

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



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Parietal Team, Inria-Saclay

NeuroSpin, CEA-Saclay

France



@ALuisaPinho
@JuanTresols

Open Science Room
From statistical to biological validity

OHBM Rome, Italy

11th of June 2019



Background and motivations

In cognitive neuroscience:



Brain systems



Mental functions

Background and motivations

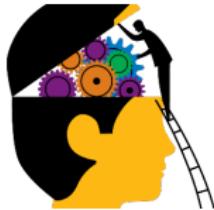
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- ▶ tackle one psychological domain

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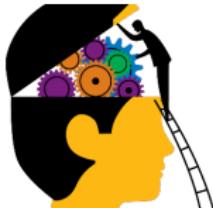
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Brain systems



Mental functions



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

Background and motivations

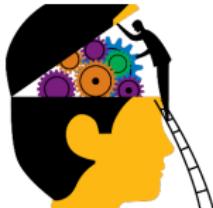
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- ▶ tackle one psychological domain
- ▶ be specific enough to accurately isolate brain processes



Very hard to achieve!
Lack of generality.



Background and motivations

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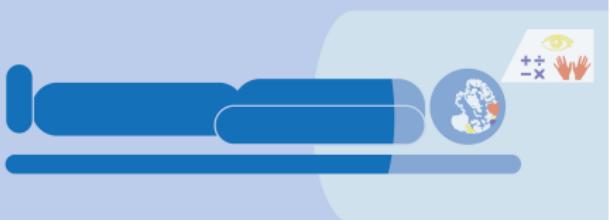
Brain systems



Mental functions

Task-fMRI experiments allow to:

- ▶ link brain systems to behavior



Features of the IBC dataset

- ▶ High spatial-resolution fMRI data
(1.5mm)

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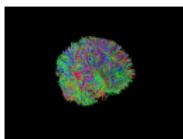
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NeuroSpin platform, CEA-Saclay, France
Siemens 3T Magnetom Prisma^{fit}
64-channel coil

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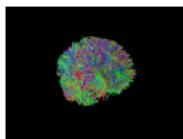
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- ▶ Inclusion of other MRI modalities



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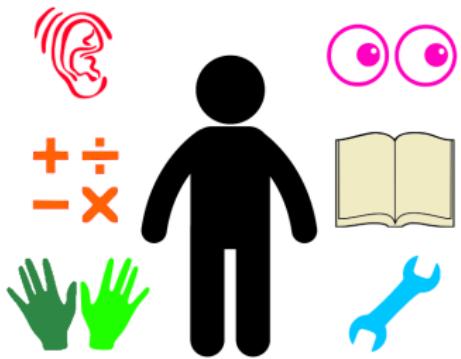


NeuroSpin platform, CEA-Saclay, France
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- ▶ Not a longitudinal study!

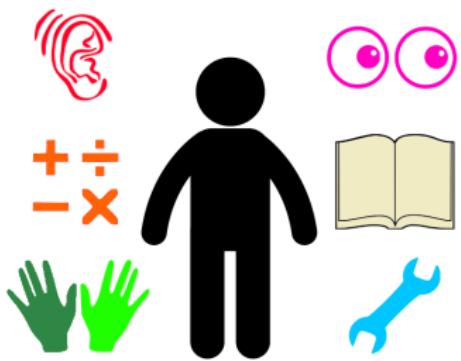
Experimental designs

- ▶ Event-related design



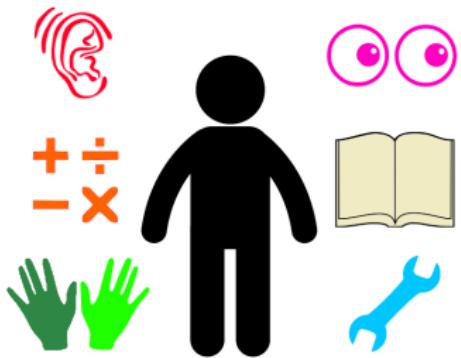
Experimental designs

- ▶ Event-related design
- ▶ Naturalistic stimuli



Experimental designs

- ▶ Event-related design
- ▶ Naturalistic stimuli
- ▶ Continuous stimulation



First release

Tasks

- ▶ ARCHI tasks
Pinel, P. et al. (2007)

