



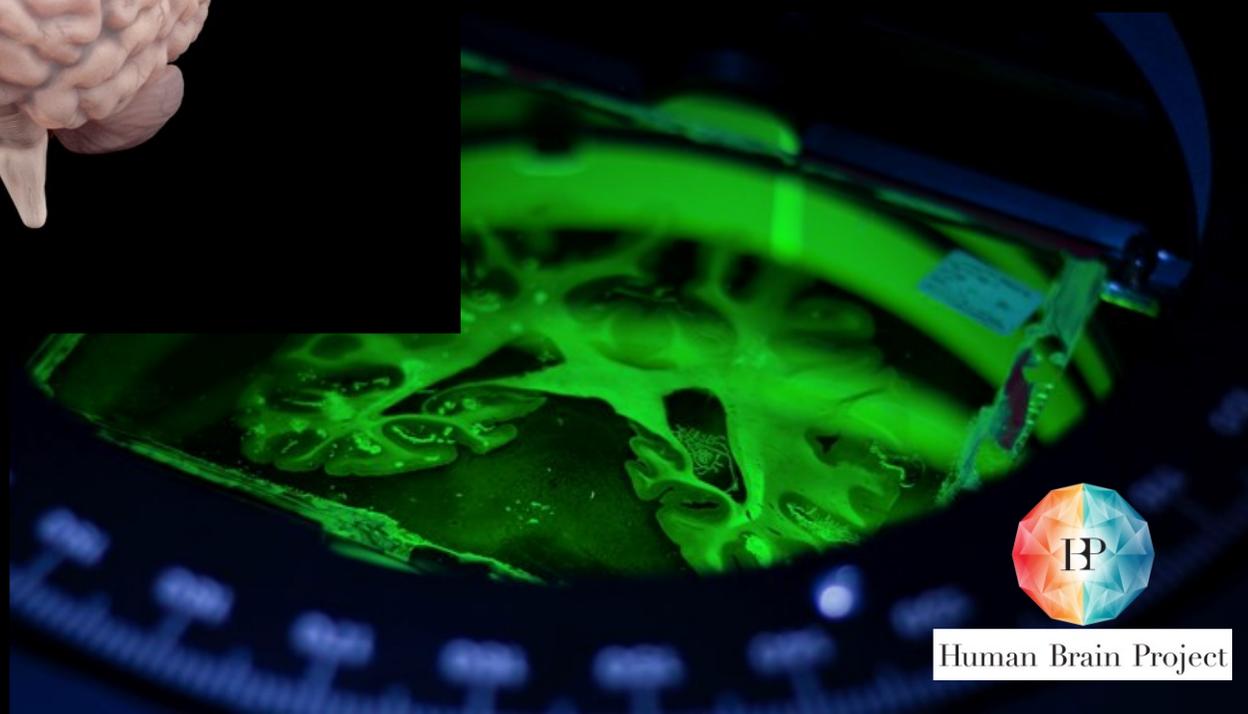
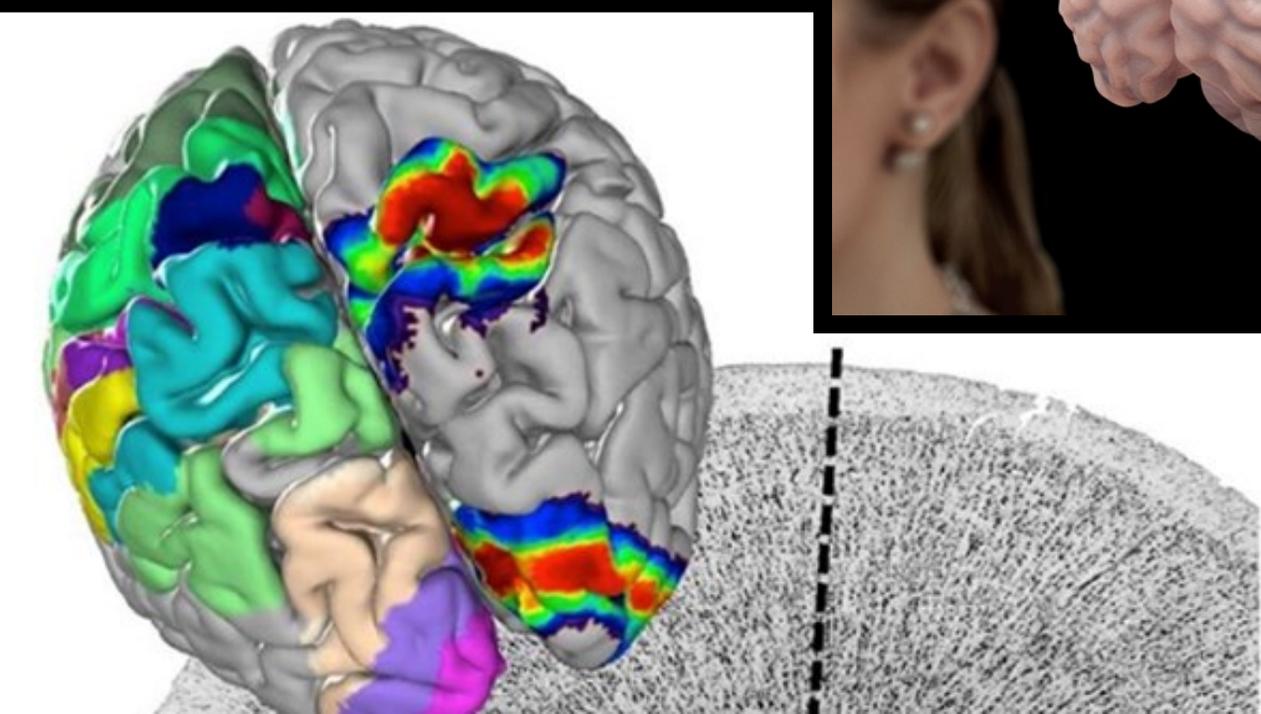
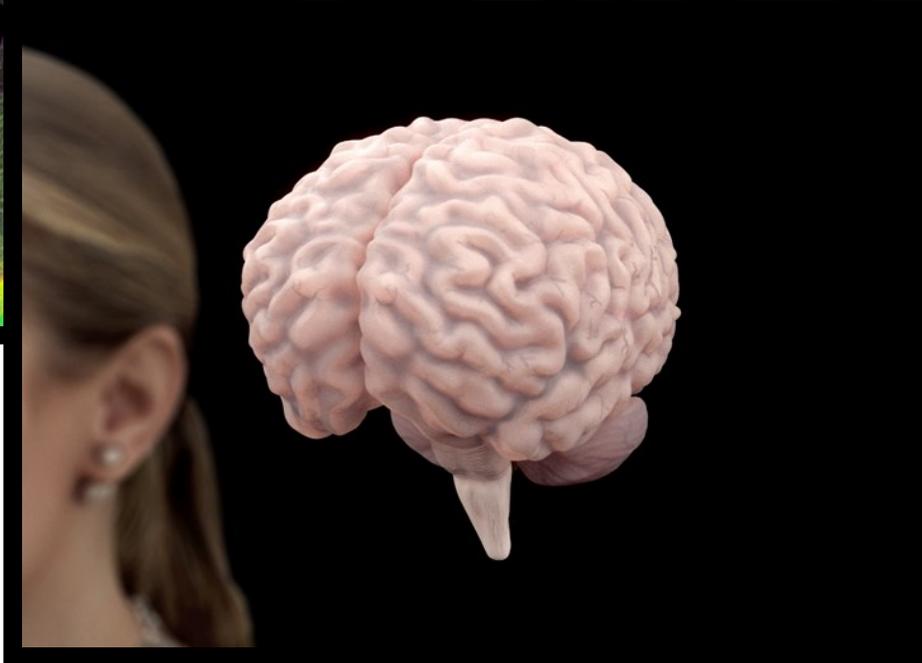
