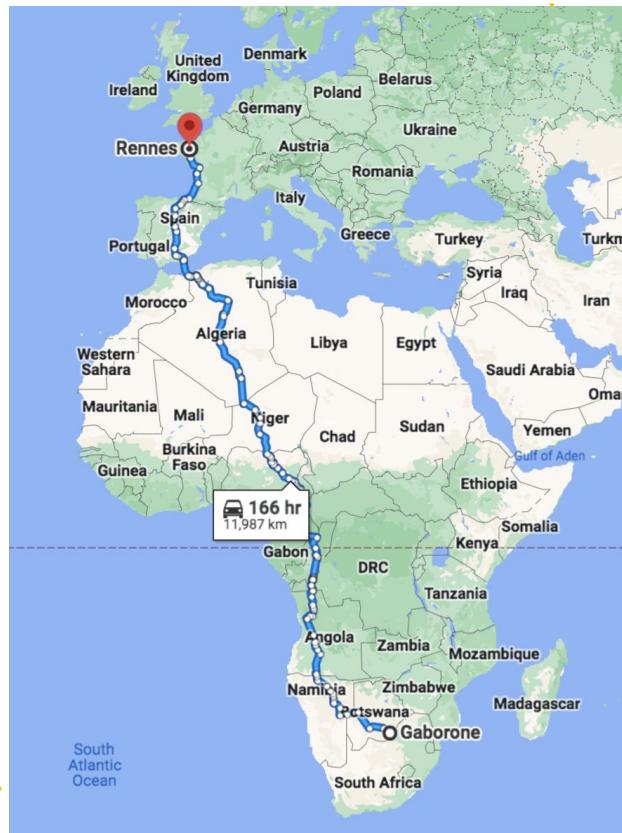


Neuroinformatician

- Data science + brain imaging
- PhD in computer science applied to neuroimaging data analysis
- Rennes (France)



IRISA



# Brain imaging

# Imaging the brain



Magnetic resonance imaging (MRI)



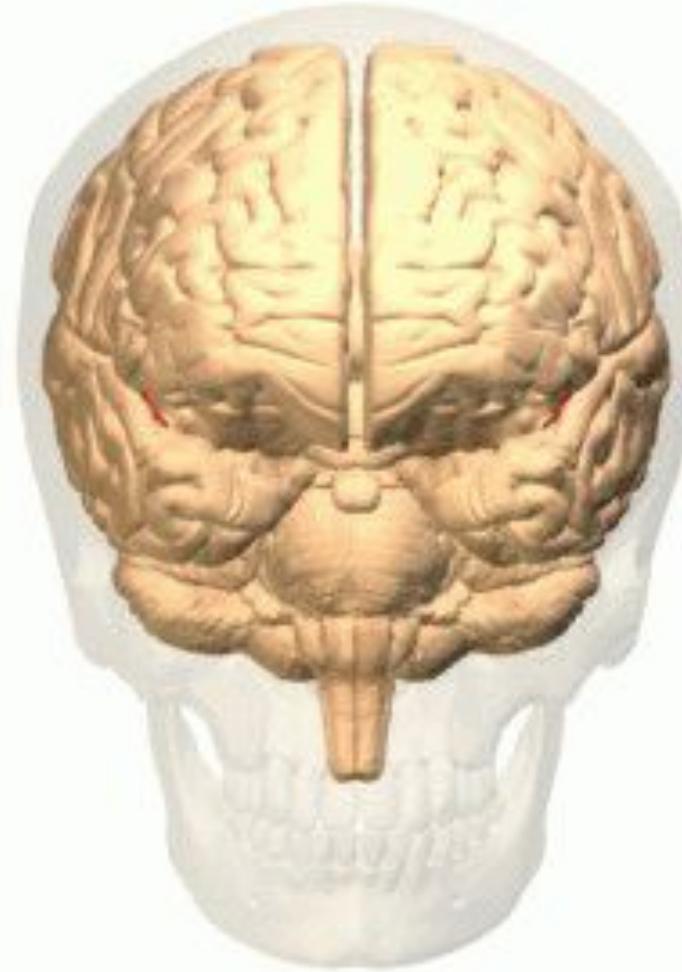
Near infrared spectroscopy (NIRS)



Electroencephalography (EEG)

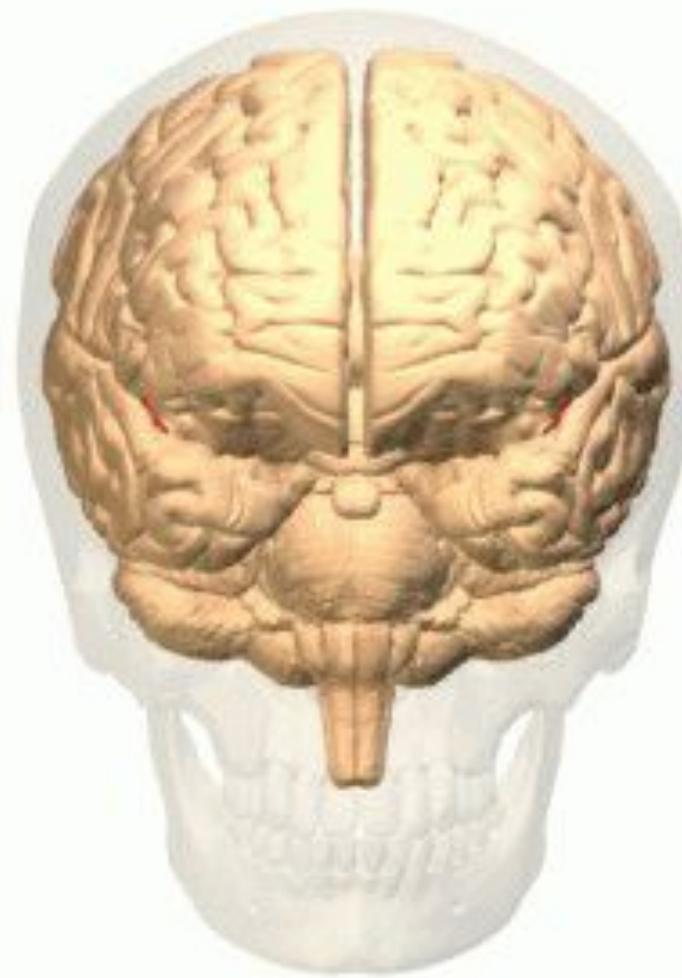
Credits: MRI, [Neurinfo](#) - NIRS, [Elisenicolegray](#) (CC BY-SA) - EEG, [Neurospin](#).

# Images of the brain



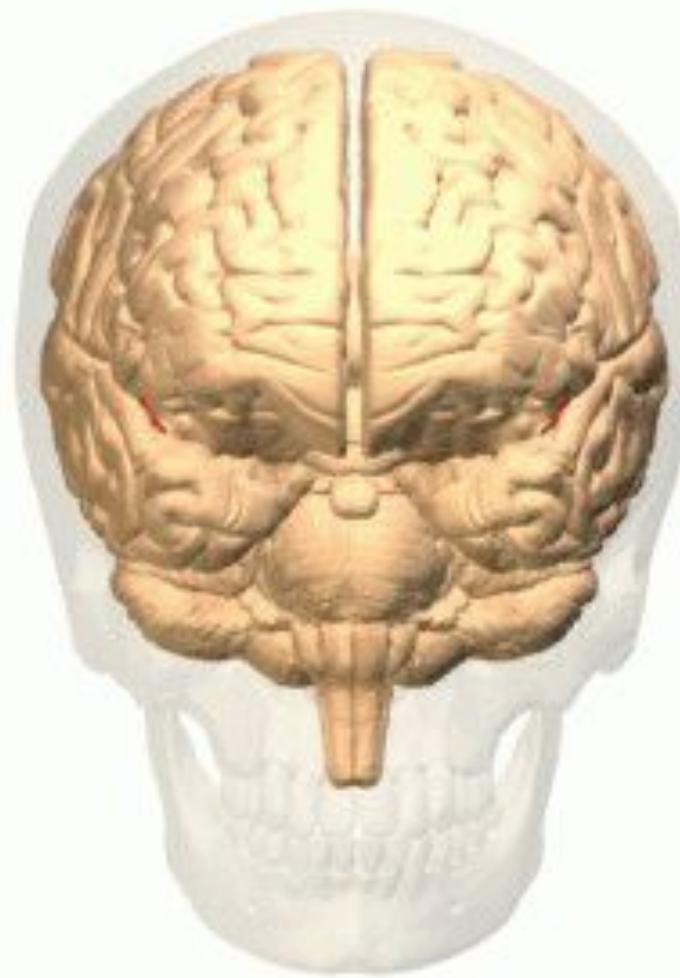
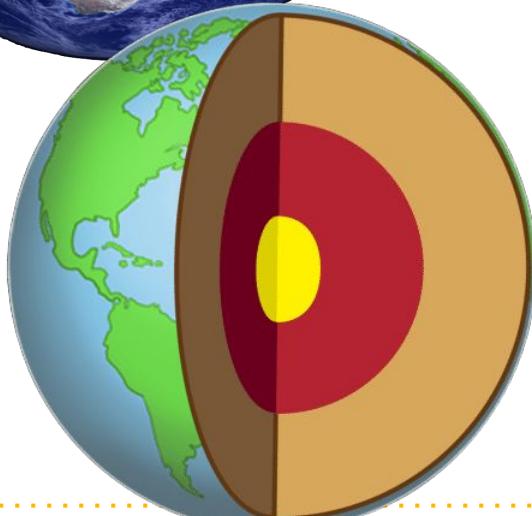
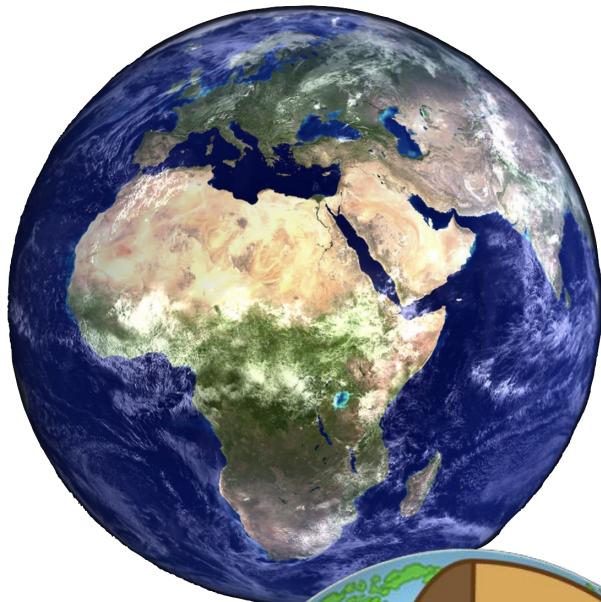
Credits: Brain, [Life Science Databases \(LSDB\)](#) (CC-BY-SA) - Globe by, Kevin Gill, [Wikipedia](#) (CC-BY-SA) - Earth layers, Domaine public / [ck12](#) - Grey and white matter, [Flickr](#), (Public Domain)

