

Individual Brain Charting, a high-resolution fMRI dataset for cognitive mapping of the human brain



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France



@ALuisaPinho

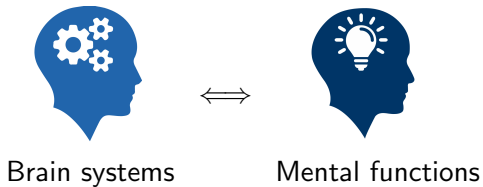
The 5th CiNet Conference
Osaka, Japan

21st of February 2019



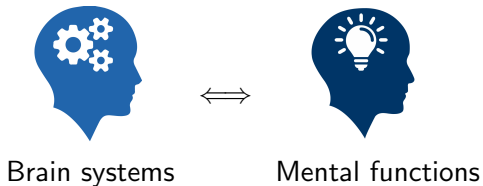
Background and motivations

In cognitive neuroscience:



Background and motivations

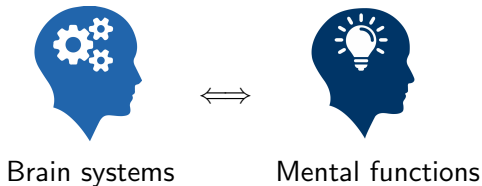
In cognitive neuroscience:



- tackle one psychological domain

Background and motivations

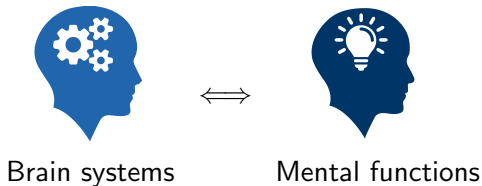
In cognitive neuroscience:



- ▶ tackle one psychological domain
- ▶ be specific enough to accurately isolate brain processes

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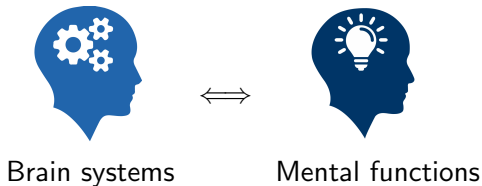


Very hard to achieve!
Lack of generality.



Background and motivations

In cognitive neuroscience:



Task-fMRI experiments allow to:

- ▶ link brain systems to behavior
- ▶ map neural activity at mm-scale



Features of the IBC dataset



- High-resolution fMRI data (1.5mm)

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- ▶ $TR = 2s$

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- ▶ Task-wise dataset:
 - ▶ Many tasks

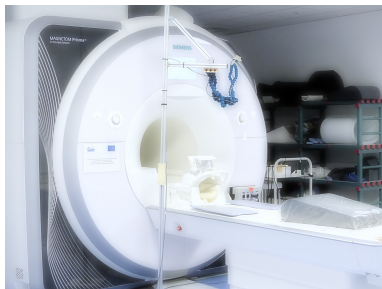
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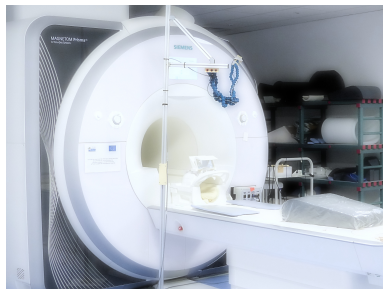
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 - ▶ Fixed environment



NeuroSpin platform, CEA-Saclay, France
Siemens 3T Magnetom Prisma^{fit}
64-channel coil

Features of the IBC dataset

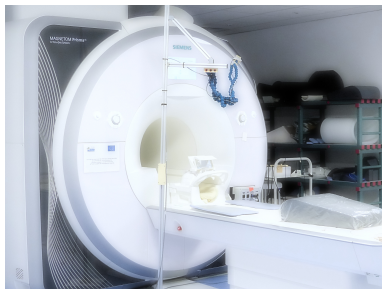
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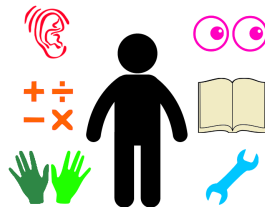
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 - ▶ Many tasks
 - ▶ Fixed cohort - 13 healthy adults
 - ▶ Fixed environment
- ▶ Inclusion of other MRI modalities
- ▶ Not a longitudinal study!