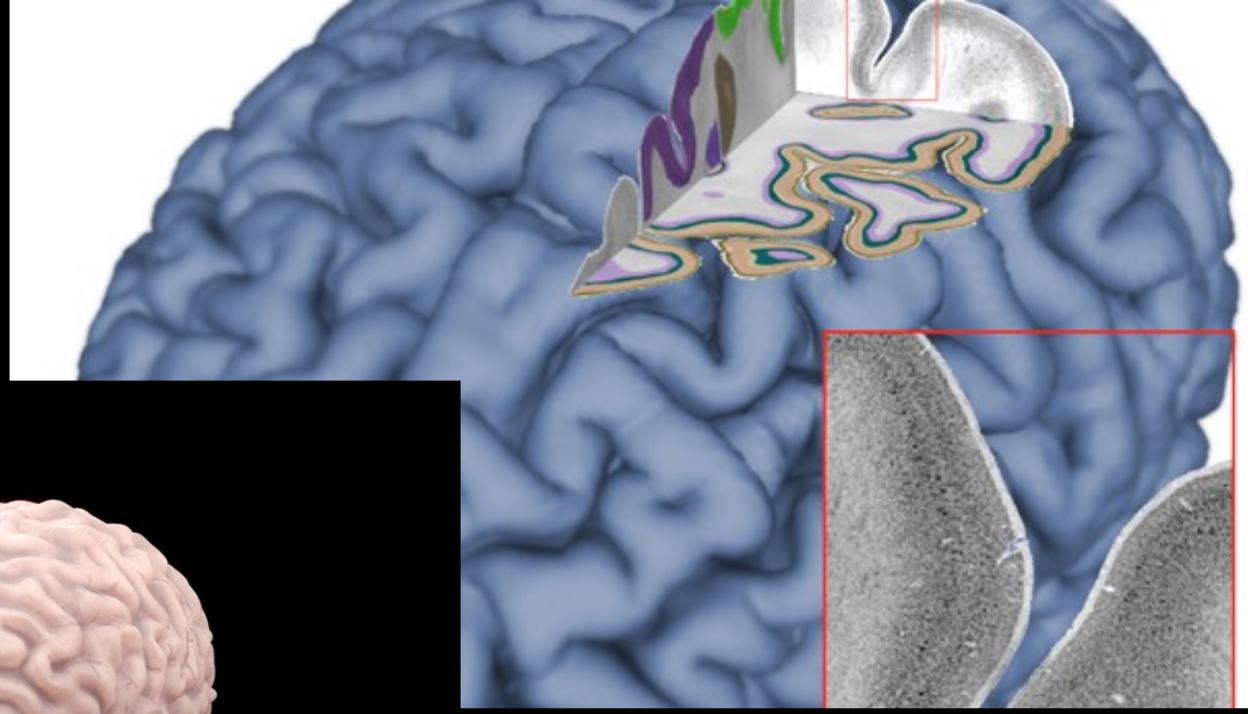
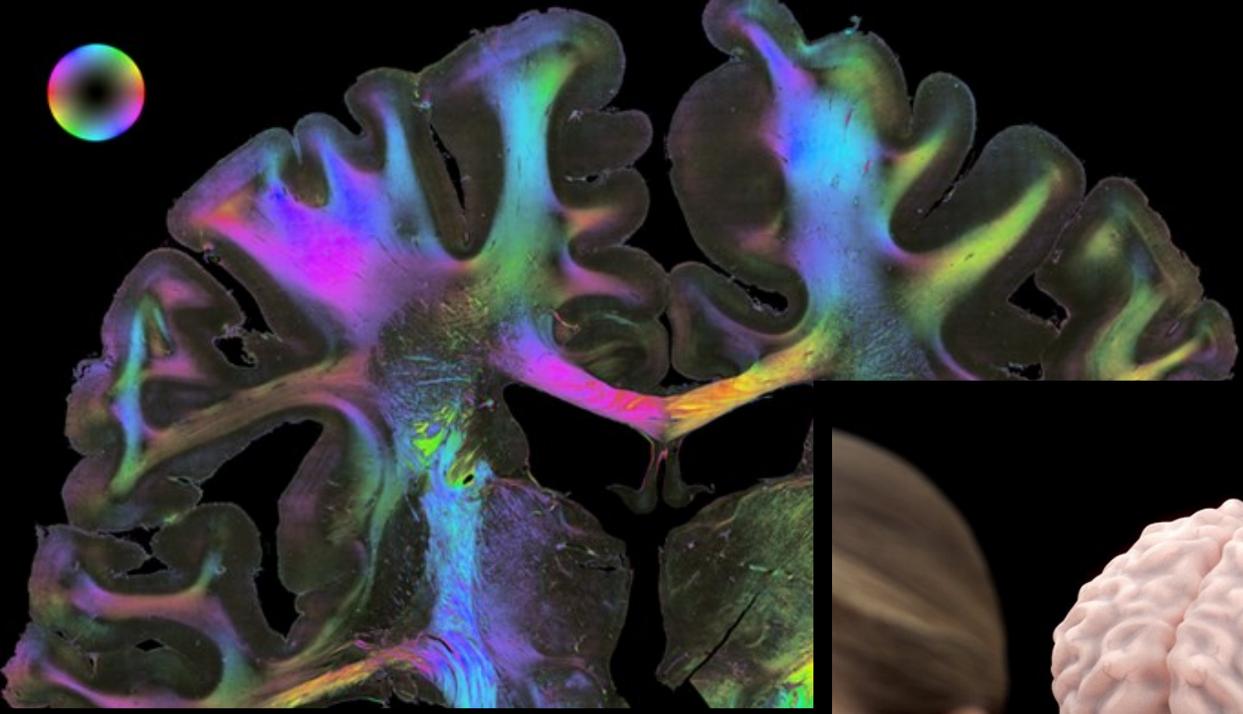
Investigación y recursos
generados en el Human
Brain Project
WP2: Redes cerebrales
que subyacen a la
cognición y la consciencia