# Brain images



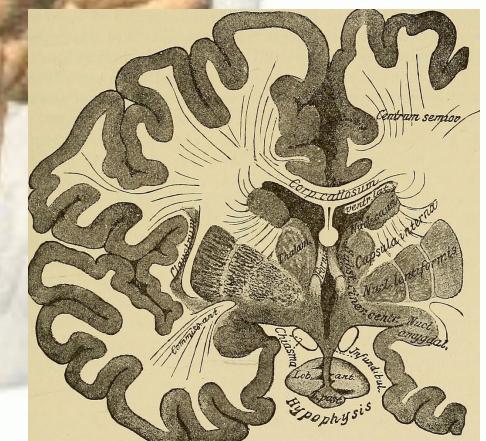
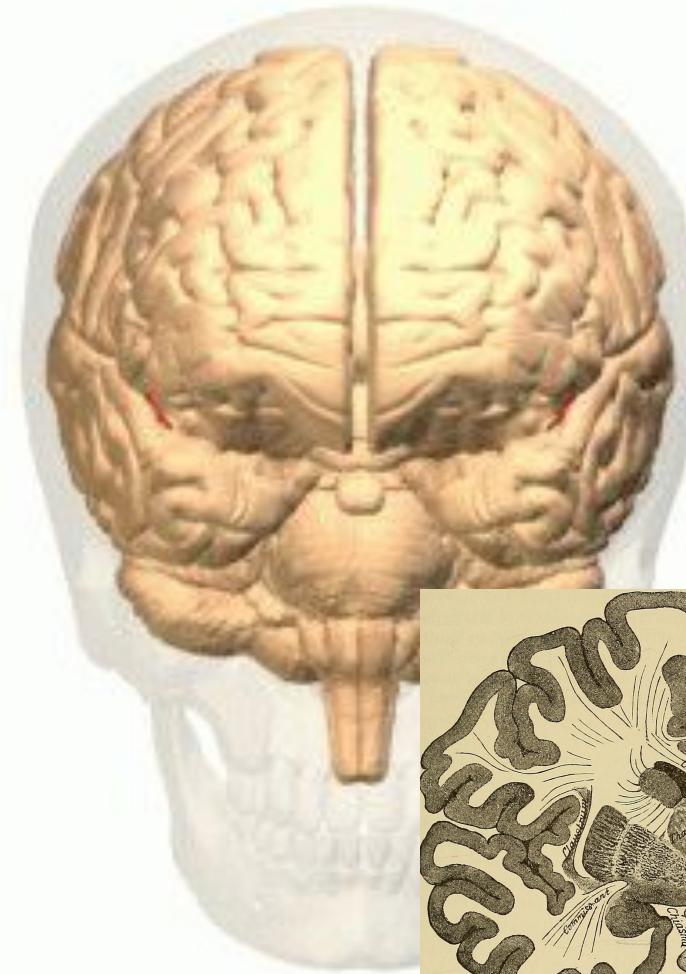
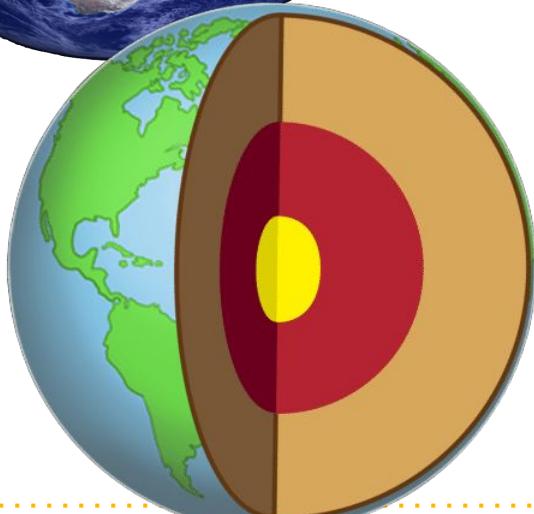
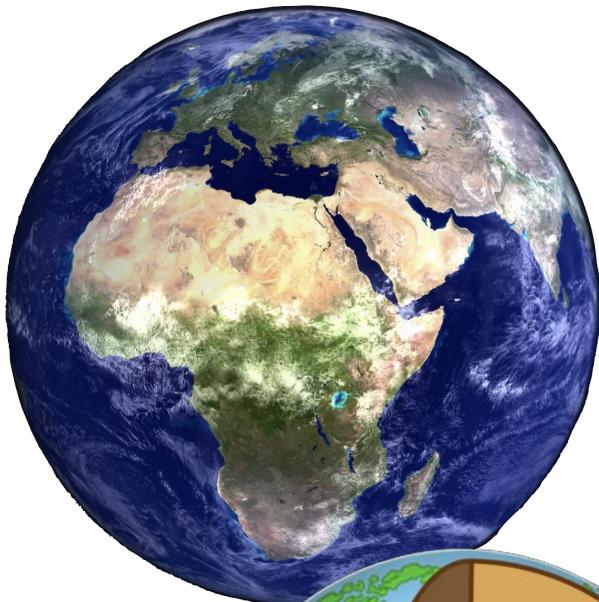
Credits: Brain, [Life Science Databases \(LSDB\)](#) (CC-BY-SA) - Globe by, Kevin Gill, [Wikipedia](#) (CC-BY-SA) - Earth layers, Domaine public / [ck12](#) - Grey and white matter, [Flickr](#), (Public Domain)

# Brain images



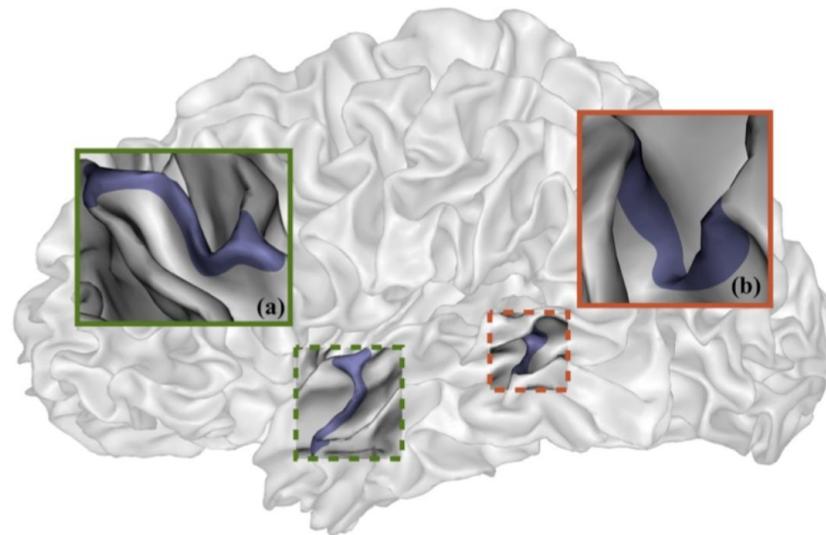
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# Brain images



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)

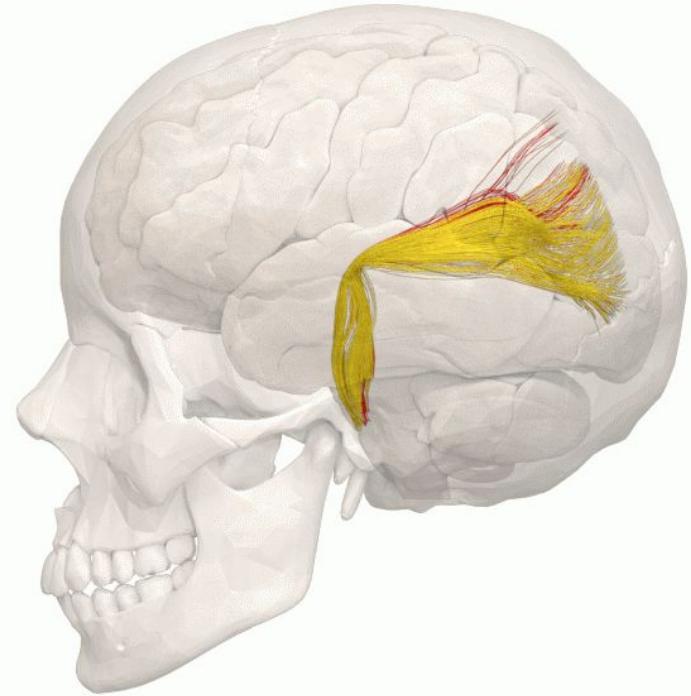
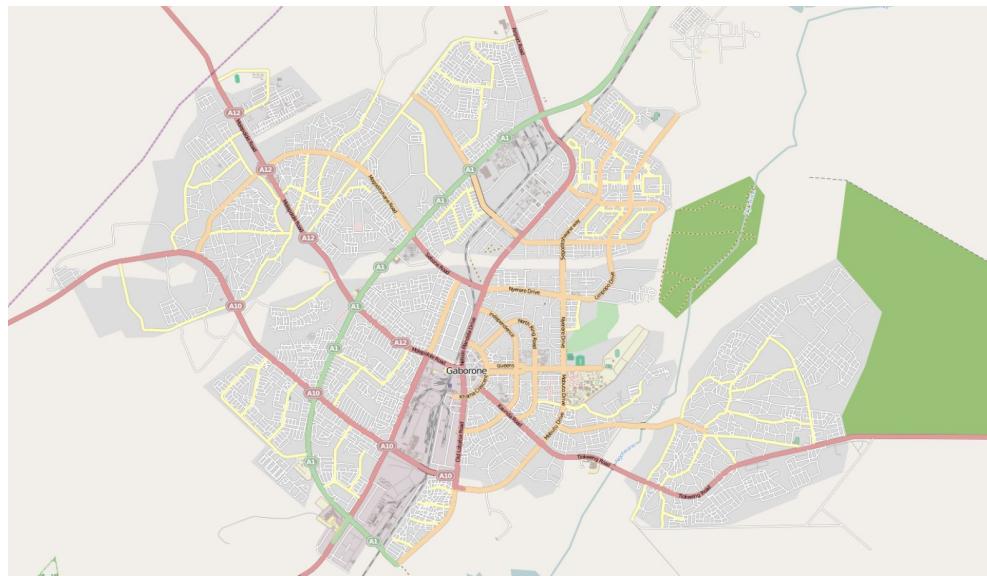
# Anatomy: cortical surfaces



