



INRIA Saclay,



Équipe Parietal <http://team.inria.fr/parietal>



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## Human Brain Project Post-doc Proposal: Charting the human brain with fMRI

**Keywords:** functional brain imaging, cognitive atlas, systems neuroscience, brain parcellation

**Duration & salary:** 12 months renewable up to 3 years, about 2100 €net monthly

**Research teams:** Parietal (INRIA Saclay) and NeuroSpin (CEA)

**Responsible:** Bertrand Thirion

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**Application:** Interested candidate should send CV and motivation letter

### Context: Large-scale functional atlas

Having a working model of brain organization has been a historical and major goal in neuroscience. With the advent of cognitive neuroimaging, it has become clearer that functional specificity is at the same time a prominent marker of architectural differences in the brain and the most natural way to characterize the differences between territories [2]. Moreover, while many brain atlases have been inferred and released, based on various imaging modalities and experimental procedures, their justification has been weakened by the absence of concomitant release of data to back up the available atlas and by the large-inter-subject variability that unavoidably blurs population models. Advances will be made possible by:

1. Acquiring a **large number of functional protocols** that probe as many cognitive processes as possible on a fixed group of subjects, so that each putative brain region (area or module) can be characterized unambiguously through a unique functional signature and position in individual brains.
2. Making the data and ensuing processing steps available to the community, so that the results of this mapping can be easily reproduced and compared to other data.

The **Human Brain Project** (HBP, <http://www.humanbrainproject.eu>) aims at developing a model of the human brain organization; the bottom-up approach that consists in building a brain by going all the way from molecular to system-level organization needs to be informed by high-level constraints that shape the macroscopic organization of the brain. A particular task has been defined as part of the HBP, that consists in repeatedly scanning a limited number of subjects with a large class of functional protocols (retinotopic, tonotopic, somatotopic, visual categories, space and number, language, social cognition, resting state...) together with high-resolution anatomy and diffusion-weighted scans. The project was launched end 2013 and the acquisition started mid-2015 <https://project.inria.fr/IBC>. The project has recently output an impressive number of high-resolution brain maps (<http://neurovault.org/collections/2138>), that provide an objective basis to inform the definition of brain regions. The richness of the dataset resides in the variety of cognitive functions probed.

### Post-doc proposal roadmap

The post-doc will be in charge of setting a set of protocols up and running to pass them on the existing pool of 12 subjects. These protocols will be provided by the community (potentially from in-house developments) are meant to cover a large array of cognitive processes (in the sense of <http://www.cognitiveatlas.org>). The validation of these protocols and the necessary adaptations and