Mavi Sánchez Vives, MD, PhD

ICREA Research Professor,
IDIBAPS, Barcelona

HBP WP2 leader

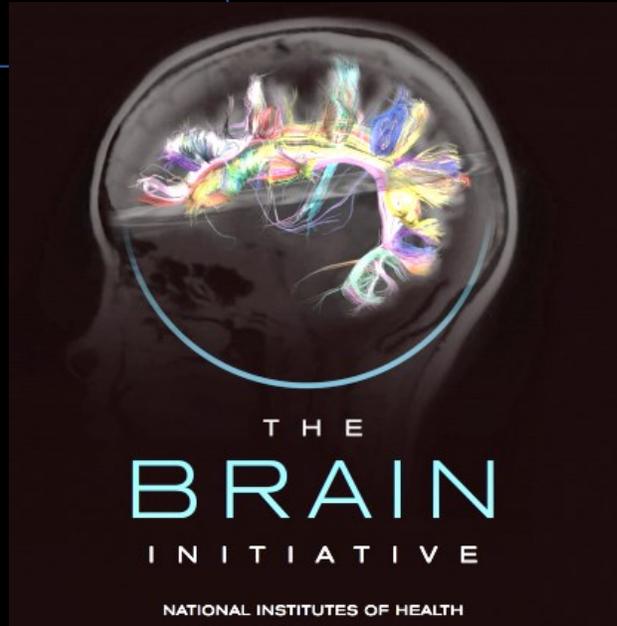




Human Brain Project



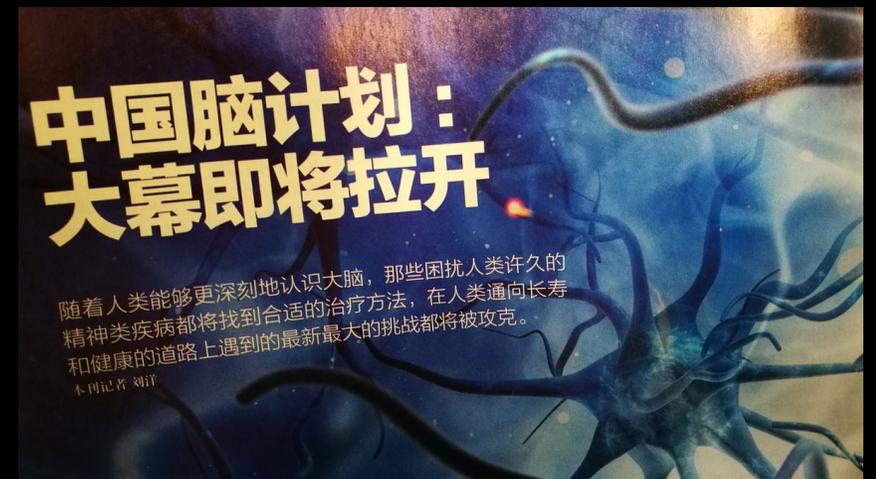
ALLEN INSTITUTE *for*
BRAIN SCIENCE

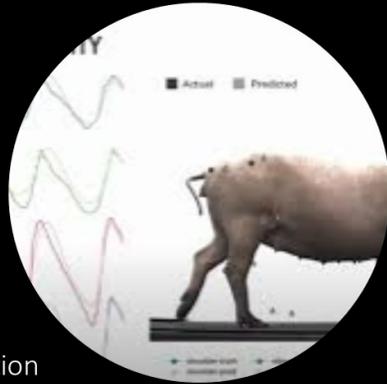


China Brain Project
Japan/MINDS
Korean Brain Initiative
Brain Canada
Australia Brain Alliance
Israel Brain Technologies
...