First release

Tasks

- ▶ ARCHI tasks
Pinel, P. et al. (2007)
- ▶ Standard

Cognitive concepts:

- ▶ visual/auditory arithmetic processing
- ▶ visual word recognition
- ▶ vertical/horizontal checkerboard
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- ▶ response selection
- ▶ left/right finger response execution

First release

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 - ▶ Spatial

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Barch, D. M. et al. (2013)

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- ▶ left/right hand response execution
- ▶ left/right toe response execution
- ▶ working memory

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- tool/body/place/face maintenance
- updating

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- ▶ relational comparison
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- ▶ visual face/place recognition
- ▶ tool/body/place/face maintenance
- ▶ updating
- ▶ visual pseudo-word/string recognition
- ▶ syntactic parsing
- ▶ string/word maintenance

First release



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▶ theory-of-mind

▶ emotion expression identification

▶ facial trustworthiness recognition

59 independent conditions

226 contrasts

▶ executive

▶ working memory

▶ story comprehension

▶ visual pattern

▶ recognition

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Future releases

Next release is coming up soon!

- ▶ Mental-Time Travel Gauthier, B., & van Wassenhove, V. (2016a,b)
- ▶ Positive-Incentive Value Lebreton, M. *et al.* (2015)
- ▶ Theory-of-Mind + Pain Matrices Dodell-Feder, D. *et al.* (2010) / Jacoby, N. *et al.* (2015)
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- ▶ Mental-Time Trajectories / Incentive Value (2016a,b)
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- ▶ 127 independent conditions
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- ▶ 279 contrasts

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- ▶ 127 independent conditions
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Other releases:

- ▶ **Visual system:** Passive-Watching of Naturalistic Scenes + Movie Watching + Retinotopy
- ▶ Anatomical data + Resting-State
- ▶ Tonotopy, Biological Motion and more...



Individual Brain Charting

Behavioral protocols



UNIVERSITY OF
CAMBRIDGE



Maastricht University





Behavioral protocols

Individual Brain Charting

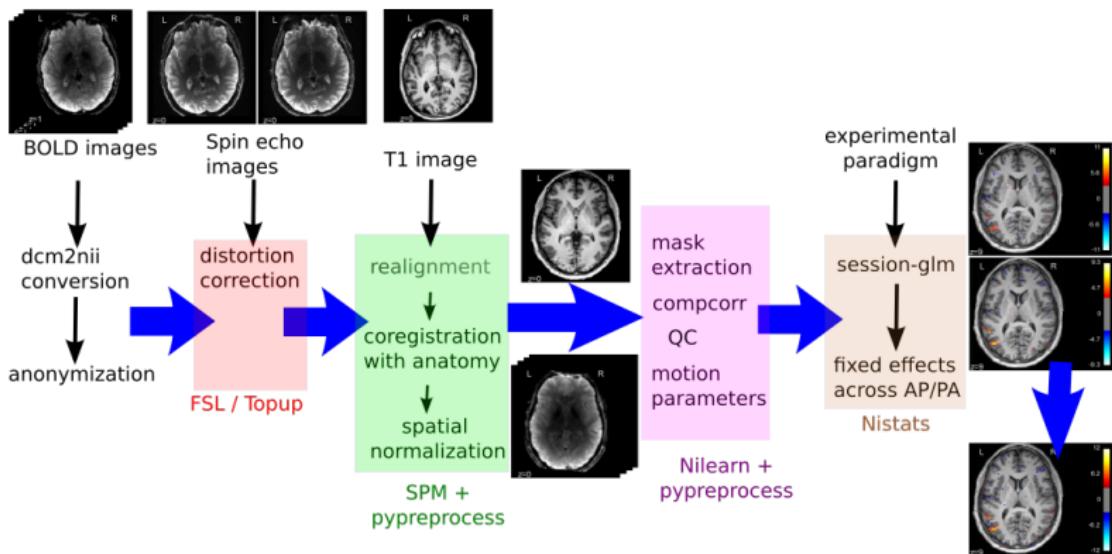


Software Tools:



