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# Towards large-scale brain imaging studies: How to deal with analytic variability?

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# Towards large-scale brain imaging studies: How to deal with analytic variability?

April 19th, 2018

Camille Maumet



# Outline

Introduction: VisAGeS and AI

Large-scale brain imaging studies

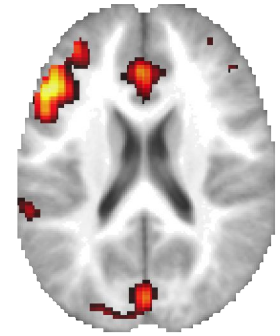
Analytic variability

# Introduction

VisAGeS and AI

# VisAGeS research objectives

Understand the brain under **typical** and **pathological** conditions with **brain imaging**



**Team leader:** Christian Barillot

## Goals

- Early Diagnosis
- Therapeutic choices
- New therapeutic protocols

Multiple sclerosis, Psychiatry, Parkinsonian disorders, Dementia, Stroke

*(Slide content from Christian Barillot, adapted)*

# Multiscale «Brain Imaging Biomarkers»

Imaging Sources

Microscopic scale  
Microscopic scale

Mesosopic Population Scale

Patient



Multimodal Characterization

MR/PET Contrast Agent  
Structures/Function Inference & learning

Big Data, Model

Clinical Medicine

Quantitative Imaging



## Majors challenges

- Models and algorithms to reconstruct, analyze and transform
- Mass of data to store, distribute and “semantize”

## Contributions & skills

- Model Inference
- Statistical Analysis & Modeling
- Sparse Representation (*compressed sensing, dictionary learning*)
- Machine Learning (*supervised/ unsupervised classification, discrete model learning*)
- Data fusion (*multimodal integration, registration, patch analysis, ...*)
- High dimensional optimization
- Data integration
- Brain computer interface
- ...

(Slide from Christian Barillot, adapted)