Human Brain Project





Neuralink presentation
August 29th, 2020

**Elon Musk's
brain-computer
interface
company raised
\$27 million and
is looking for
plenty more**





Why now?

We CAN study the brain

- **Advances in brain imaging and optics**
- **Developments in micro and nanoelectronics**
- **New materials, e.g. graphene**
- **Light controlled drugs, optogenetics**
- **Computational capabilities and AI**
- **Developments in robotics and VR**
- **Genomics and gene therapy**
- ...

We NEED to study the brain

- **Prevalence of neuropsychiatric disease in Europe: 180 M people/year**
- **Increasing prevalence**
- **10% of DALYs (years for life lost due to early disease of disability)**
- **Cost: 800.000 M euros / year**
- **MENTAL HEALTH in the center of the agenda due to Covid-19**
- **Novel technologies that can interact with the brain**
- ...

Why do we need a common platform for brain sciences?



- We generate much larger sets of data: more resolution, more channels, ...
- We need new resources to analyze these larger sets of data
- We have moved towards a more collaborative science: need of platforms
- New research projects require “Data management plans”
- Open science: New publications ask for the original data
- Cost of data acquisition is high/ Data cannot be lost
- ... change in paradigm
 - New challenges: how to generate these platforms to be useful and used
 - Regulations: Still, we should protect the rights of experimentalists, with proper citations, data embargo, etc



EBRAINS

EBRAINS is a **new digital research infrastructure** that draws on cutting-edge neuroscience, computing and related technologies to translate the latest scientific discoveries into innovation in industry and medicine.



EBRAINS is key to generating the **necessary synergy between research efforts that are often fragmented, across nations and between different scientific disciplines**; providing a unique, distributed digital research infrastructure for all of Europe and beyond.

EBRAINS aims at accelerating collaborative brain research with a **comprehensive package of tools and facilities**.

Curated and Shared Data:
EBRAINS FAIR data services

Brain Atlas Services:
Navigate the brain in 3D

Brain Modelling and Simulation Workflows:
Integrated tools to create and investigate models of the brain

Closed loop AI and Robotics Workflows:
Design, test, and implement robotic AI solutions

Medical Brain Activity Platform:
Human intracerebral EEG database and analysis service

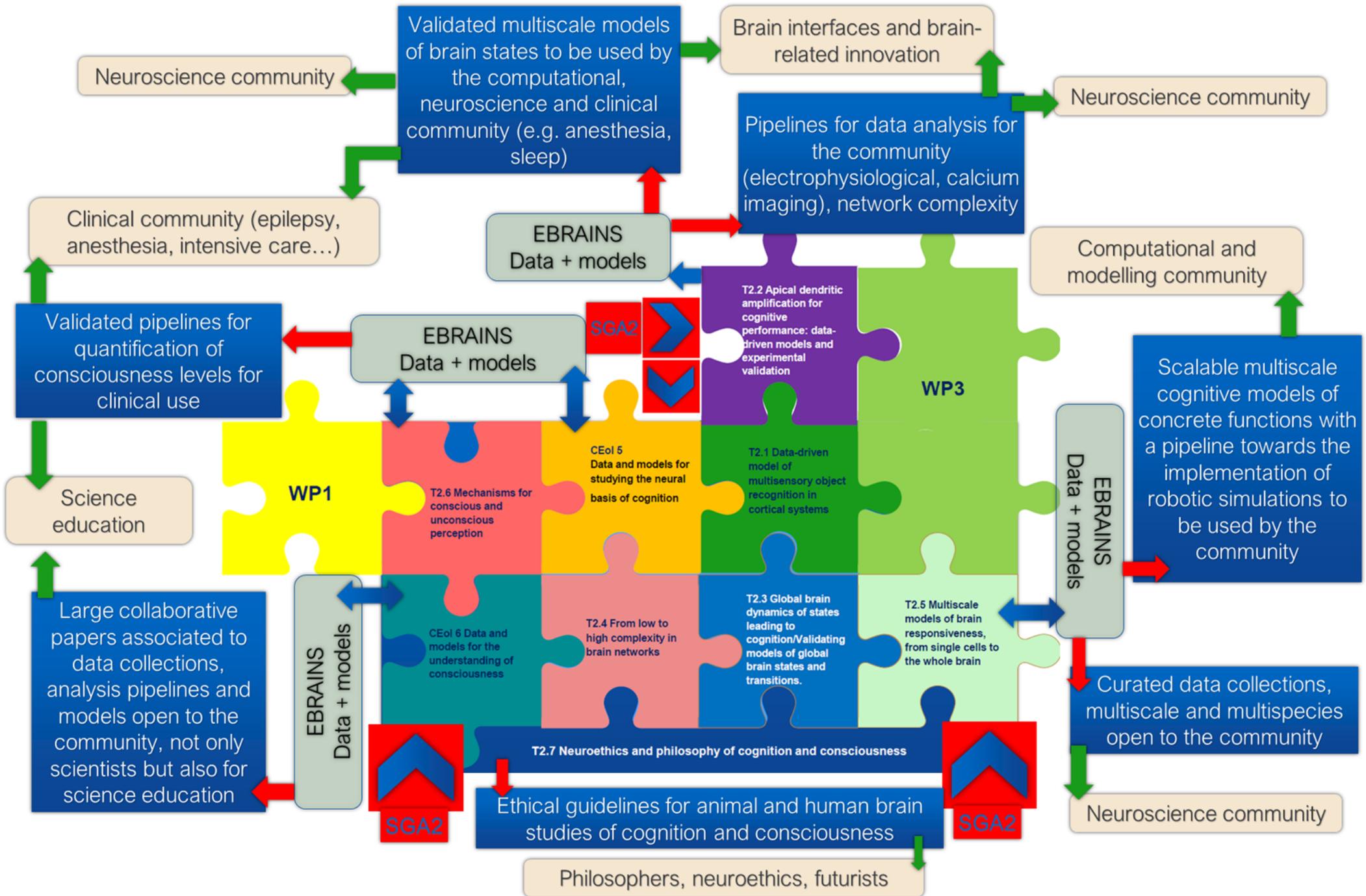
Interactive Workflows on High-Performance Computers or Neuromorphic Computers:
Europe-wide access to scalable and interactive compute services