Psychtoolbox 3.0
Routines for Psychophysics

Analysis pipeline



Data access

Raw MRI data

- ▶  HBP Knowledge Graph Data Platform ▶ Link

Data access

Raw MRI data

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- ▶  OpenNEURO **ds000244** [▶ Link](#)

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Behavioral Protocols

- ▶  hbp-brain-charting/public_protocols

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Behavioral Protocols

- ▶  [hbp-brain-charting/public_protocols](https://github.com/hbp-brain-charting/public_protocols)
 - More public repositories of behavioral protocols to reproduce experiments!
 - Normatives to describe the experimental paradigms!

Data access

Analysis Pipeline

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

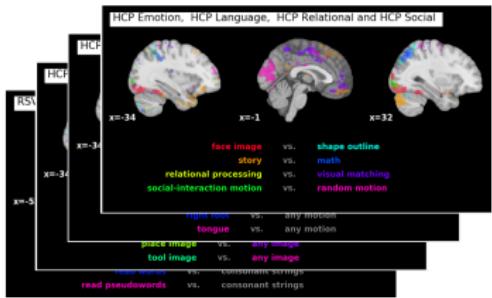
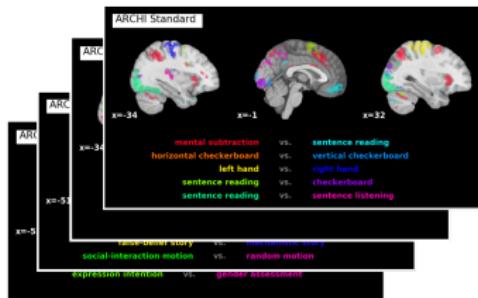
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Data derivatives

-  **NEUROV рАУЛТ** Collection id=4438 [▶ Link](#)



Data access

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Data derivatives



SCIENTIFIC DATA

OPEN

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

Ana Lúcia Pirho^{1,2,3}, Alexis Amadon², Torsten Ruest^{1,2,3}, Murielle Fabre^{2,3,4,5,6}, Elvis Dohmoto^{1,2,3}, Isabelle Denghin^{2,3,4,5,6}, Chantal Ginsty^{2,3}, Séverine Beucue-Desmidt^{2,3}, Séverine Roger^{1,2}, Laurence Laurier^{2,3}, Véronique Joly-Tessier^{2,3}, Gaëlle Mediouni-Cloarec¹, Christine Double^{2,3}, Bernadette Martin^{2,3,4,5}, Philippe Pinel², Evelyn Eger^{2,3,4,5}, Gaël Varoquaux^{1,2,3}, Christophe Pallier^{2,3,4,5}, Stanislas Dehaene^{1,2,3,4,5,6}, Lucie Hertz-Pannier^{1,2,3} & Bertrand Thirion^{1,2,3}