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A task is:

- ▶ a well-controlled sequence of behavioral operations

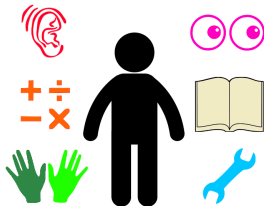


A task is:

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Paradigms:

- ▶ block-design

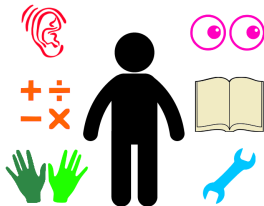


A task is:

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Paradigms:

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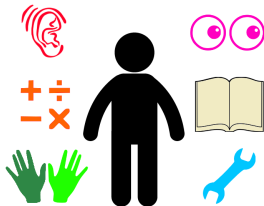


A task is:

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Paradigms:

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Long-range cognitive order:

Perception



High-cognition

Tasks

- ▶ ARCHI tasks
 - ▶ Standard
 - ▶ Spatial
 - ▶ Social
 - ▶ Emotional
- ▶ HCP tasks
 - ▶ Emotion
 - ▶ Gambling
 - ▶ Motor
 - ▶ Language
 - ▶ Relational
 - ▶ Social
 - ▶ Working Memory
- ▶ RSVP Language

- ▶ Sensory processing:
 - ▶ Retinotopy
 - ▶ Tonotopy
 - ▶ Somatotopy
- ▶ High-cognitive order:
 - ▶ Calculation
 - ▶ Language
 - ▶ Social cognition
 - ▶ Theory-of-mind

Tasks

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- ▶ Sensory processing:

- ▶ Retinotopy

- ▶ Tonotopy

- ▶ Somatotopy

- ▶ **59 independent conditions**

- ▶ High-cognitive order:

- ▶ Calculation

- ▶ Language

- ▶ Social cognition

- ▶ Theory-of-mind

Behavioral protocols

Software Tools:



Psychtoolbox 3.0
Routines for Psychophysics



Presentation

neurobehavioralsystems

Behavioral protocols

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Psychtoolbox 3.0
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Presentation

neurobehavioralsystems

Protocols available on:



[hbp-brain-charting/public_protocols](https://github.com/hbp-brain-charting/public_protocols)

Behavioral protocols

Software Tools:



- ▶ More public repositories of behavioral protocols to reproduce experiments!
- ▶ Normatives to describe the experimental paradigms!

Protocols available on:



[hbp-brain-charting/public_protocols](https://github.com/hbp-brain-charting/public_protocols)

Storage of raw MRI data



Individual Brain Charting



HBP Knowledge Graph Data Platform

► [Link](#)

Storage of raw MRI data



HBP Knowledge Graph Data Platform

► [Link](#)



OpenNEURO

ds000244

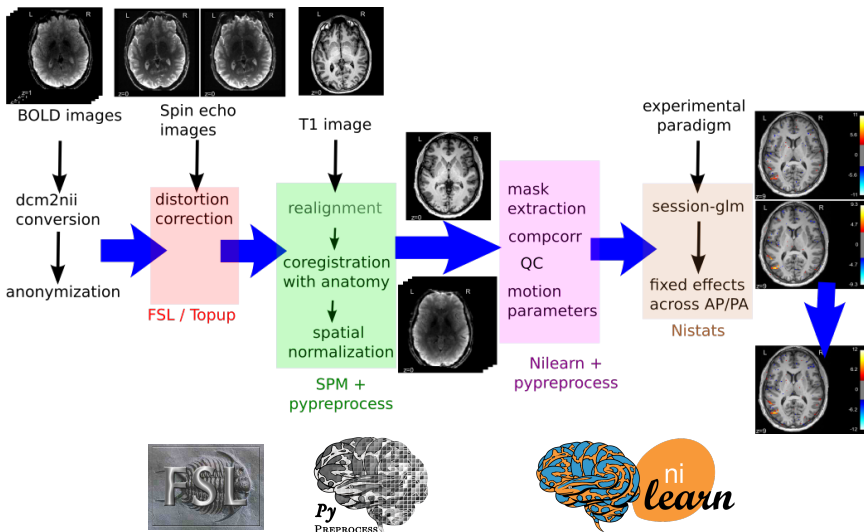
► [Link](#)