Song et. al (2021)

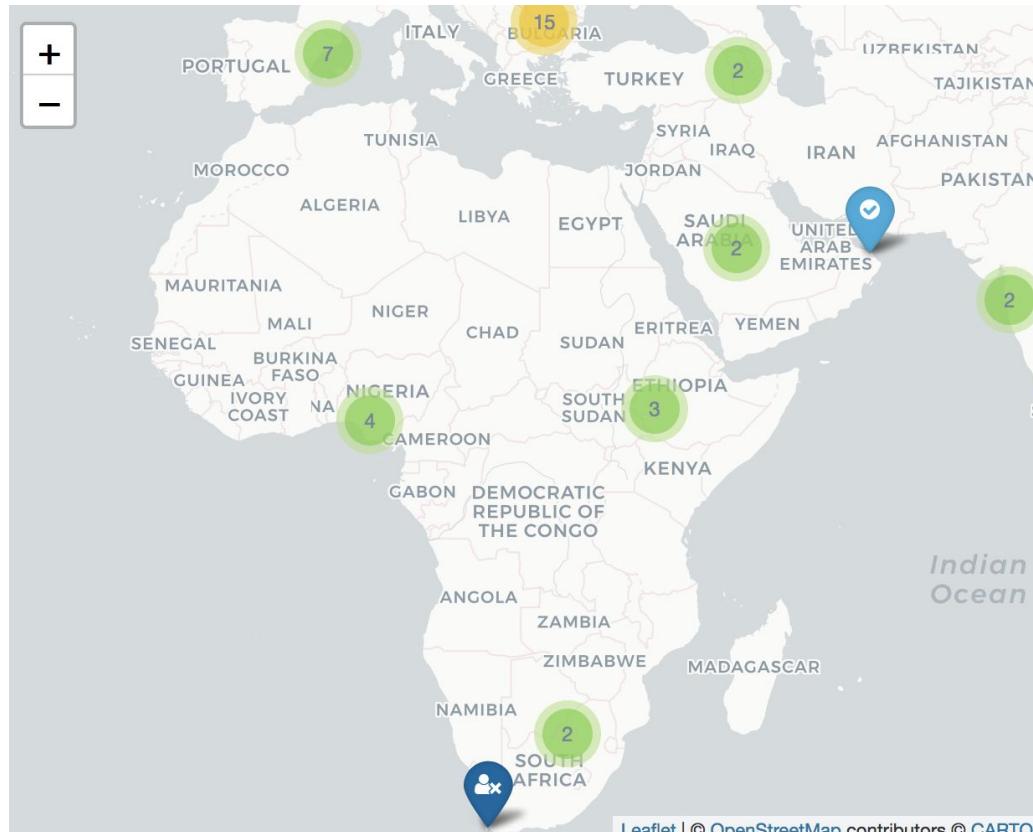
Credits: Pli de passage, [\(Song et al, 2021\)](#) - Setswana hill by Athena Lao, [Wikipedia](#) (CC-BY-SA).

# Connectivity

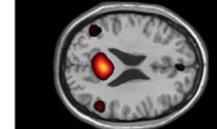
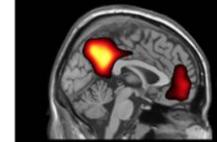
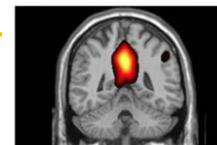


Credits: Tractography, group work [Wikipedia](#) (CC-BY-SA) - Gaborone road map by OpenStreetMap contributors, [Wikipedia](#) (CC-BY-SA).

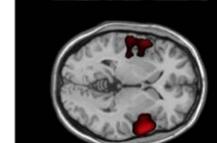
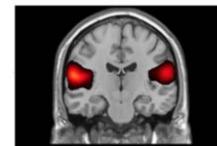
# Brain function



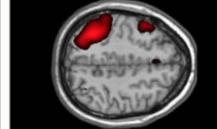
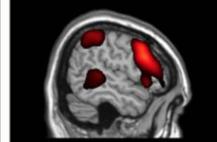
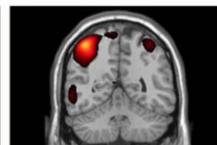
Default mode network



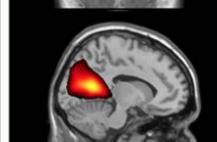
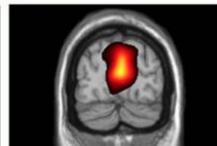
Auditory network



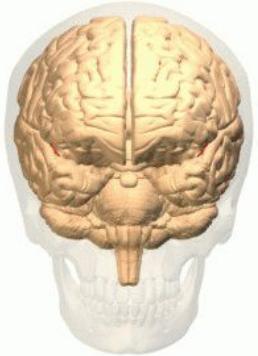
Executive control network left



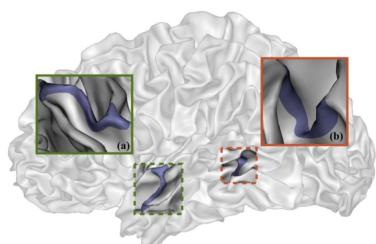
Visual medial network



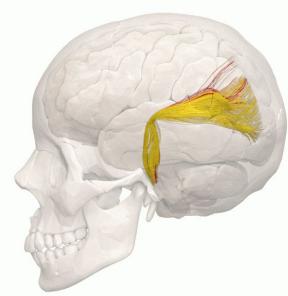
# Many types of brain maps



Human brain



Anatomy



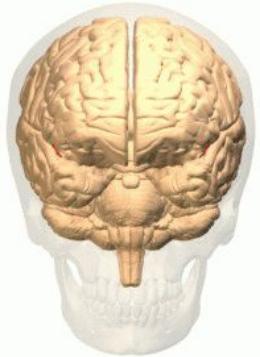
Connectivity



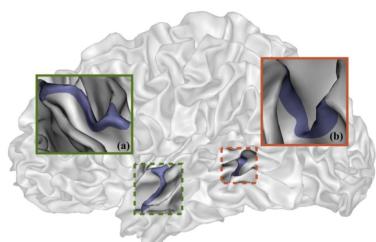
Function



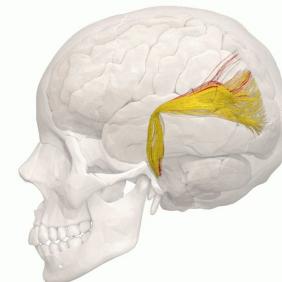
# Many types of brain maps



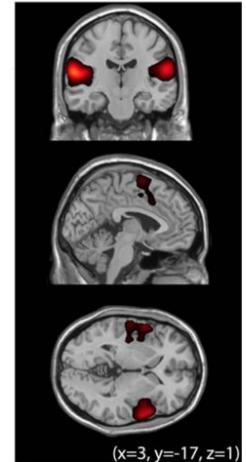
Human brain



Anatomy



Connectivity



Function



# Example functional MRI study

Studying developmental Language disorder

Study started in 2005 in Rennes.

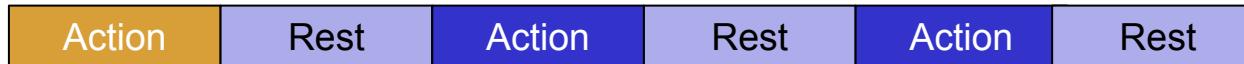
Team of clinicians and research scientists.

40 children participated.

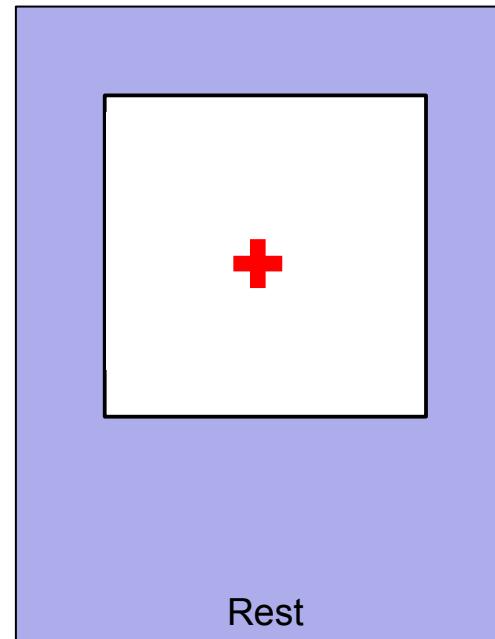
[De Guibert et. al \(2010\)](#), [De Guibert et. al \(2011\)](#)