doi.org/10.1038/sdata.2018.105

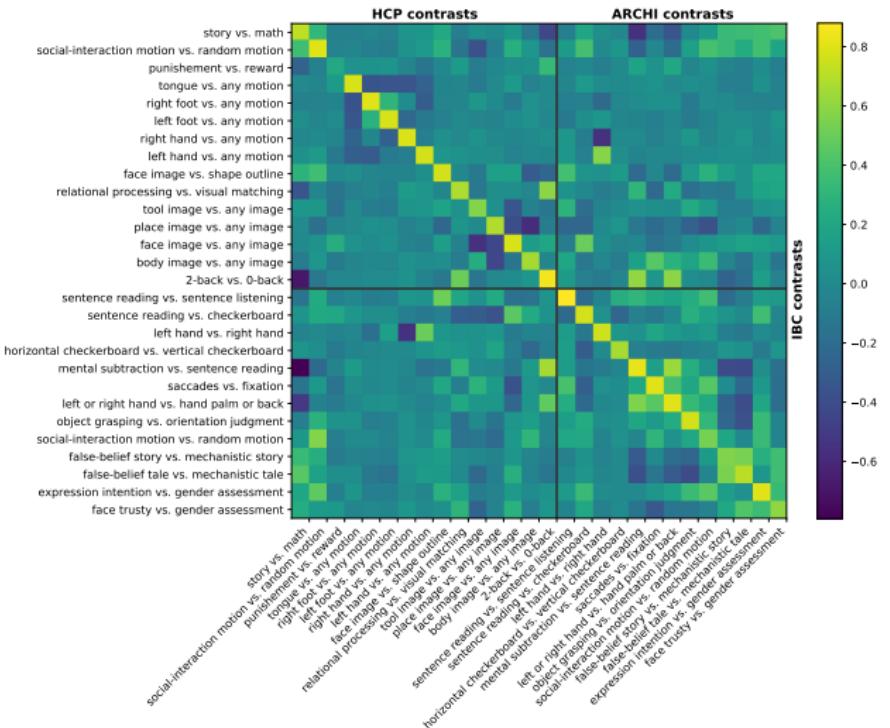


Results

IBC reproduces ARCHI and HCP



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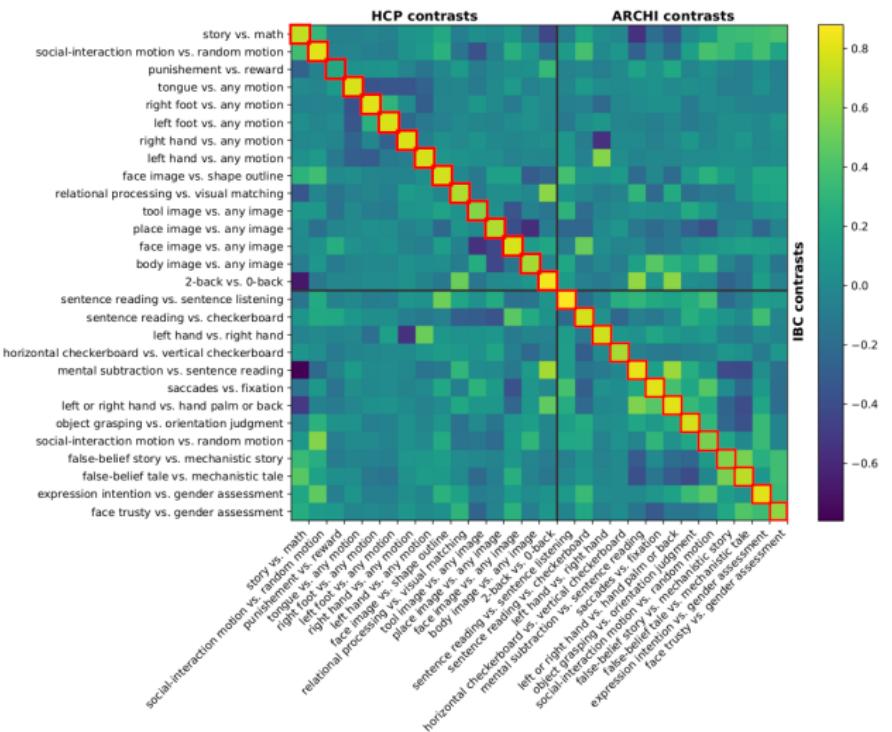
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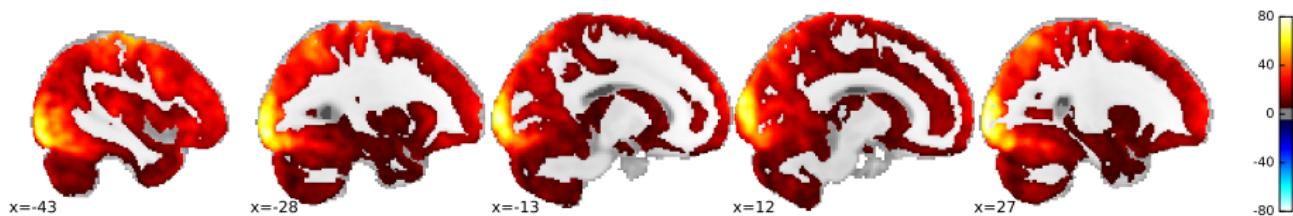
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Brain coverage