Data organization: BIDS Specification

Analysis pipeline



Individual Brain Charting



Analysis pipeline

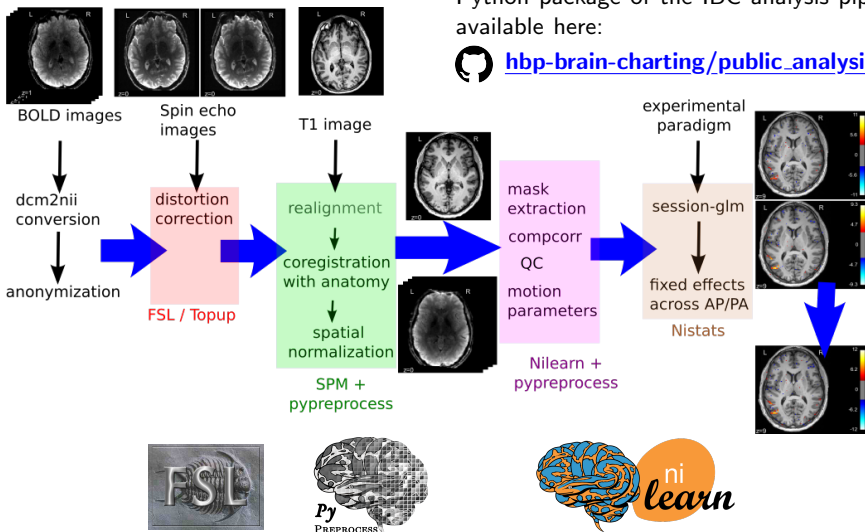


Individual Brain Charting

Python package of the IBC analysis pipeline
available here:



[hbp-brain-charting/public_analysis_code](https://github.com/hbp-brain-charting/public_analysis_code)



SCIENTIFIC DATA

OPEN

Data Descriptor: Individual Brain Charting, a high-resolution fMRI dataset for cognitive mapping

Ana Luísa Pinho^{1,2,3}, Alexis Amadon², Torsten Ruest^{1,2,3}, Murielle Fabre^{2,3,4,5,6},
Elvis Dohmatob^{1,2,3}, Isabelle Denghien^{2,3,4,5,6}, Chantal Ginisty^{2,7},
Séverine Becuwe-Desmidt^{2,7}, Séverine Roger^{2,7}, Laurence Laurier^{2,7},
Véronique Joly-Testault^{2,7}, Gaëlle Médiouni-Cloarec^{2,7}, Christine Doublet^{2,7},
Bemadette Martins^{2,7}, Philippe Pinel², Evelyn Eger^{2,3,4,5,6}, Gaël Varoquaux^{1,2,3},
Christophe Pallier^{2,3,4,5,6}, Stanislas Dehaene^{2,3,4,5,6,8}, Lucie Hertz-Pannier^{2,5,7,9}
& Bertrand Thirion^{1,2,3}

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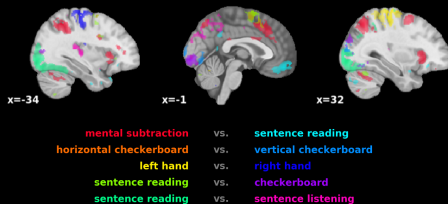
Results

Post-processed data

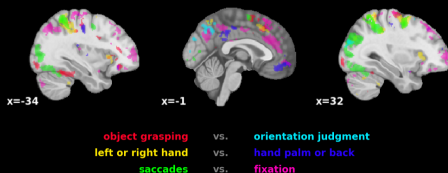


Individual Brain Charting

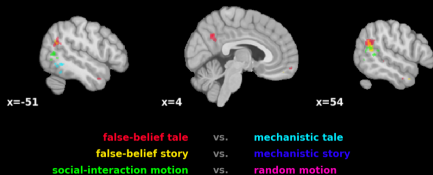
ARCHI Standard



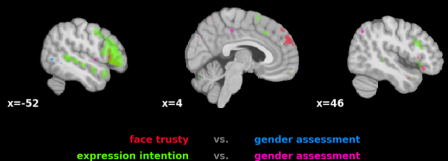
ARCHI Spatial



ARCHI Social



ARCHI Emotional



Collection id=4438

[▶ Link](#)

Group-level z-maps

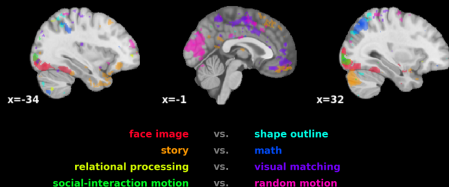
$q_{FDR} < 0.05$

Post-processed data

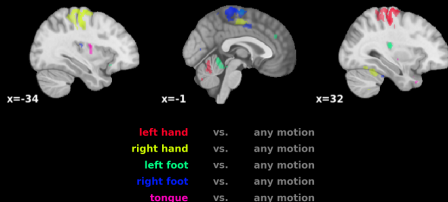


Individual Brain Charting

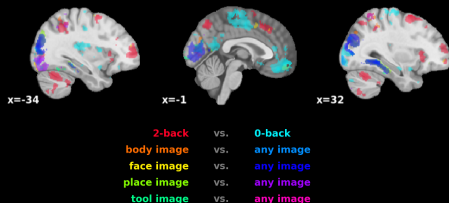
HCP Emotion, HCP Language, HCP Relational and HCP Social