# fMRI protocol



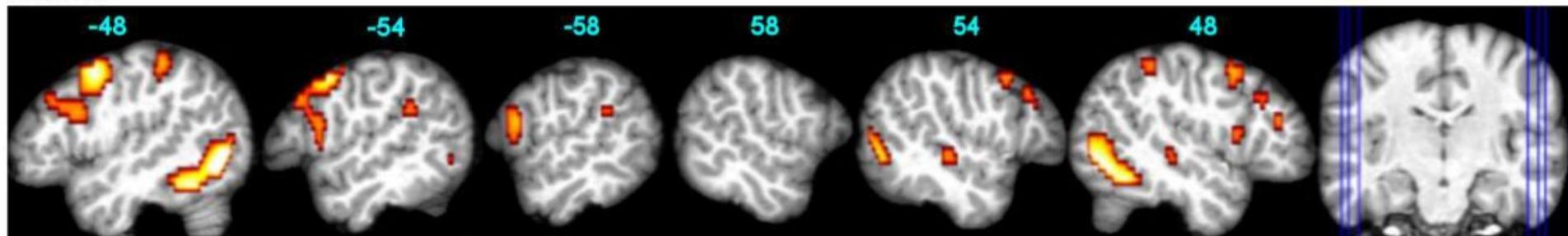
- Language paradigm using a block design



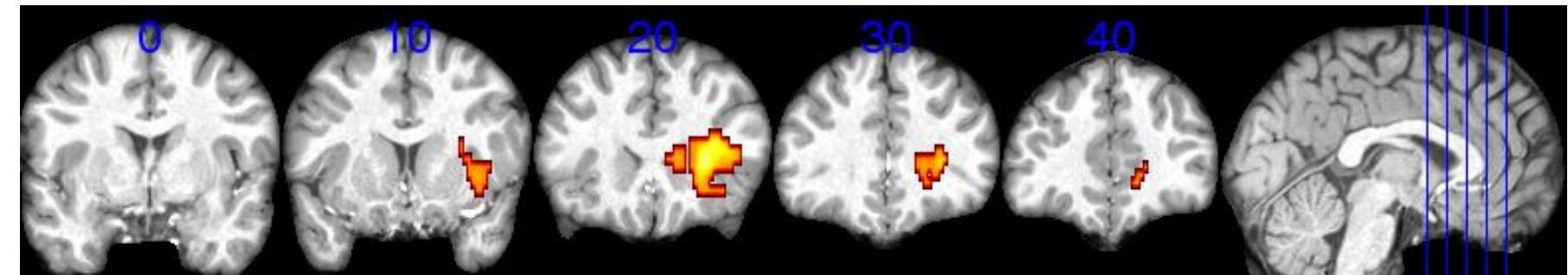
# Results

DLD Group activity during the Phon-diff task

Phon-diff



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)

Logout

File Edit View Insert Cell Kernel Widgets Help

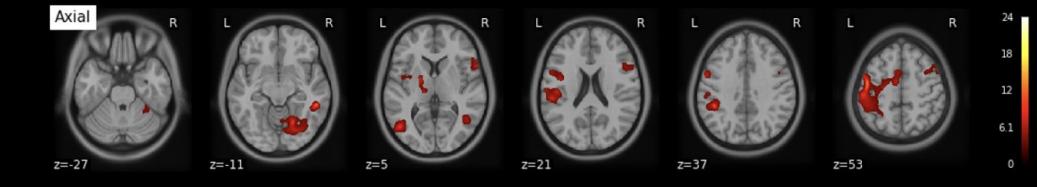
Not Trusted | Python [conda env:neuro] O

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

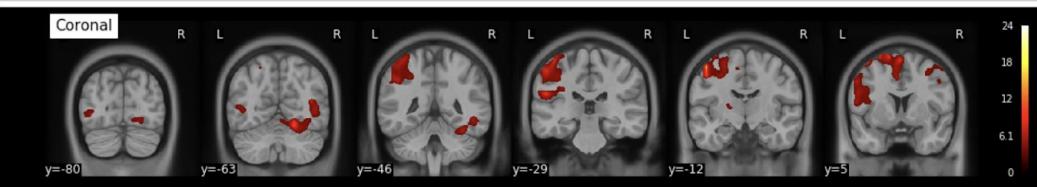
In [2]: `anat_img = '/data/ds000114/derivatives/fmriprep/mni_icbm152_nlin_asym_09c/1mm_T1.nii.gz'  
act_img = '/output/datasink/2ndLevel/spm_con_0002_fwhm8/spmt_0001_thr.nii'  
func_img = '/data/ds000114/sub-01/ses-test/func/sub-01_ses-test_task-fingerfootlips_bold.nii.gz'`

### Looking at fMRI data

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



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



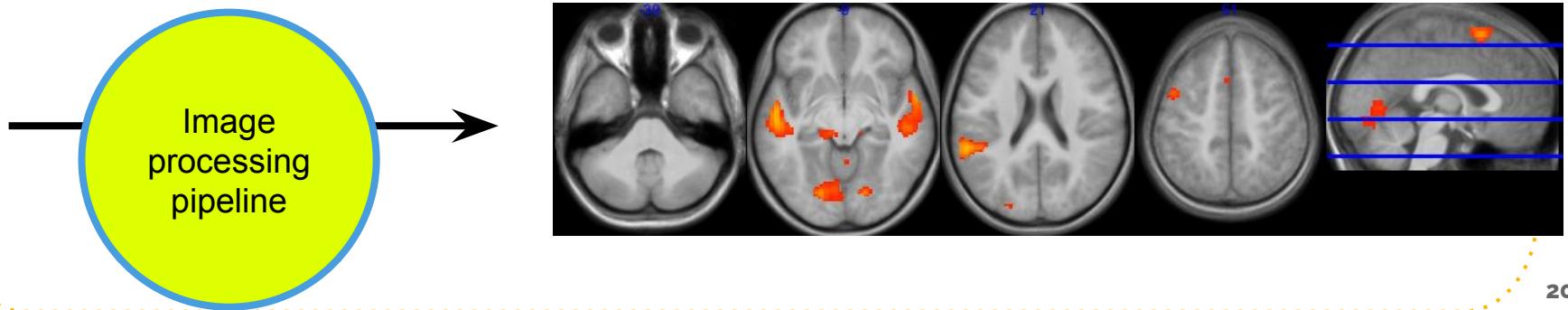
In [5]: `plot_stat_map(act_img, title='Sagittal', bg_img=anat_img, display_mode='x', cut_coords=(range(-49,52,17)));`

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

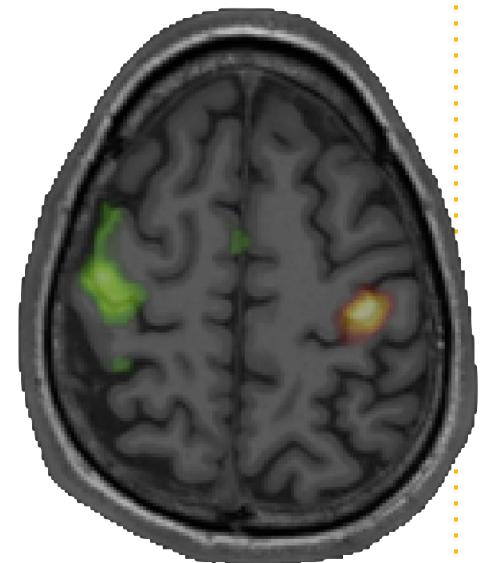
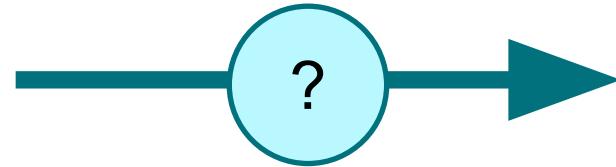
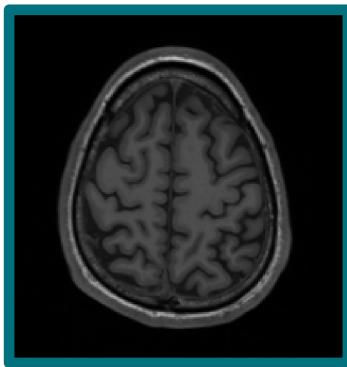
# Functional MRI: raw data



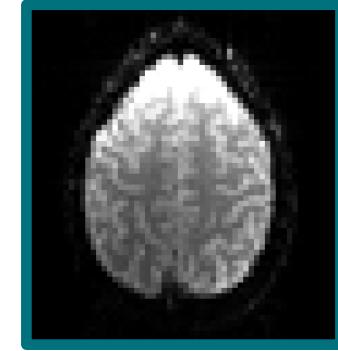
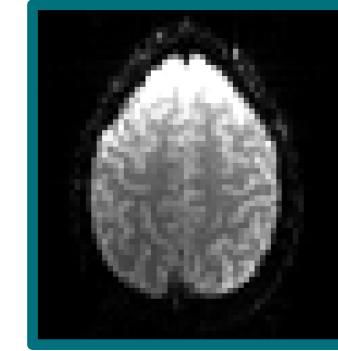
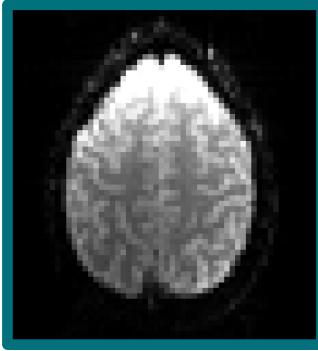
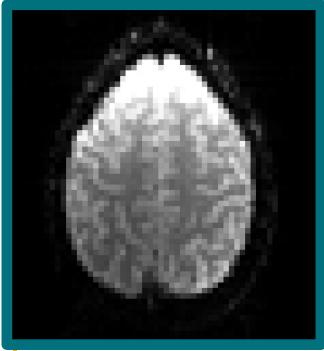
- 64 brain volumes / subject / paradigm