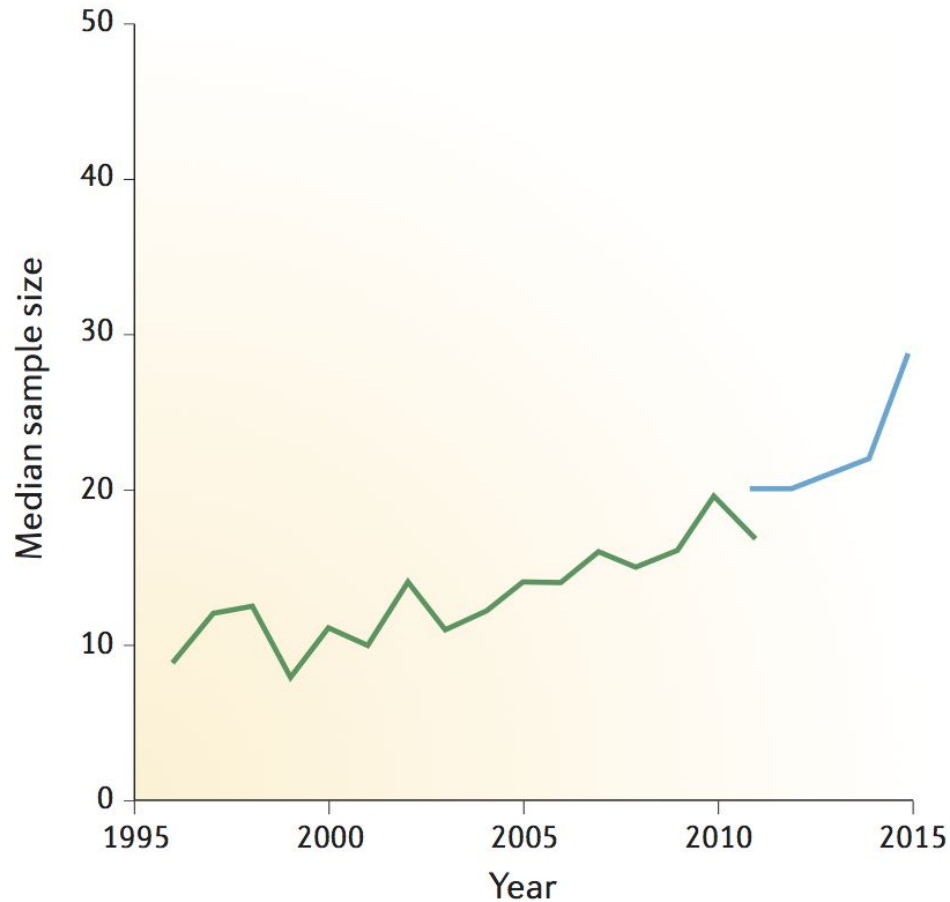
# VisAGeS in AI



# **Towards large-scale brain imaging studies**



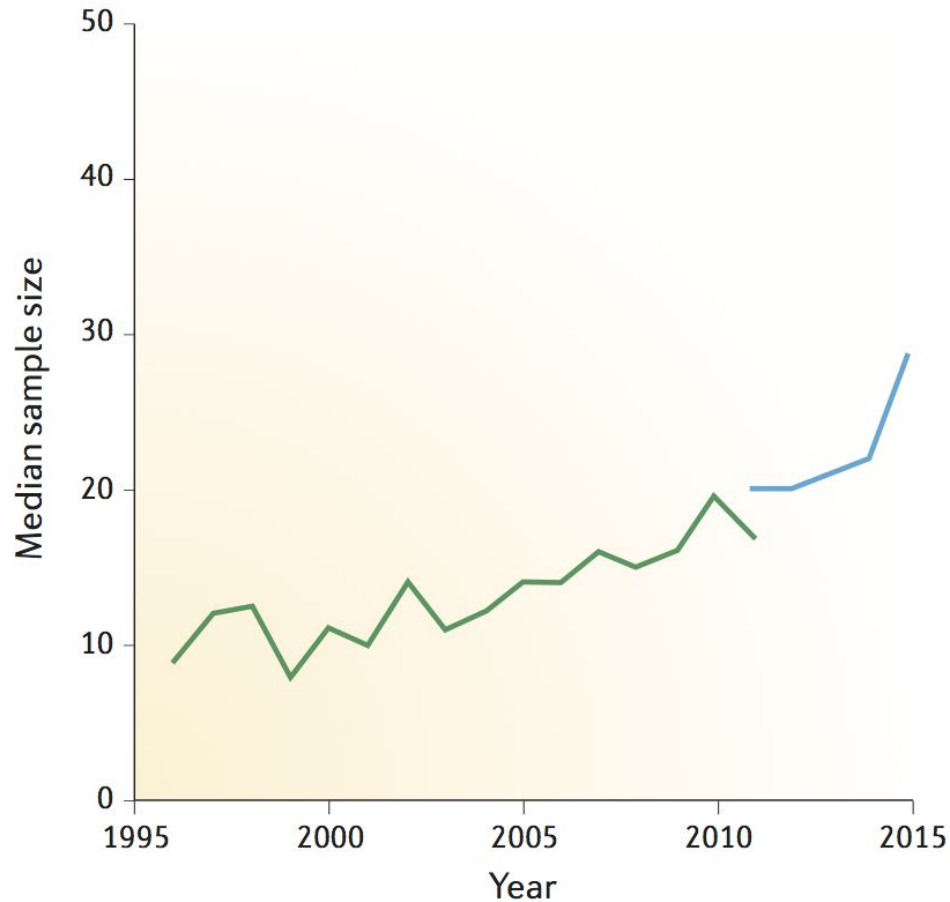
# Sample sizes in brain imaging research



2015: 30 subjects / study

[Poldrack et. al, Nature Neuroscience 2017]

# Sample sizes in brain imaging research



2015: 30 subjects / study

Low diversity &  
Low statistical power

[Poldrack et. al, Nature Neuroscience 2017]