Group-level F-map

$p_{FWE} < 0.05$

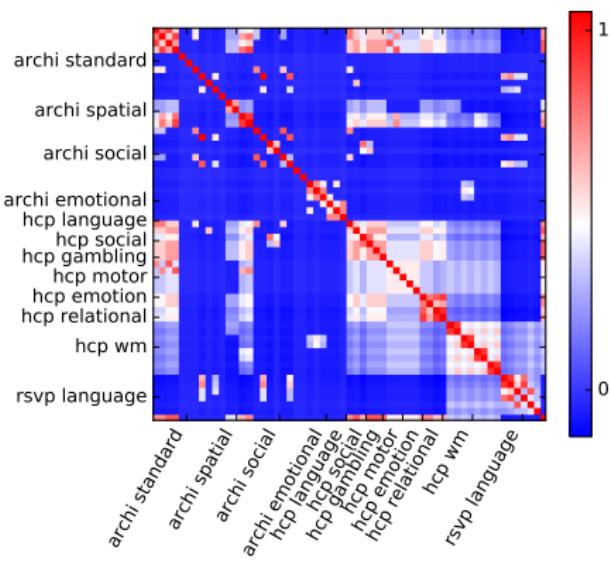
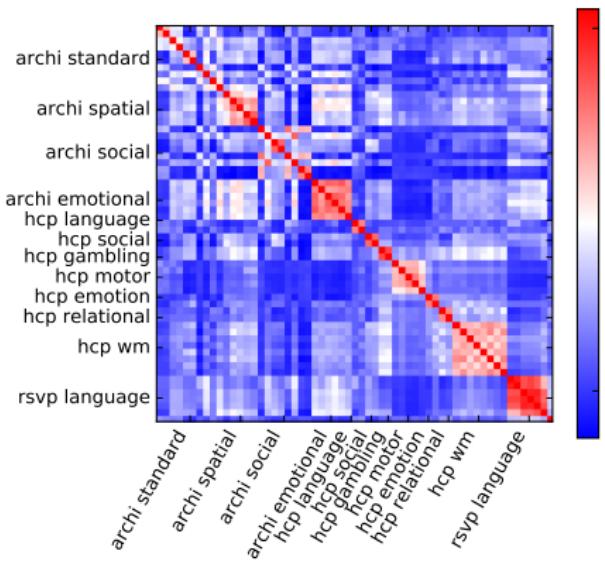


Comprehensive brain coverage of functional activity
already in the first release!