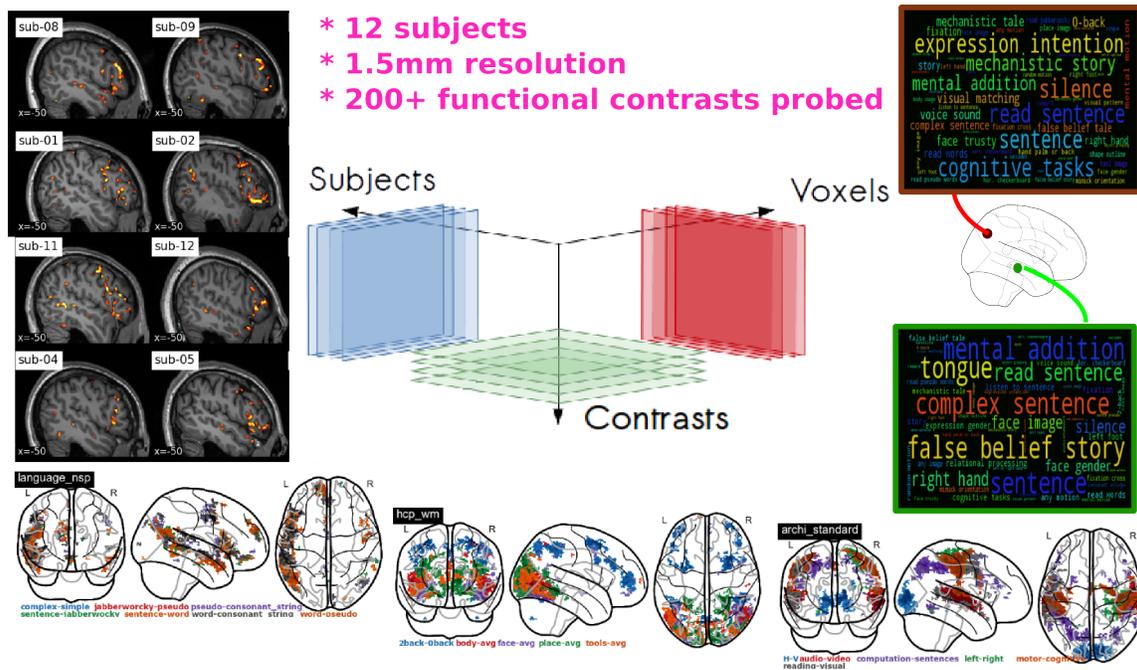


Figure 1: Principle of the IBC project: High resolution individual brain images make it possible to map accurately brain responses. The accumulation of these data lead to a much more complete description of the functional organization of the brain.

implementations of the protocols, will be carried out in close collaboration with the Unicog lab at Neurospin (<http://www.unicog.org>).

The post-doc will take part to the set of acquisitions performed on Neurospin 3T (and possibly the 7T in the longer term) scanner at high resolution (1.5mm) and analyze the data by using a pipeline provided by the lab. He/she will be involved in the improvement of this pipeline and will obtain activation maps related to these various contrasts, with support from technical experts. The data will be analyzed both in the volume and on the cortical surface. Detailed reports will be provided to assess the quality of the data, motivate the participants and document the content of the database. The analysis of the whole dataset will yield at least two kinds of results:

- A **parcellation of the brain** volume into functionally specific territories that can be characterized precisely based on the contrasts used in the functional tasks. Care will be taken that all the corresponding regions are identified in all subjects of the group.
- A meta-analysis that will ensure that **each cognitive function** probed can be unambiguously defined by a **unique activation pattern**, in a manner that can be generalized across individuals (reverse inference, see e.g. [3]).

The data will also systematically be compared with existing resources (OpenfMRI, NeuroVault, Neurosynth, Human Connectome Project). The methodological aspects will be carried out in close collaboration with the Parietal team at Neurospin (<http://team.inria.fr/parietal>), that

has recently developed specific techniques to perform brain parcellation effectively [5, 1] and to discriminate between distributed activation patterns [4]. The post-doc will also re-use the existing pipeline and quality checking tools of the Parietal team.

#### Results:

All the raw and processed data, stimuli, as well as the functional atlases inferred from the data will be put online to become a **reference for the neuroimaging community**, together with an exhaustive documentation on the acquisition and processing parameters. The candidate will have the opportunity to present the first large-scale analysis of the data to the neuroimaging community and to the HBP consortium. This will include making decision on regions where functional selectivity is not consistent in the literature (e.g. selectivity to categories in the ventral visual cortex). Care will be taken to describe adequately the topographical organization of the maps on the cortical surface. The post-doc will take part to decisions regarding the choice of functional localizer experiments to carry out for the sake of completeness and accuracy of the functional brain atlas, including high resolution maps acquired in ROIs, possibly at 7T.

#### Required skills:

- **Mandatory:** Prior experience on running and analyzing an fMRI protocol, including in particular localization-related protocols (retinotopy, tonotopy, somatotopy etc.).
- **Mandatory:** PhD in cognitive neuroscience.
- **Desired:** prior experience on meta-analysis
- **Desired:** prior experience of working/programming in Python.
- **Desired:** basic knowledge of MVPA.
- **Mandatory:** The candidate should be willing to work in a multi-disciplinary environment (cognitive neuroscience, MRI acquisition, computer science).

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