# More and more open data are available!



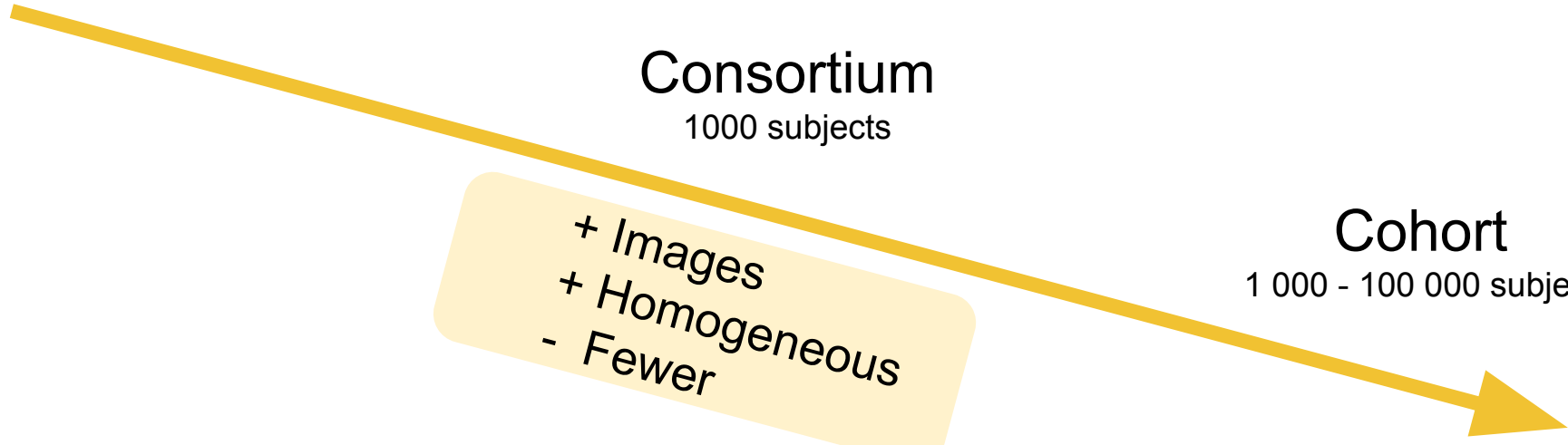
Photo de Neil Conway

Single study  
30 subjects

Consortium  
1000 subjects

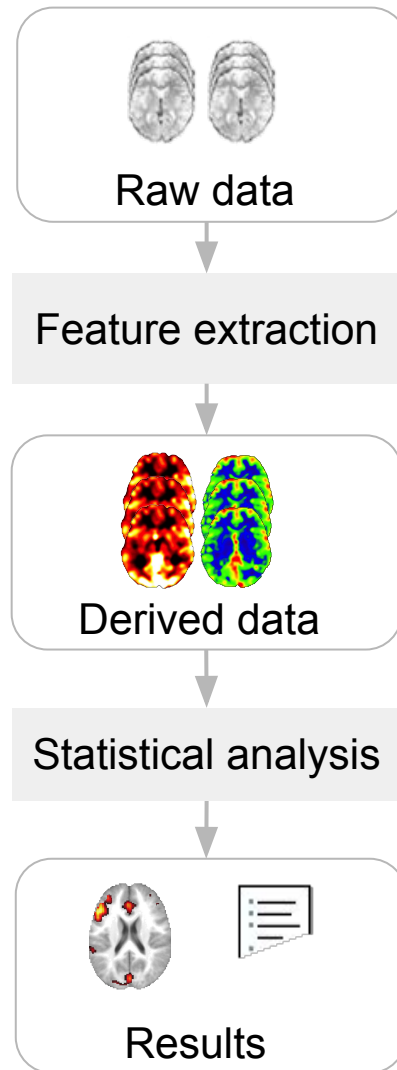
+ Images  
+ Homogeneous  
- Fewer

Cohort  
1 000 - 100 000 subjets

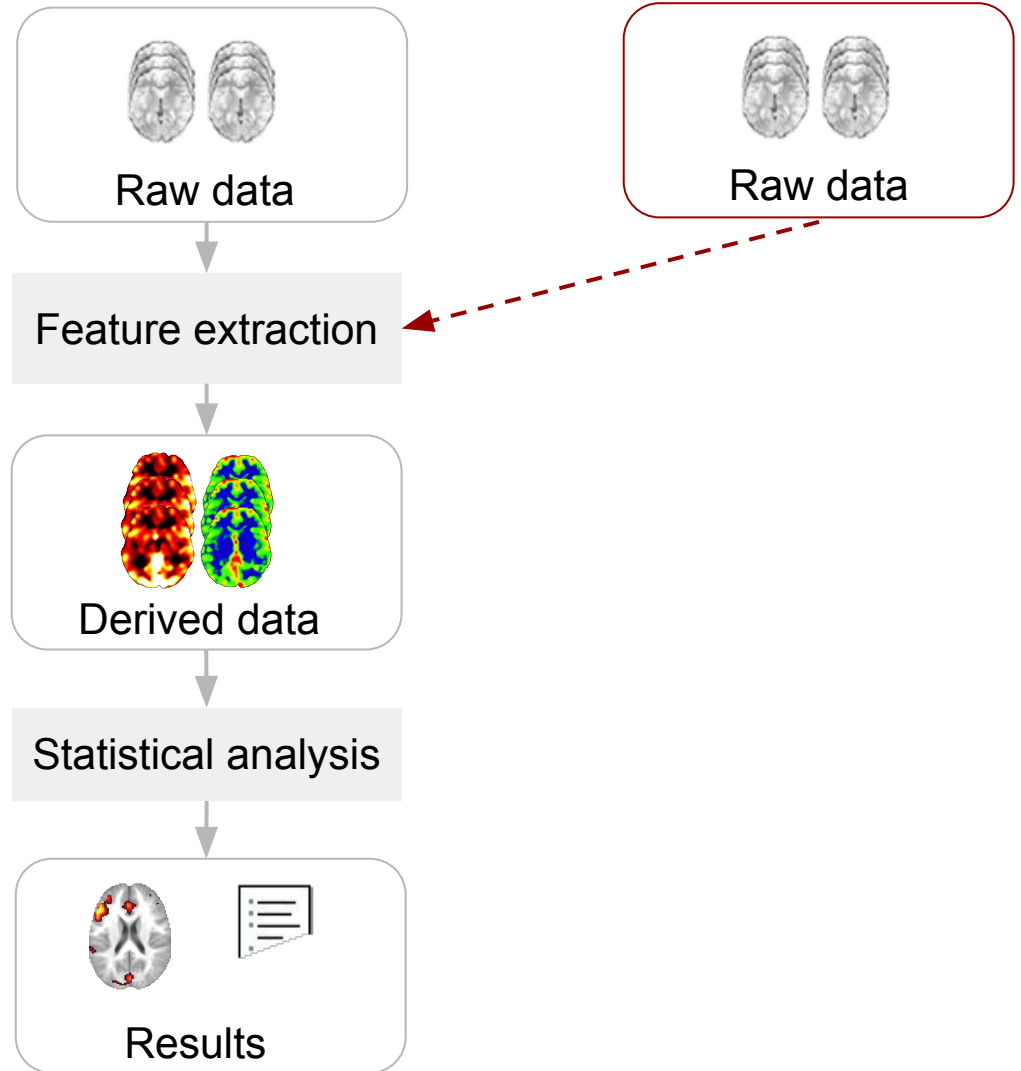


**How to deal with analytic variability?**

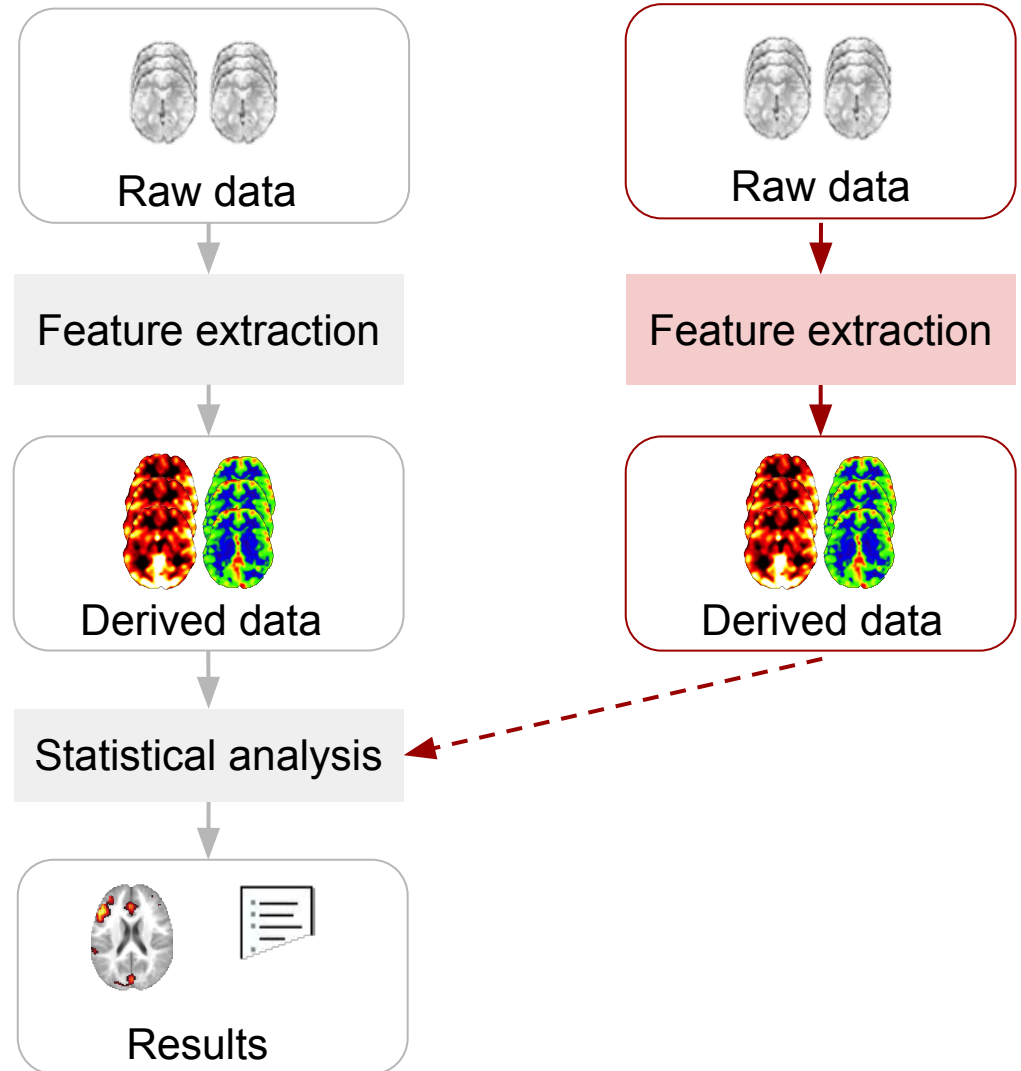