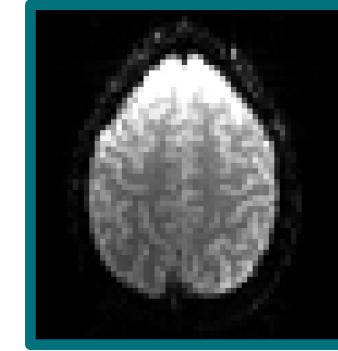
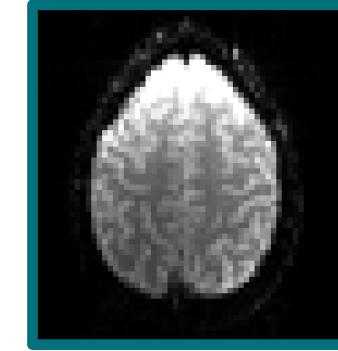
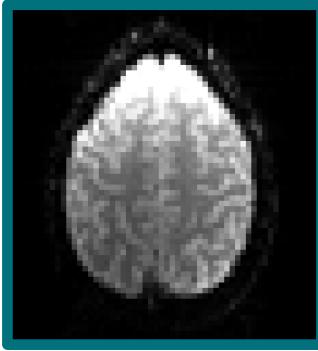
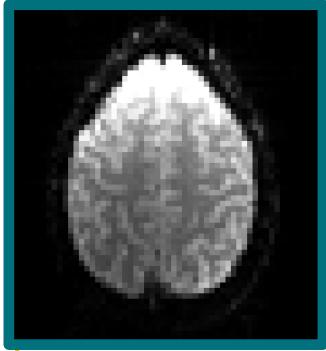
# Data analysis



# Motion correction



# Motion correction



# Motion correction



# Motion correction



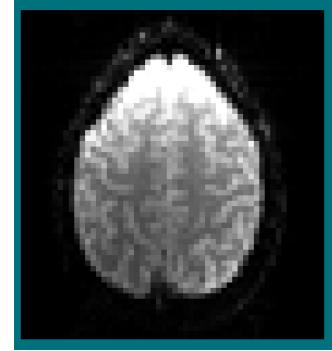
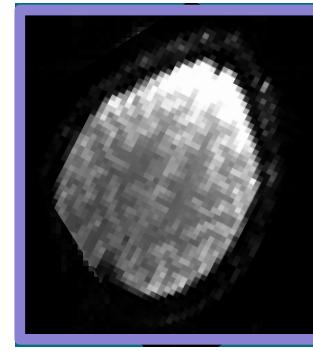
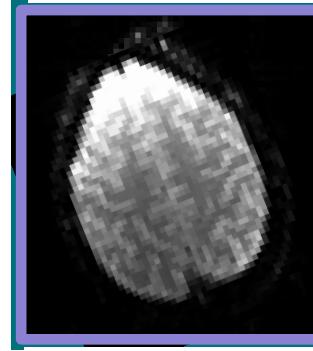
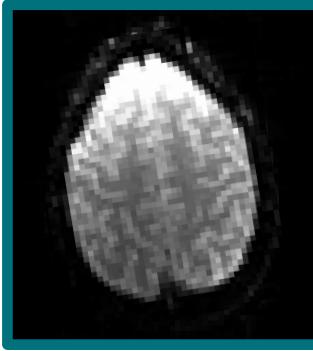
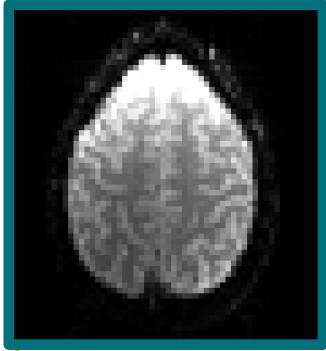
Credits: cat by Sheilagraber, [Wikimedia commons](#) (CC-BY)

# Motion correction

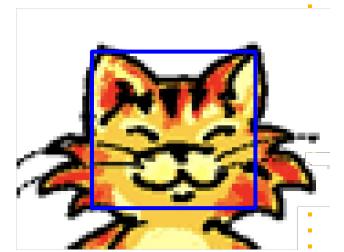
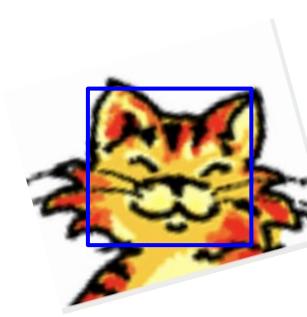
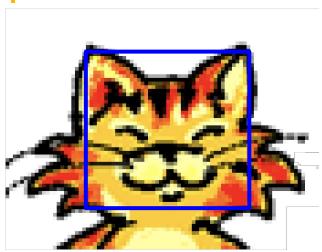
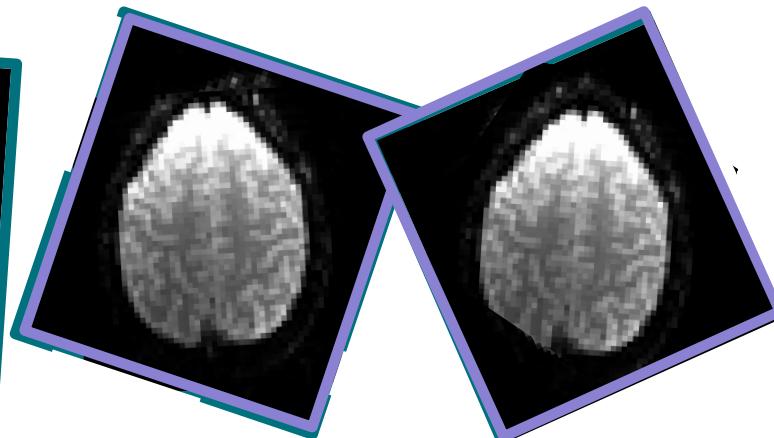
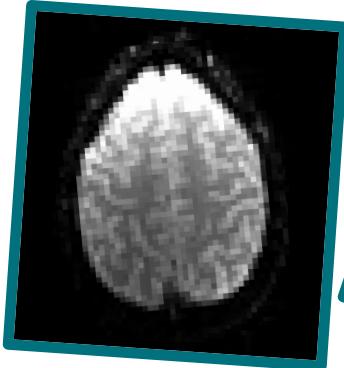


Credits: cat by Sheilagraber, [Wikimedia commons](#) (CC-BY)

# Motion correction



# Motion correction



# Motion correction

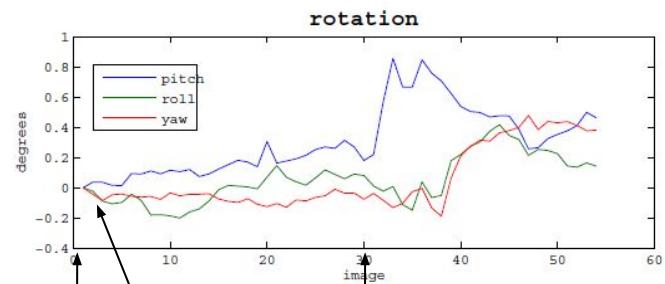
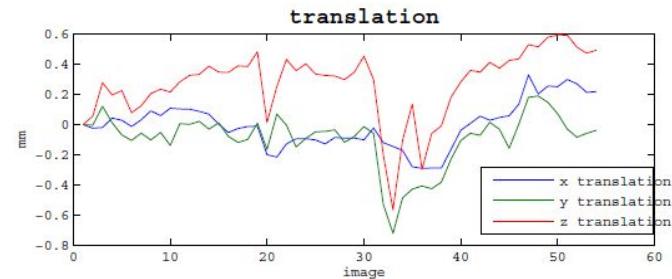
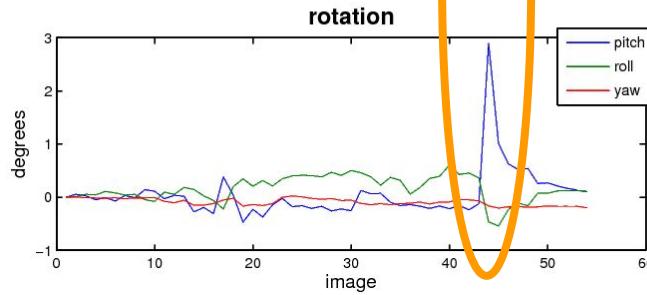
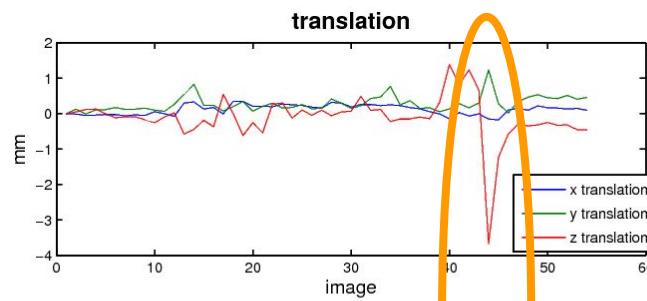
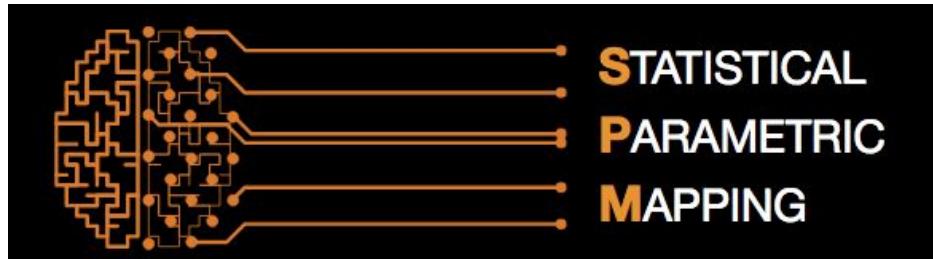


Image 1  
Image 2  
Image 30



# Demo : motion correction

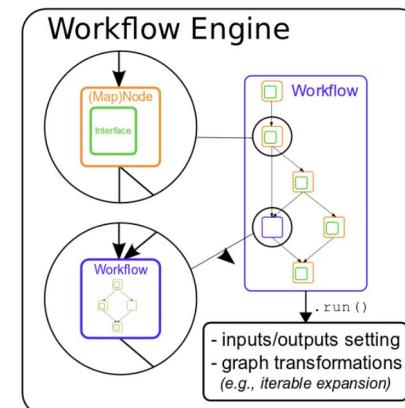
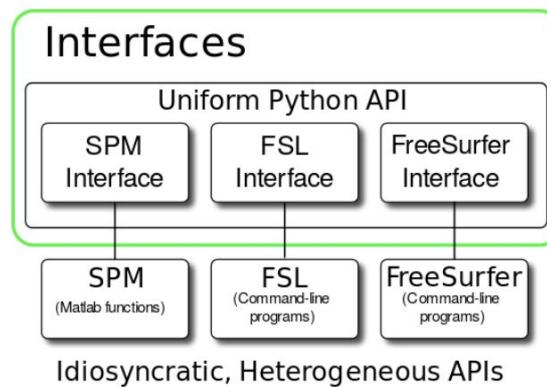


<https://www.fil.ion.ucl.ac.uk/spm/>



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

<https://nipype.readthedocs.io>





# Demo : motion correction

Elodie Germani

Jupyter face\_rep\_example - Jupyter Notebooks

127.0.0.1:8888/notebooks/Softs/reproduced\_tutorial/face\_re...