Activation similarity fits task similarity

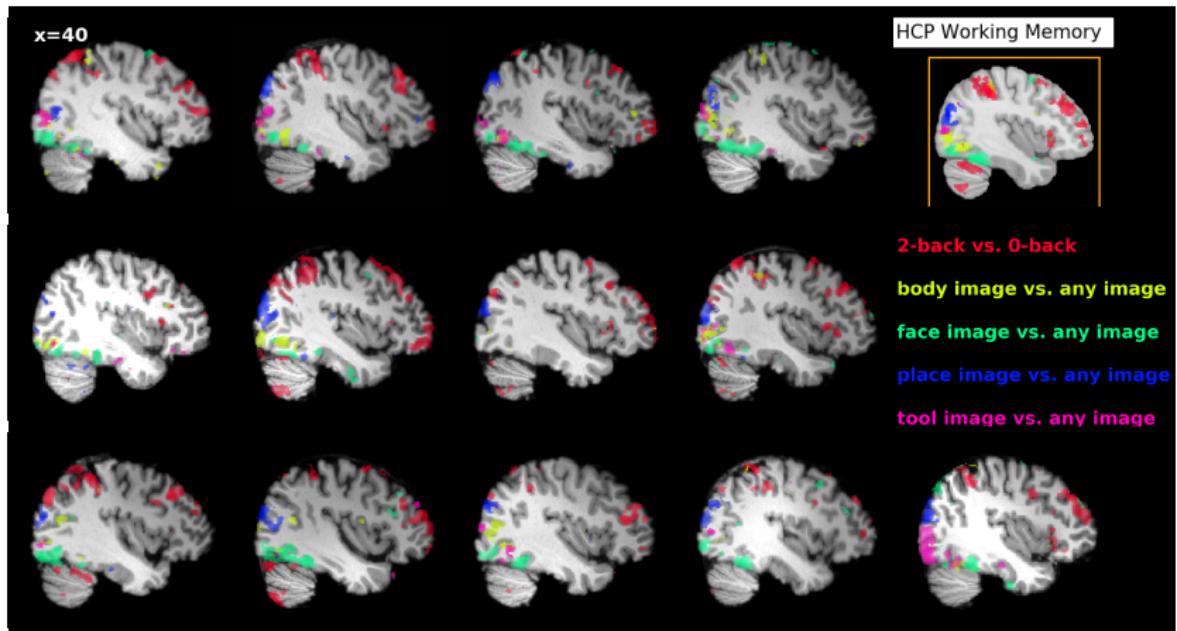


Individual Brain Charting



Variability of Functional Signatures

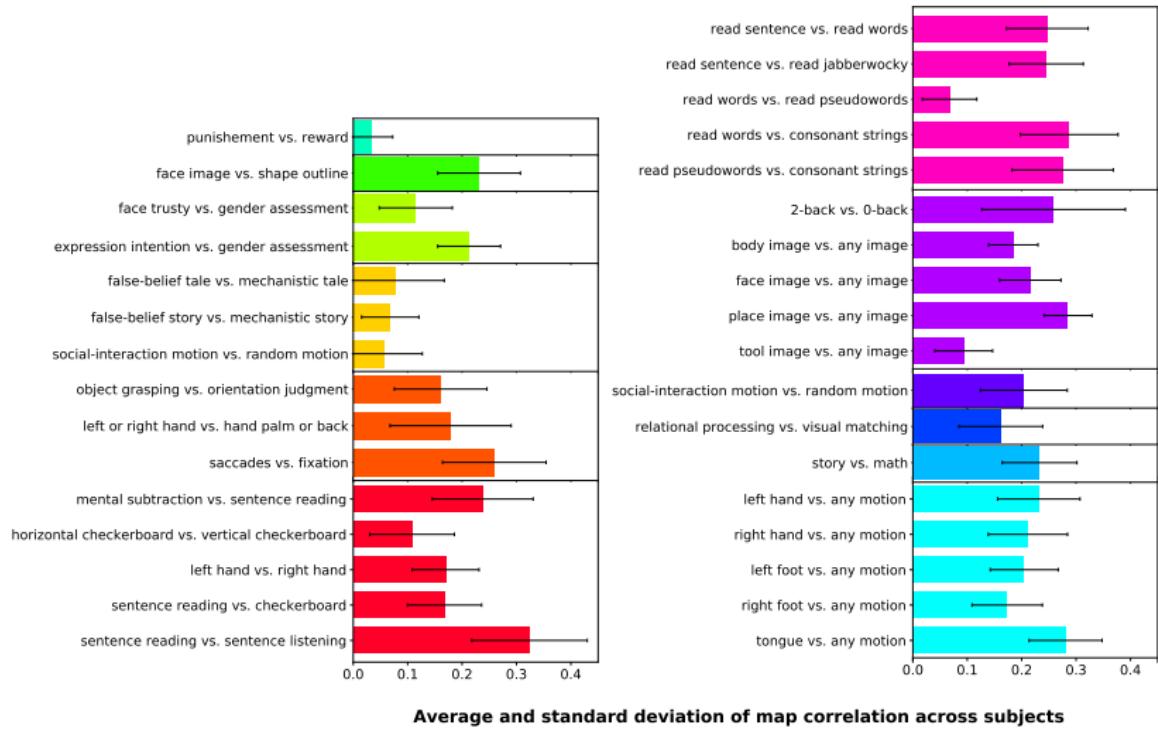
Individual Brain Charting



Individual z-maps

Variability of Functional Signatures

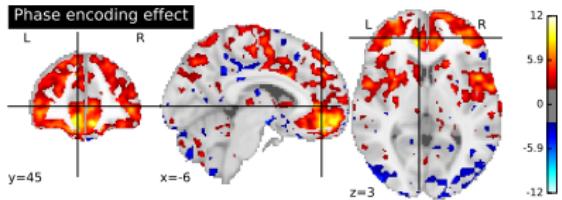
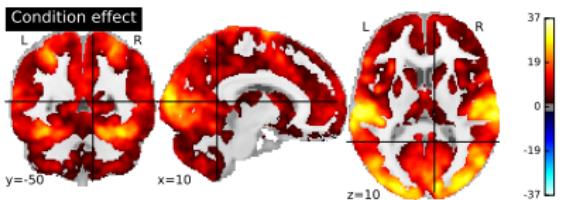
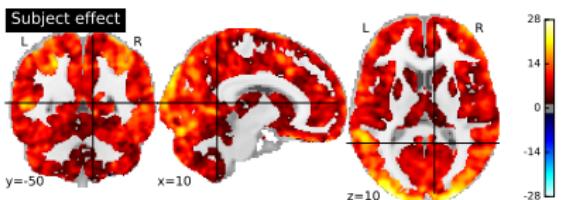
Individual Brain Charting