# Challenge: analytical variability



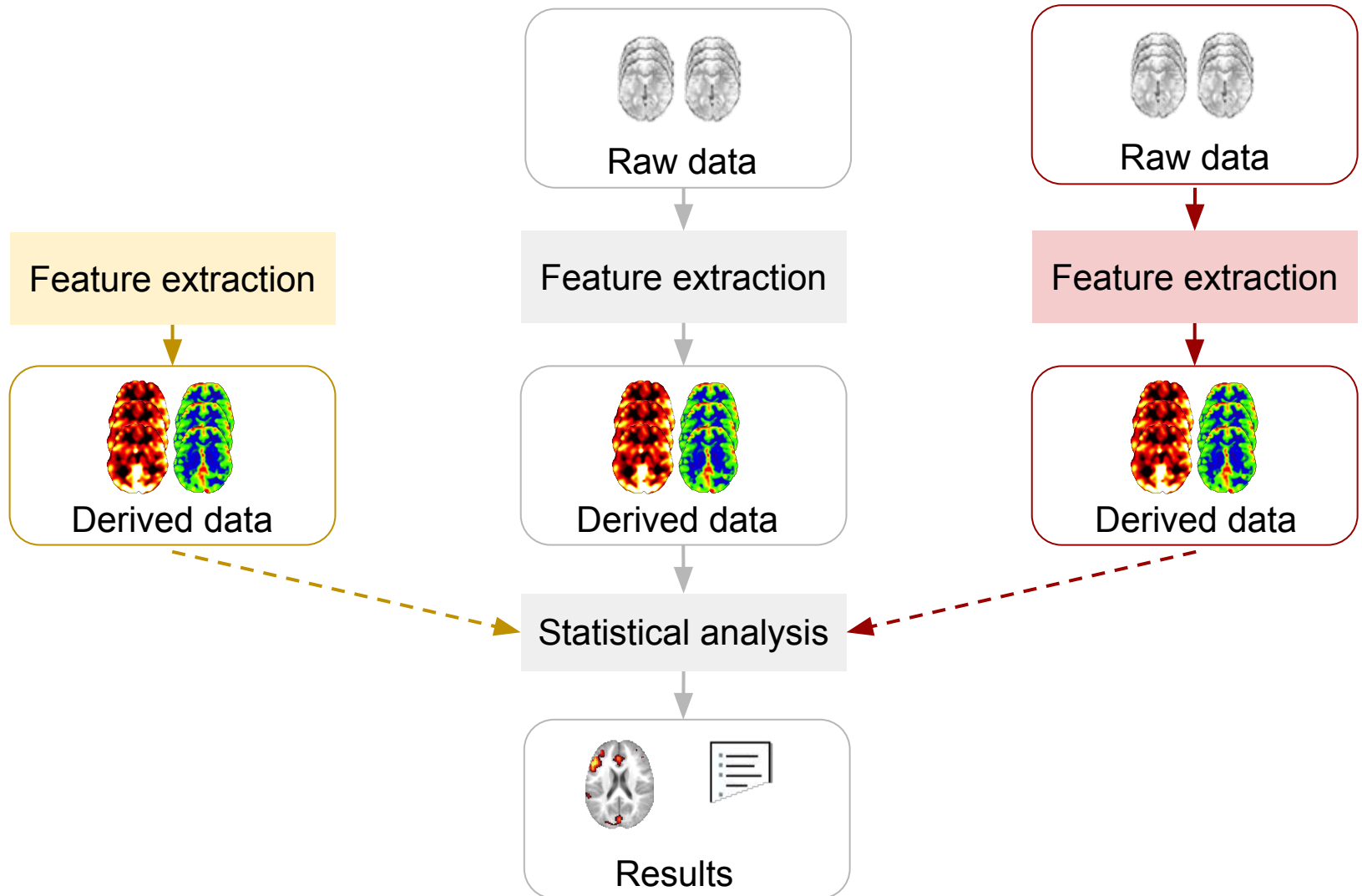
# Challenge: analytical variability



# Challenge: analytical variability

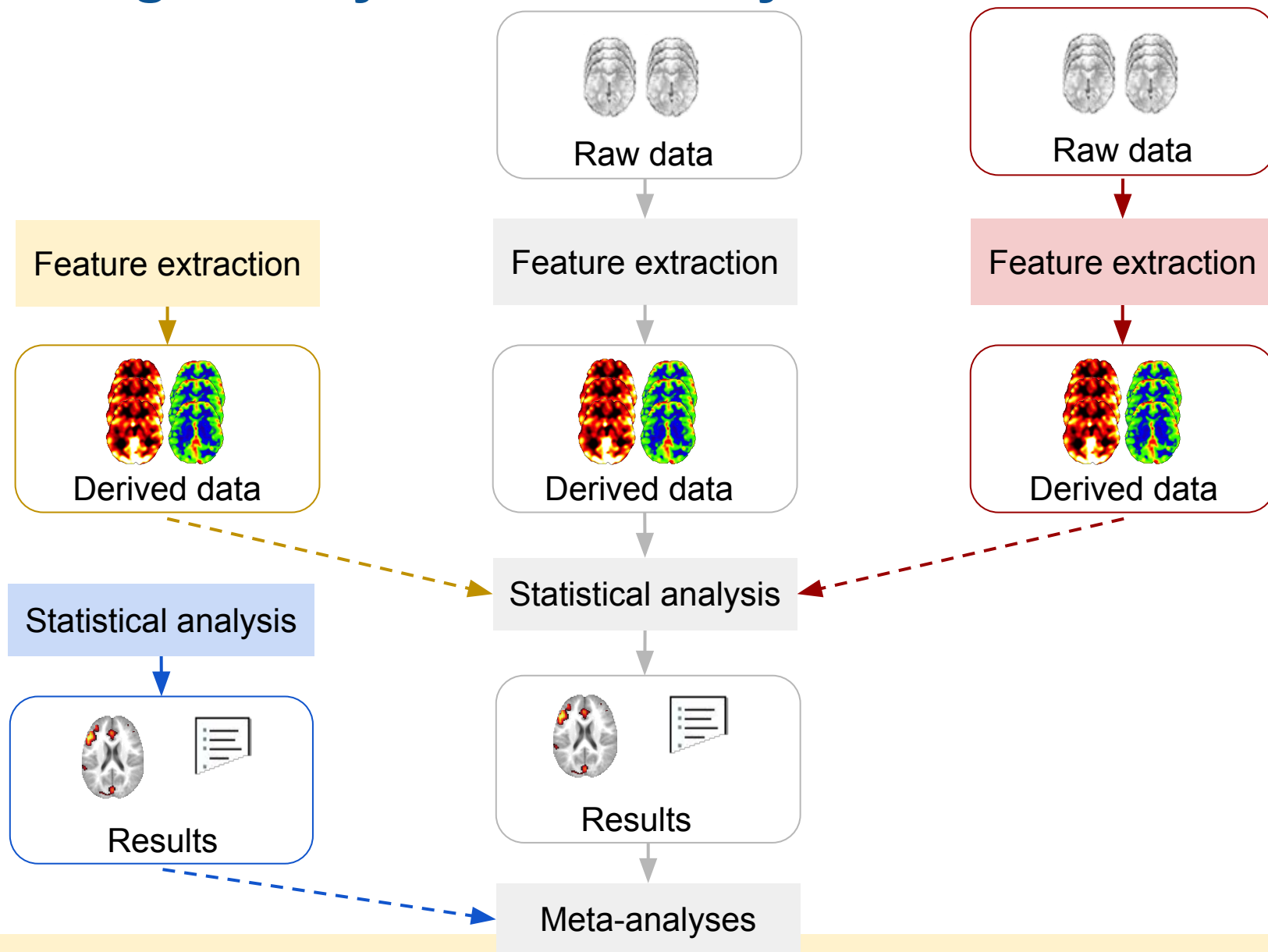


# Challenge: analytical variability





# Challenge: analytical variability



**Quantify**  
Estimate variations  
across pipelines

**Compensate**  
Remove unwanted  
"pipeline effect"