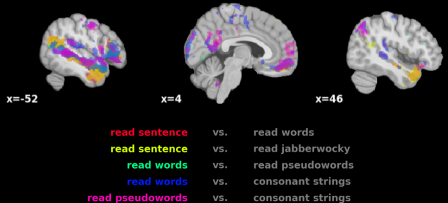
HCP Motor



HCP Working Memory



RSVP Language



Group-level F-map

$p_{FWE} < 0.05$

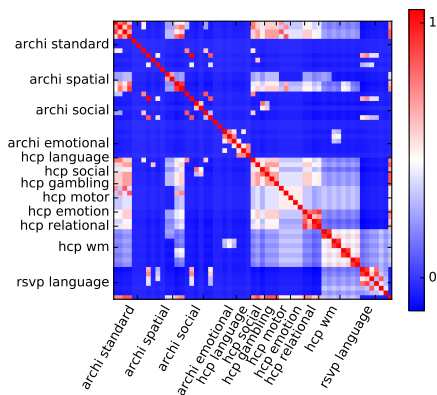
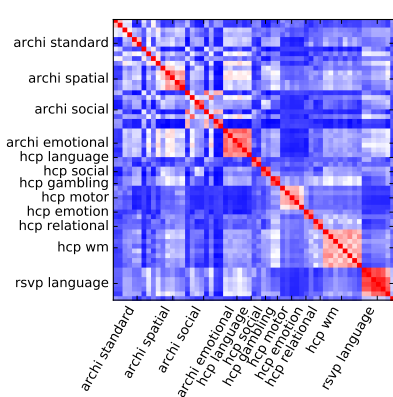


Comprehensive brain coverage of functional activity
already in the first release!