Most Visited git remote rm - Goo... Paiment-FR1-LCLC... Getting Started CR Réunions LCLC ... Zimbra: Réception Zimbra: Réception ... Other Bookmarks

Jupyter face\_rep\_example Last Checkpoint: 9 minutes ago (autosaved) Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

In [5]:

```
from nipype.interfaces.spm import RealignUnwarp
from nipype.interfaces.utility import Function
from nipype.interfaces.io import SelectFiles, DataSink
from nipype 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)
```

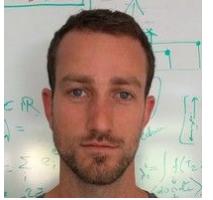
Out[7]:

```
['RawEPI', 'Structural', 'all_conditions.mat', 'sots.mat', 'workingdir_moco']
```

In [8]:

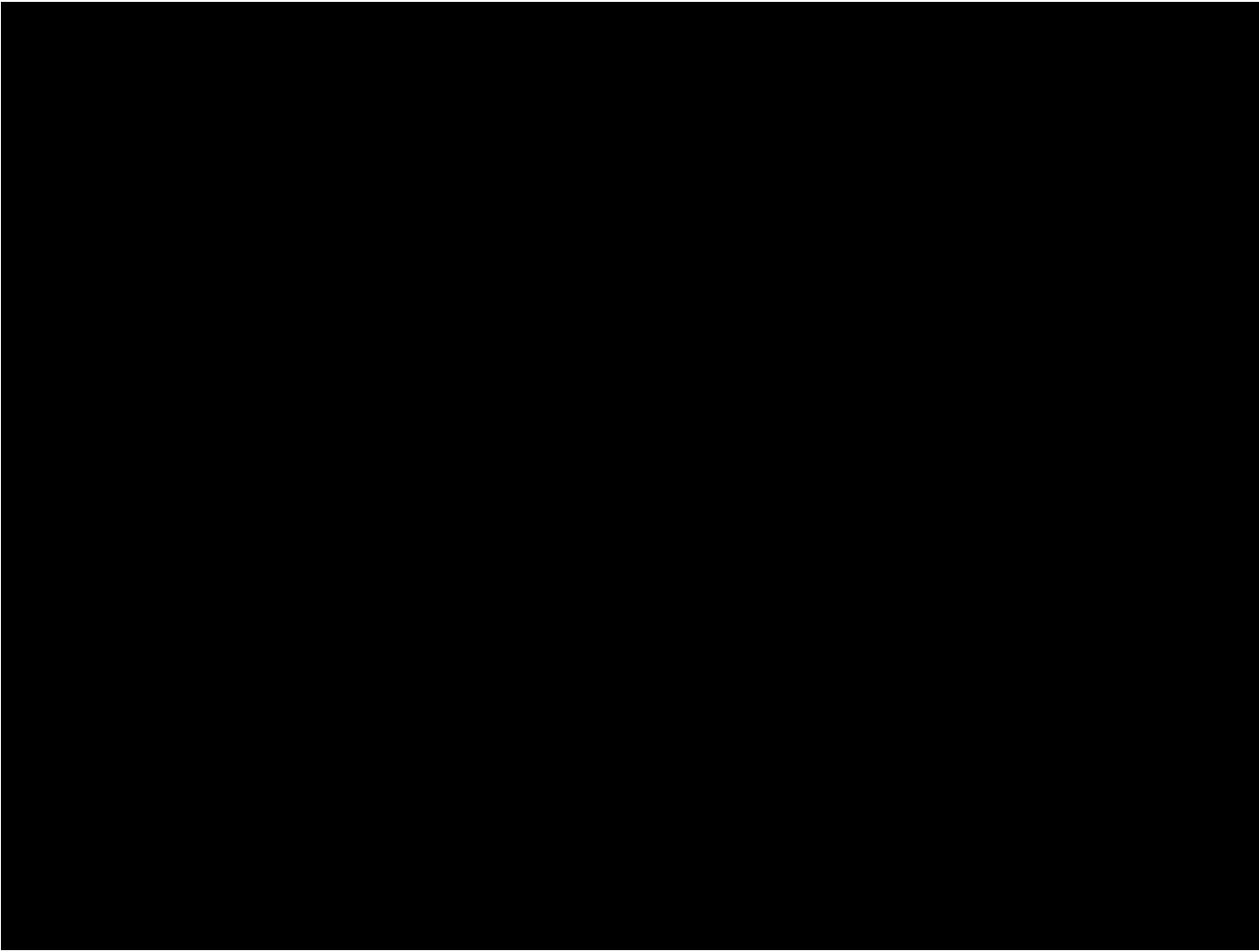
```
# NODE AND TEMPLATE FOR SELECTING FILES
anat_file = os.path.join('Structural', 'sM03953_0007.img')
func_file = os.path.join('RawEPI', 'sM03953_0005_*.img')

templates = {'anat':anat_file,
             'func':func_file}
```



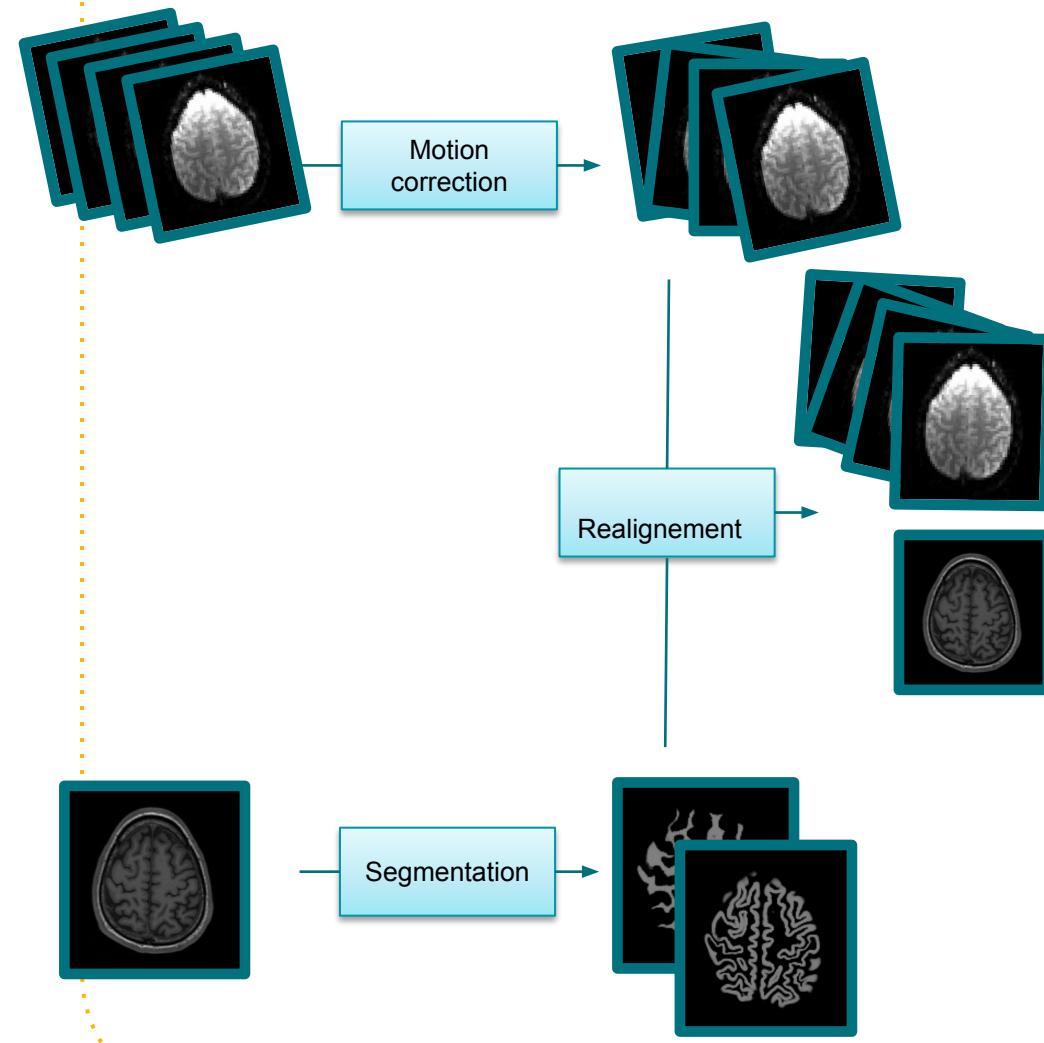
# Motion correction

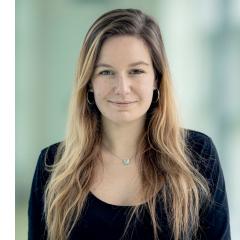
Quentin  
Duché



Credits: Video by Quentin Duché, Empenn.