**Quantify**  
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"pipeline effect"

# Impact of Analysis Software on Task fMRI Results

- 3 published studies
- Reanalysed with 3 fMRI tools
- Reusing the same data

SPM

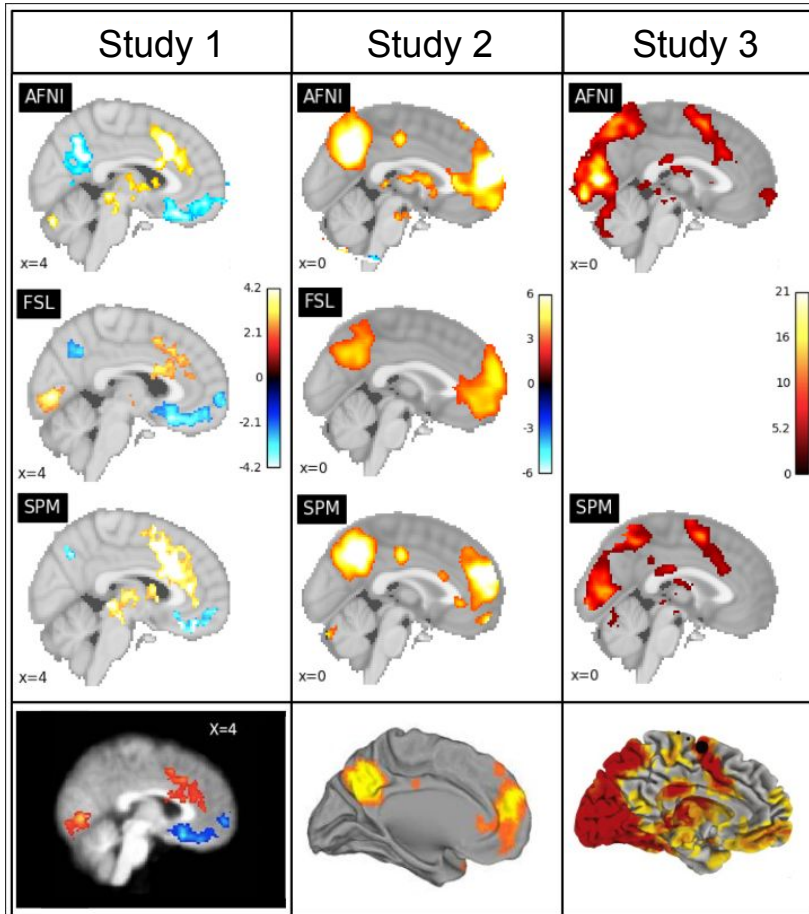


 OpenfMRI

**Research question:** how choice of software package impacts on analysis results?

# Impact of Analysis Software on Task fMRI Results

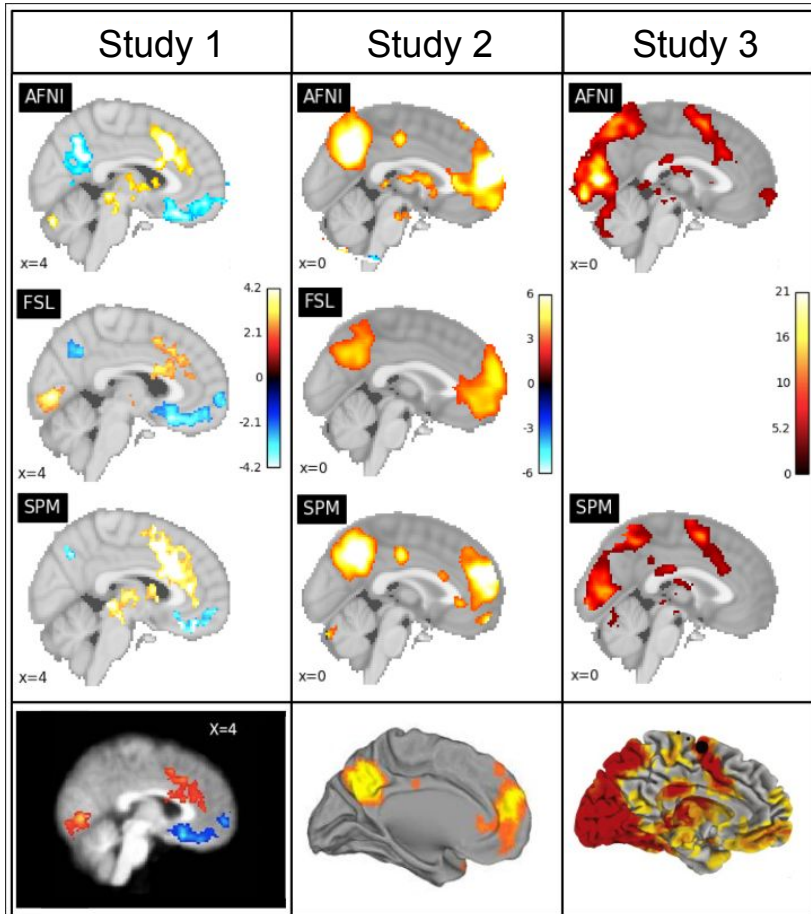