Activation similarity fits task similarity



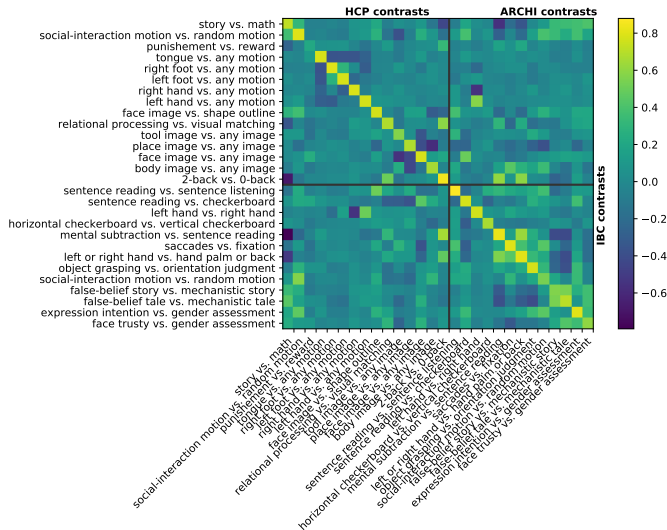
Individual Brain Charting



IBC reproduces ARCHI and HCP



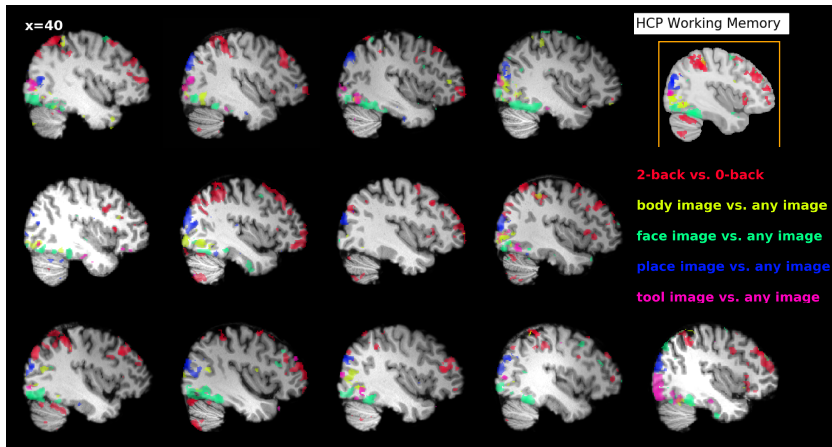
Individual Brain Charting



Variability of Functional Signatures



Individual Brain Charting



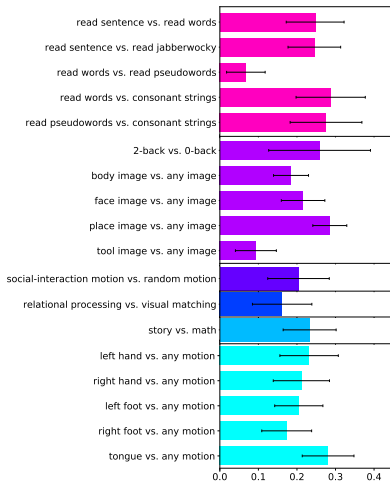
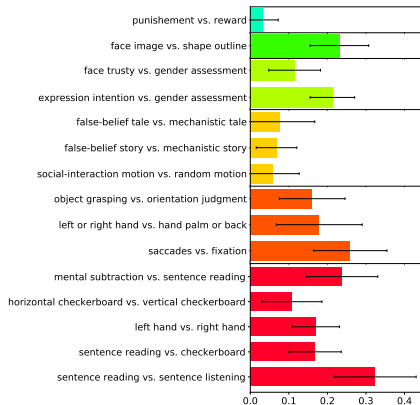
Group-level z-maps

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Variability of Functional Signatures



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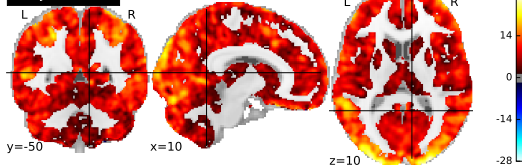
Average and standard deviation of map correlation across subjects

Effect of subject and task on brain activity

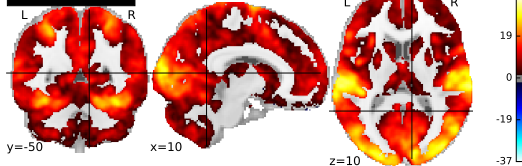
Group-level z-maps

$q_{FDR} < 0.05$

Subject effect



Condition effect

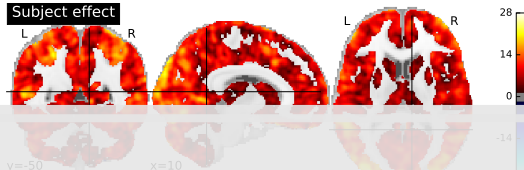


Effect of subject and task on brain activity

Group-level z-maps

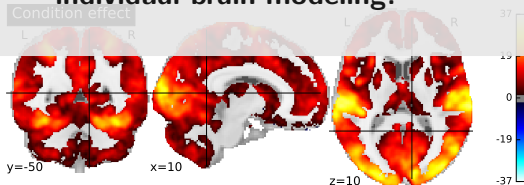
$$q_{FDR} < 0.05$$

Subject effect



- IBC data suitable for cognitive and individual-brain modeling!

Condition effect



Future releases



Individual Brain Charting

Next release is coming up soon!

- ▶ Passive-Watching of Naturalistic Scenes
- ▶ Retinotopy
- ▶ Movie Watching

Future releases

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Other releases:

- ▶ Anatomical data + Resting-State
- ▶ Chronesthesia, Positive-Incentive Value, Theory-of-Mind, Visual Short-Term Memory, Enumeration, Self-Reference Effect, Tonotopy and more...

Concluding remarks

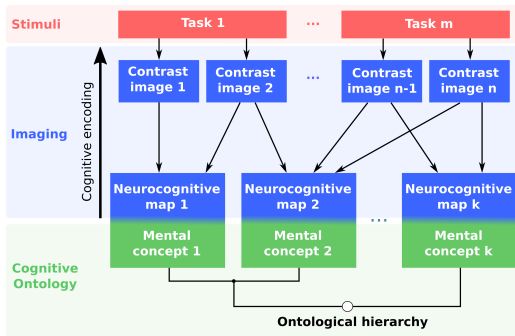
- ▶ Data acquisition till 2022

Concluding remarks

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- ▶ Final dataset: 50 acquisitions per participant

Concluding remarks

- Data acquisition till 2022
- Final dataset: 50 acquisitions per participant
- Encoding models for cognitive mapping



Thanks!

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NeuroSpin

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inria
inventors for the digital world

PARIETAL



Bertrand Thirion

...and to
the IBC volunteers!!!



Human Brain Project

Thanks!



Individual Brain Charting

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 **PARIETAL**



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Human Brain Project

 **Women in
Neuroscience**