Effect of subject and task on brain activity

Per-voxel one-way ANOVA

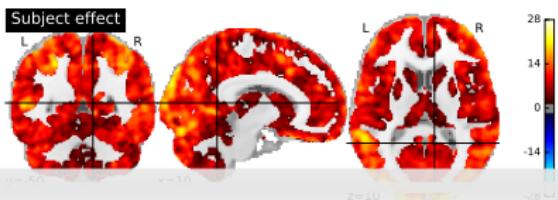
$q_{FDR} < 0.05$



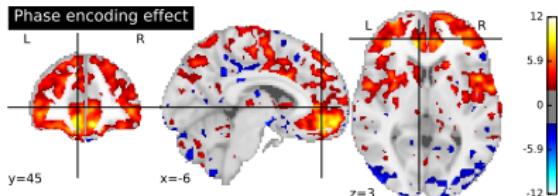
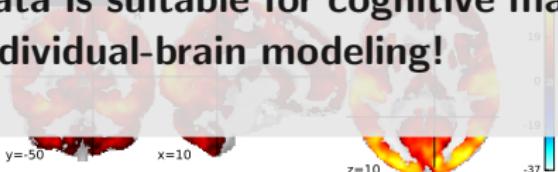
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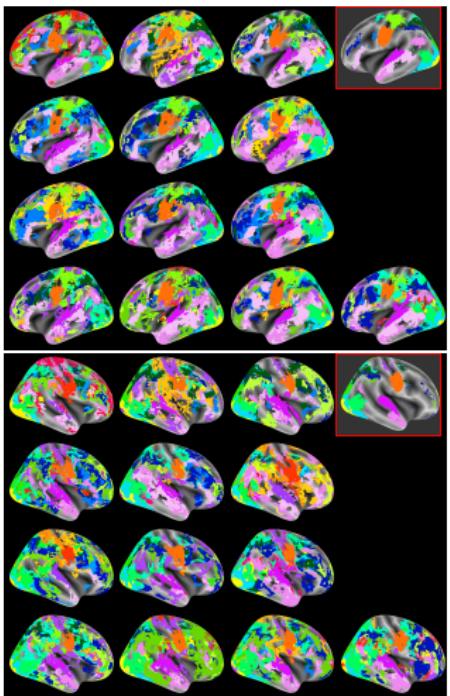
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- IBC data is suitable for cognitive mapping and individual-brain modeling!