## Reproducing the main figure



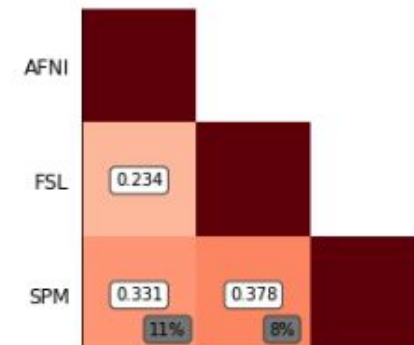
**Preprint:** Bowring, Maumet\* and Nichols\*, 2018. [www.hal.inserm.fr/inserm-01760535](http://www.hal.inserm.fr/inserm-01760535)

# Impact of Analysis Software on Task fMRI Results

## Reproducing the main figure



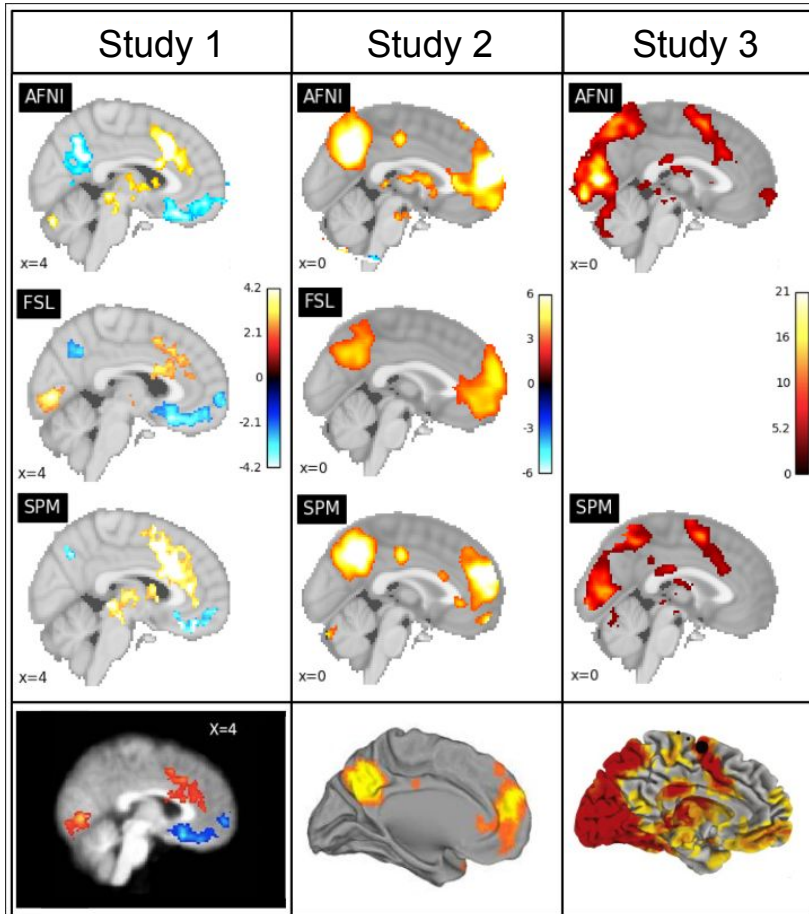
## Dice coefficients: 0.23 - 0.38



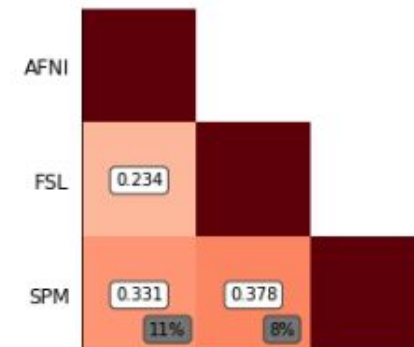