# More preparation steps...





# Demo : Preprocessing

Elodie Germani

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



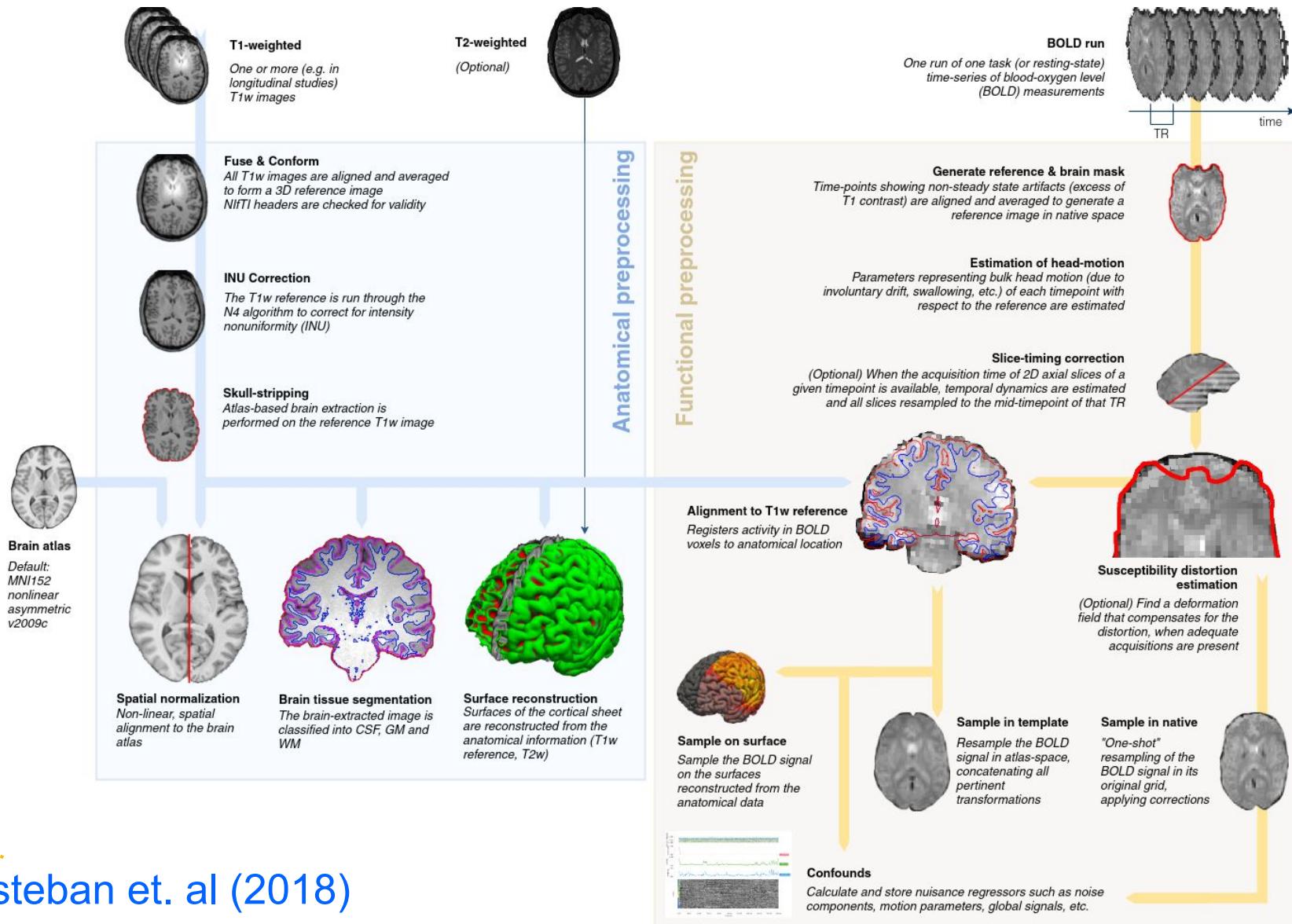
<https://www.fil.ion.ucl.ac.uk/spm/>



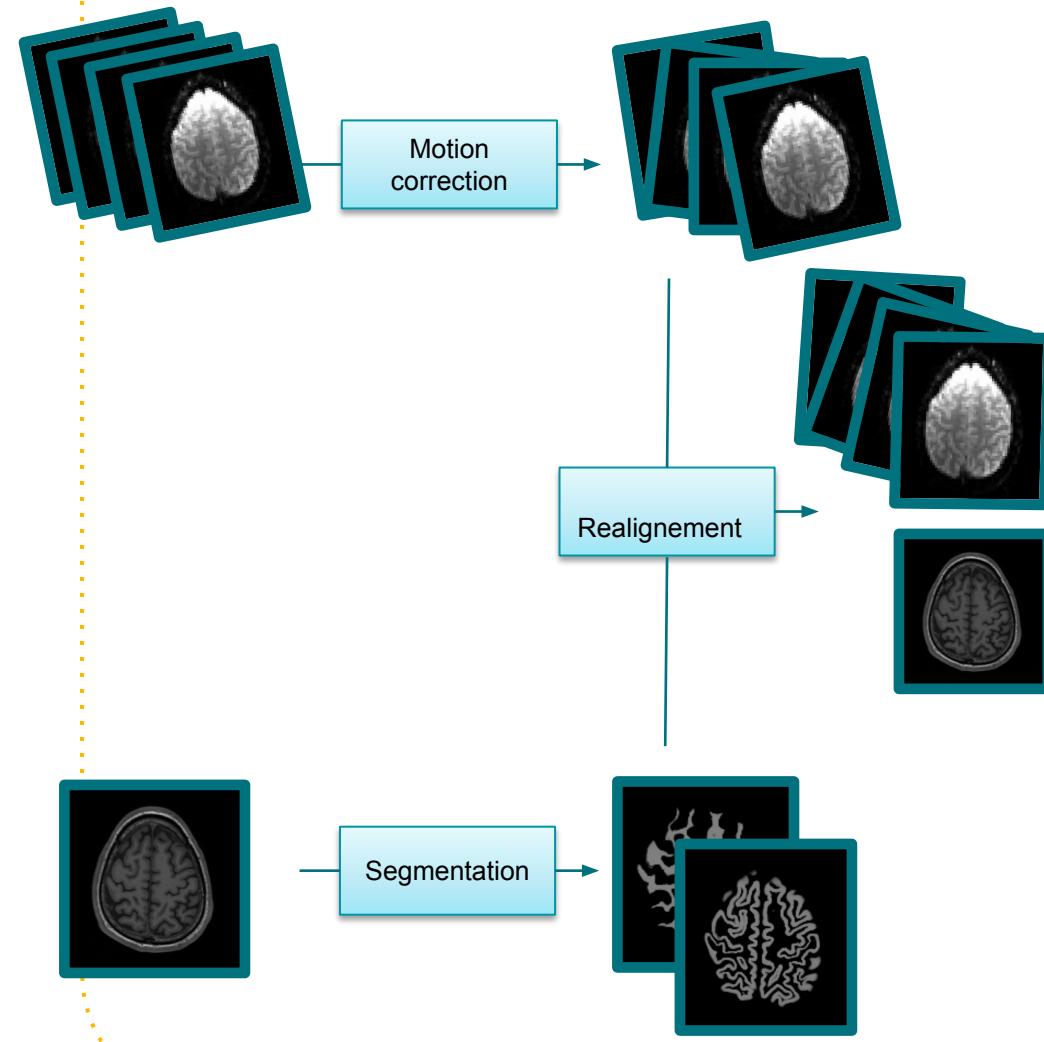
**Nipype:**  
**Neuroimaging in Python**  
**Pipelines and Interfaces**

<https://nipype.readthedocs.io>

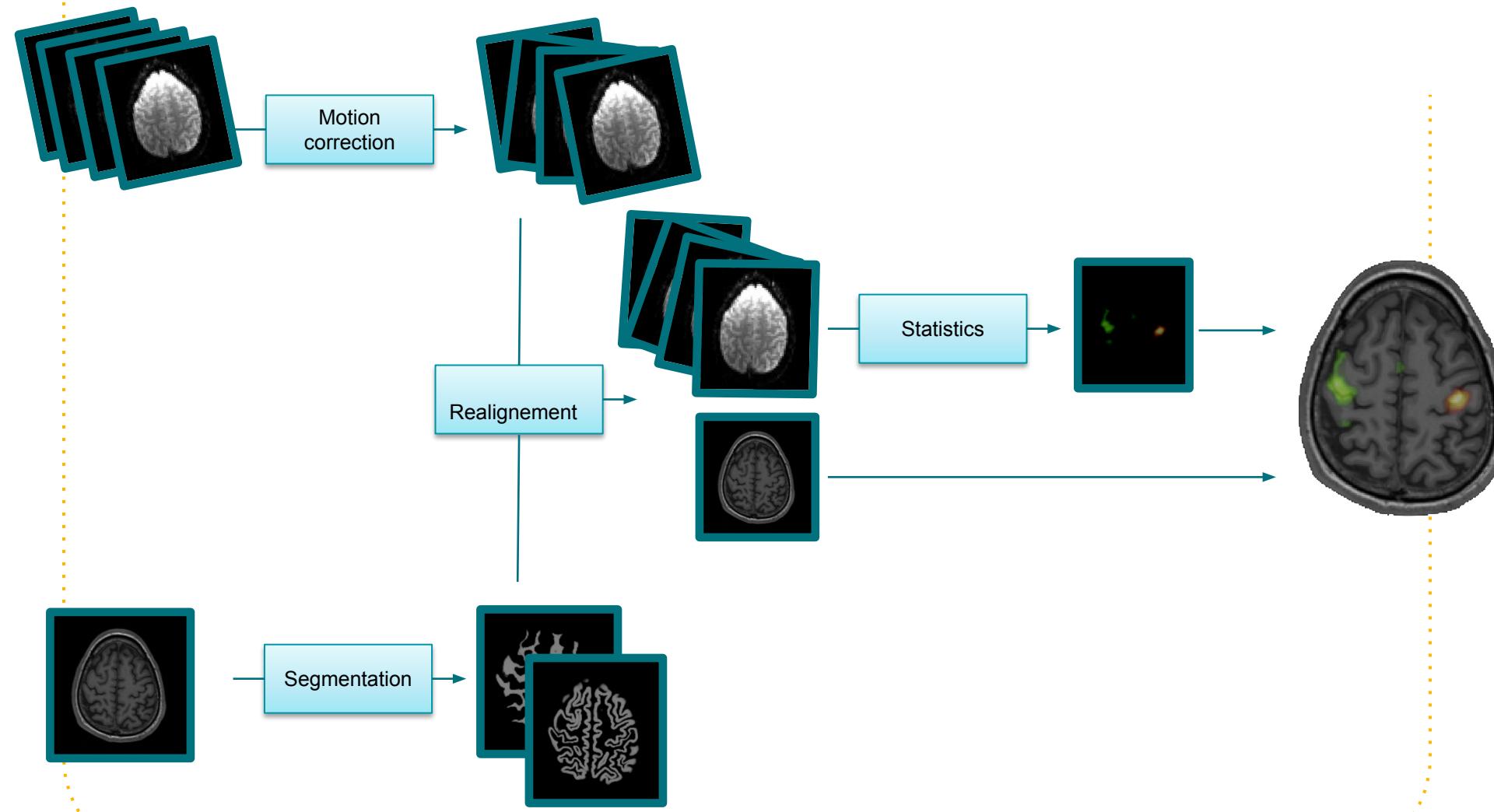
# And even more preparation...