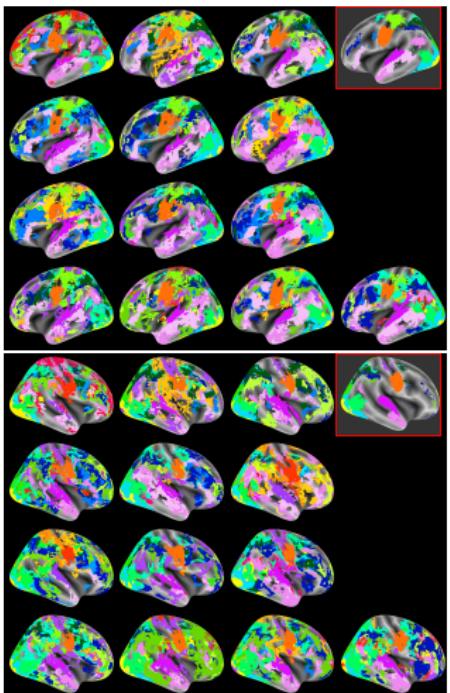


Exploring individual cognitive topographies



read sentence, read words
social-interaction motion, story
left hand, read pseudowords
mechanistic tale, natural sound
gender assessment, mechanistic stor
social-interaction motion, voice soun
tongue
left foot, right foot
read words, tool image
face image, sentence reading
button presses
orientation judgment, right hand
2-back, relational processing
place image, reward
random motion, saccades
random motion
hand palm or back
expression intention, object grasping
left or right hand, mental subtraction
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Tasks consistently map brain networks across individuals.

Concluding remarks

- ▶ Data acquisition till 2022

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50 acquisitions per participant

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Share your protocols
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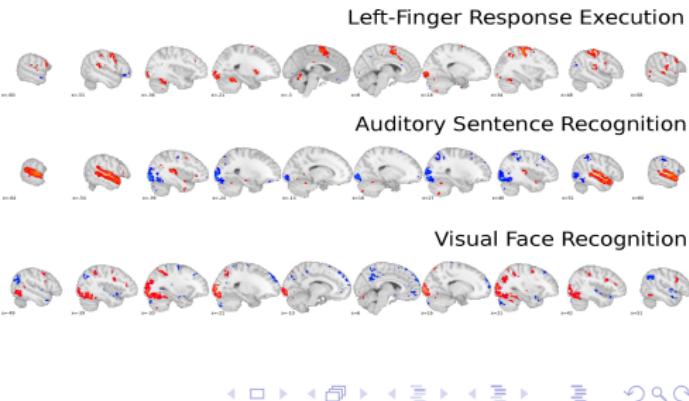
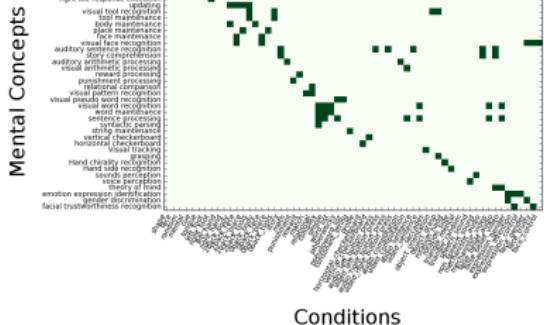
Concluding remarks



Individual Brain Charting

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

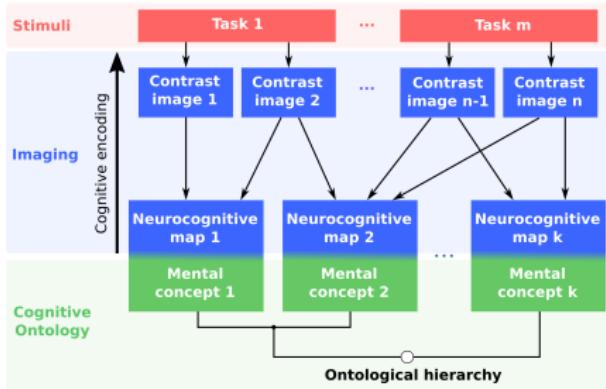
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Concluding remarks

- ▶ Data acquisition till 2022
- ▶ Final dataset:
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- ▶ Encoding models for cognitive mapping

Share your protocols
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Thanks!



Individual Brain Charting



Inria
inventors for the digital world



...and to
the IBC volunteers!!!



 PARIETAL

Bertrand Thirion



Human Brain Project

For more information, consult: project.inria.fr/IBC
Visit us tomorrow at the poster session: #W585

Repository for Women in Neuroscience

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Support the project:

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- spread the word
- submit recommendations