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# Impact of Analysis Software on Task fMRI Results

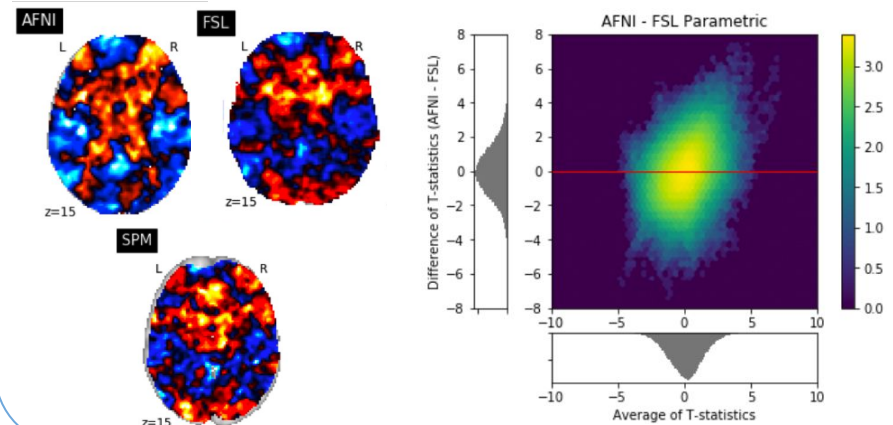
## Reproducing the main figure



## Dice coefficients: 0.23 - 0.38



## Unthresholded statistics



Preprint: Bowring, Maumet\* and Nichols\*, 2018. [www.hal.inserm.fr/inserm-01760535](http://www.hal.inserm.fr/inserm-01760535)