# More preparation steps...

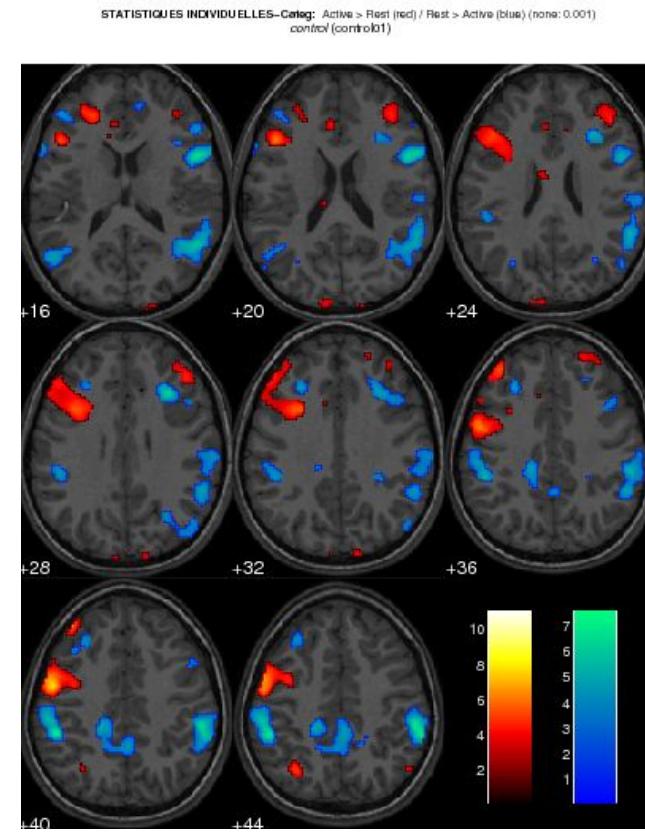
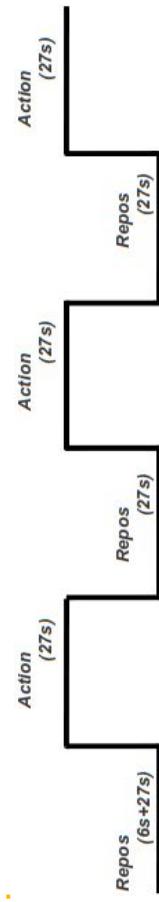
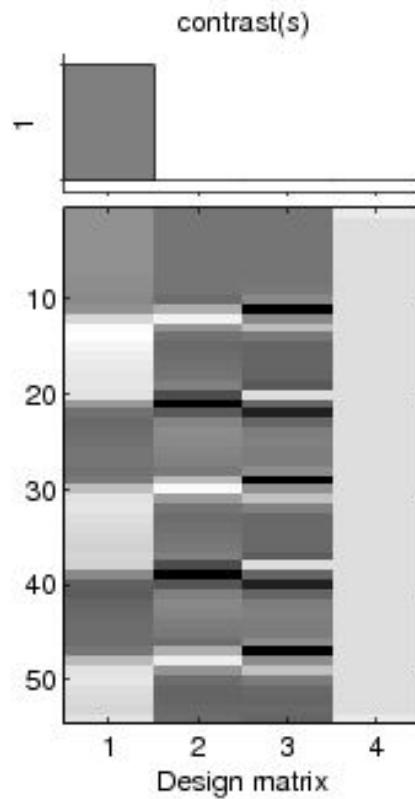


# More preparation steps...



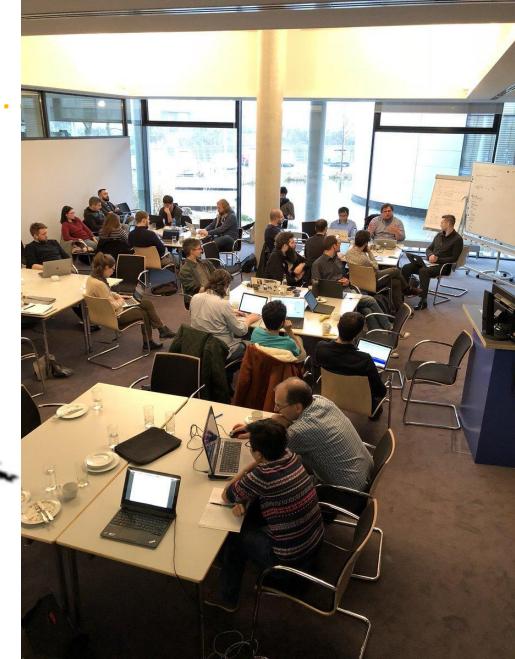
# Statistical analysis

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

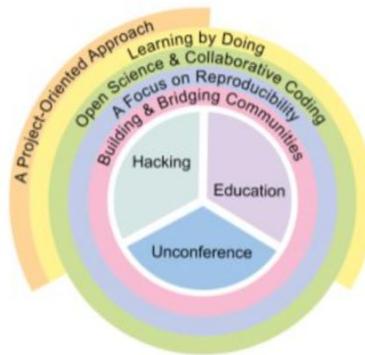


**Collaborative and  
community-driven  
research**

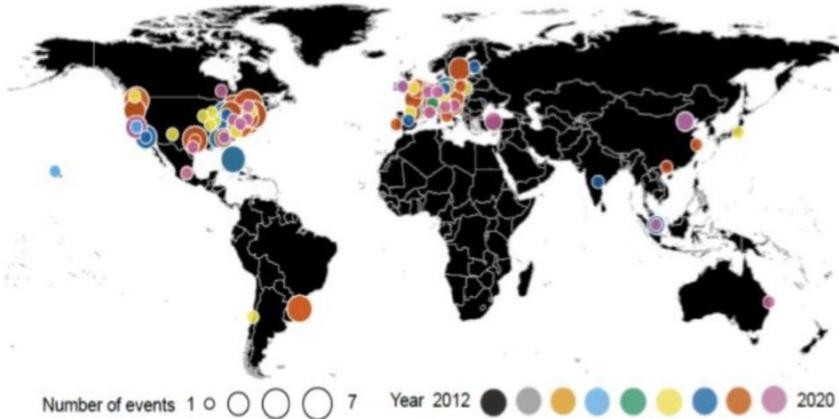
# Brainhack: project-based community science



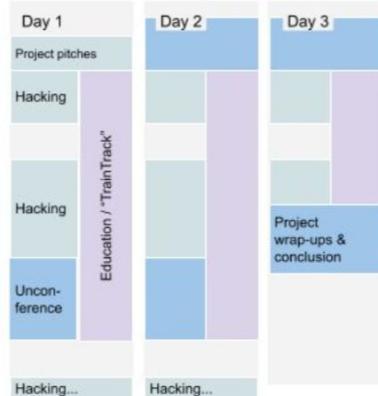
A. Anatomy of a Brainhack



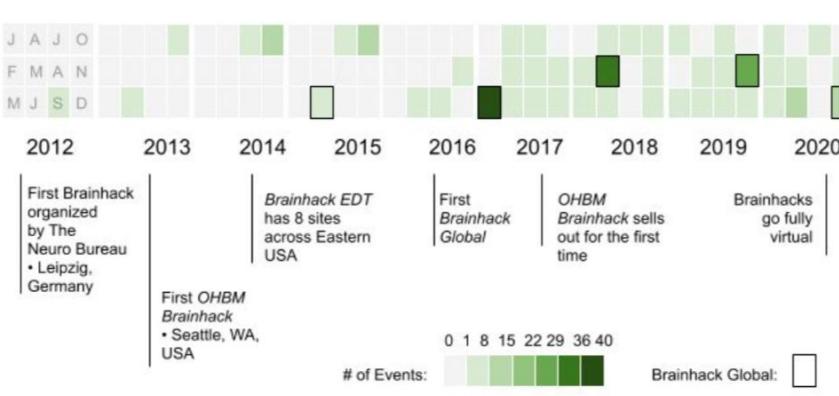
C. Brainhack Cartography



B. Timeline of a Single Event

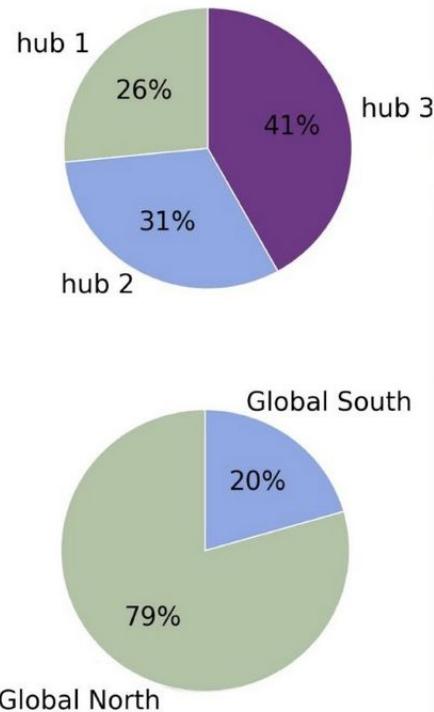


D. Brainhack Timeline



Gau\*, R., Noble\*, S., Heuer\*, K., Bottenhorn\*, K., Bilgin\*, I. P., Yang\*, Y. F., ... & Brainhack Community (2021). Brainhack: developing a culture of open, inclusive, community-driven neuroscience. <https://psyarxiv.com/rytjq/>

# 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](http://neuroinformatics.incf.org)

May 13, 2022



# An introduction to neuroinformatics

Camille Maumet

# Thank you!



Credit: Sculpture by Malin Björnsdotter "Cerebia", [OHBM Brain Art SIG](#); Presentation template by [SlidesCarnival](#), adapted



@cmaumet