# Impact of Analysis Software on Task fMRI Results

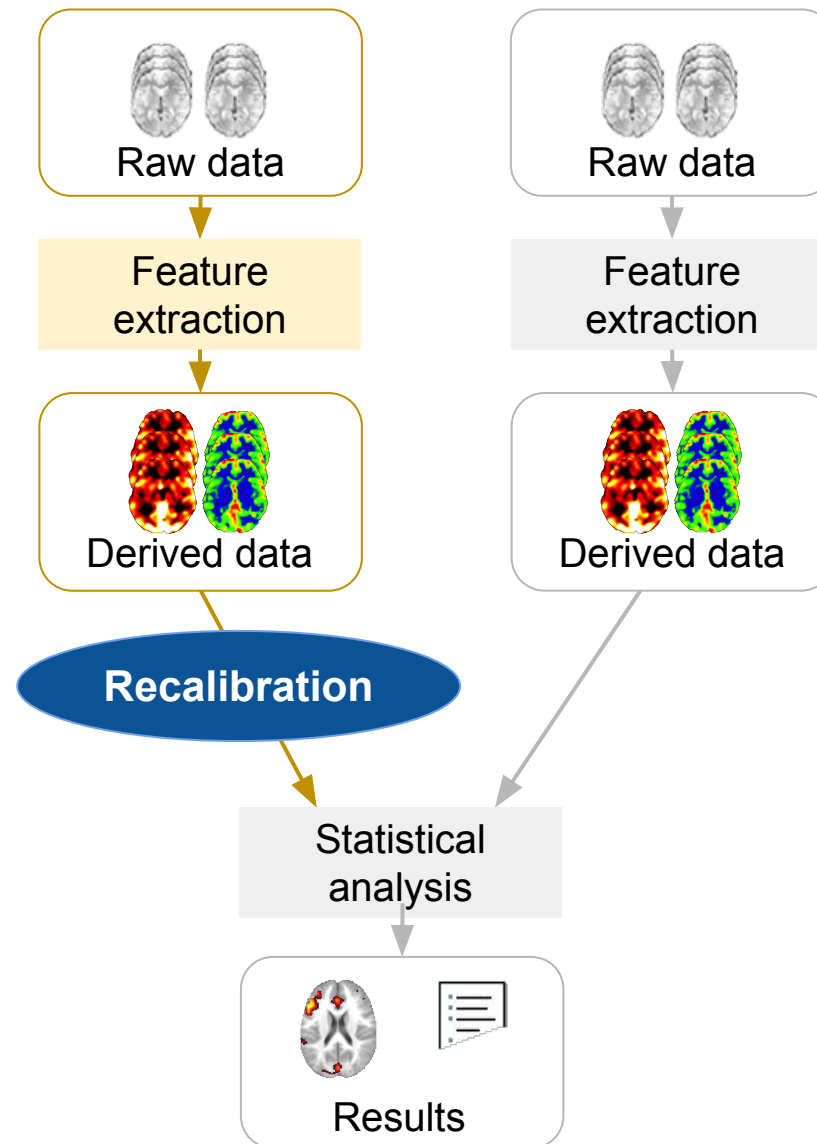
- Challenges
  - Use the "same" pipeline across fMRI tools
    - Implementation details ↔ Methodological differences
  - How much difference is too much?
    - "Compatibility" across pipelines



**Quantify**  
Estimate variations  
across pipelines

**Compensate**  
Remove unwanted  
"pipeline effect"

## 2. Remove unwanted "pipeline effect"



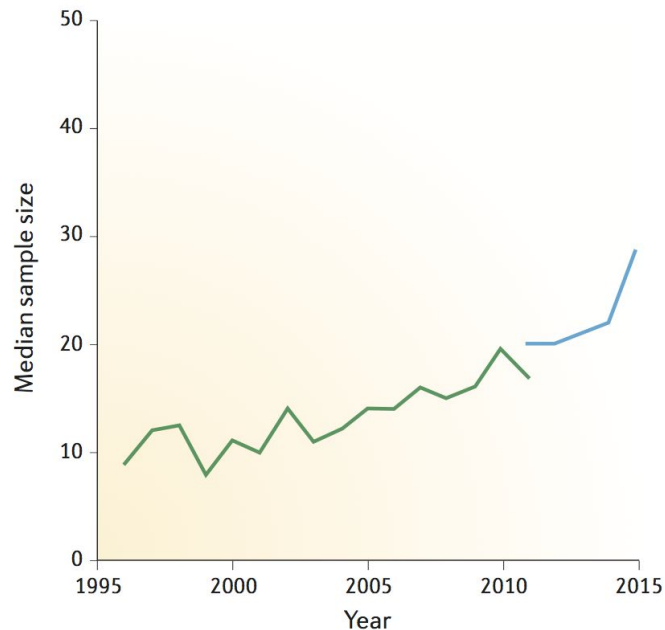


Photo de Neil Conway

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