The EBRAINS **services are a game-changer**, enabling brain researchers to tackle their questions and other disciplines **to benefit from brain research.**

WP2 Networks underlying brain cognition and consciousness

- T2.1 Data-driven model of multisensory object recognition in cortical systems
- T2.2 Apical dendritic amplification for cognitive performance: data-driven models and experimental validation
- T2.3 Global brain dynamics of states leading to cognition, validating models of global brain states and transitions.
- T2.4 From low to high complexity in brain networks
- T2.5 Multiscale models of brain responsiveness: from single cells to the whole brain
- T2.6 Mechanisms for conscious and unconscious perception
- T2.7 Neuroethics and philosophy of cognition and consciousness
- T2.8 WP2 Coordination, management and WP-related outreach
- T2.9 Influence of Complex Reward Computation and Working Memory Load onto Decision-Making
- T2.10 Brain Inspired Consciousness
- Task T2.11 Technical engineering and scientific integration
- Task T2.12 Singularity of the human consciousness





WP2 Networks underlying brain cognition and consciousness

- Mechanisms of cognition, implementation in models and robots
- Data and models of brain states: from unconsciousness to consciousness with a connection with the clinic: disorders of consciousness (TBI, stroke...), anesthesia levels
- Consciousness: measurement in DOC (stimulation, fMRI), perceptual consciousness
- Ethical guidelines in neuroscience research and consciousness studies
- Generation of EBRAINS resources: data collections, models and analysis pipelines (data includes humans and animal models)
- Live papers, Showcases, Usecase



EBRAINS Knowledge Graph



EBRAINS

A metadata management system built for EBRAINS

 Search (e.g. brain or neuroscience)



SEARCH

FIND and **SHARE** data and models

CONNECTS you to the **TOOLS** to help you analyse the data

SUPPORTS rich terminologies and ontologies

BRINGS together different fields on brain research

Findable, Accesible, Interoperable and Reusable

More than 850 Datasets, 90 Models and 130 Software Tools

<https://kg.ebrains.eu/>

EBRAINS Knowledge Graph

A metadata management system built for EBRAINS



EBRAINS

 Search (e.g. brain or neuroscience)



SEARCH

SHARE YOUR DATA

Receive Data Management Support

Get a citable DOI and ensure proper credit

Store your data in a long-term repository

Enable data reuse

Get new funding opportunities

Foster new collaborations

<https://kg.ebrains.eu/>

Showcase: Brain Complexity and Consciousness



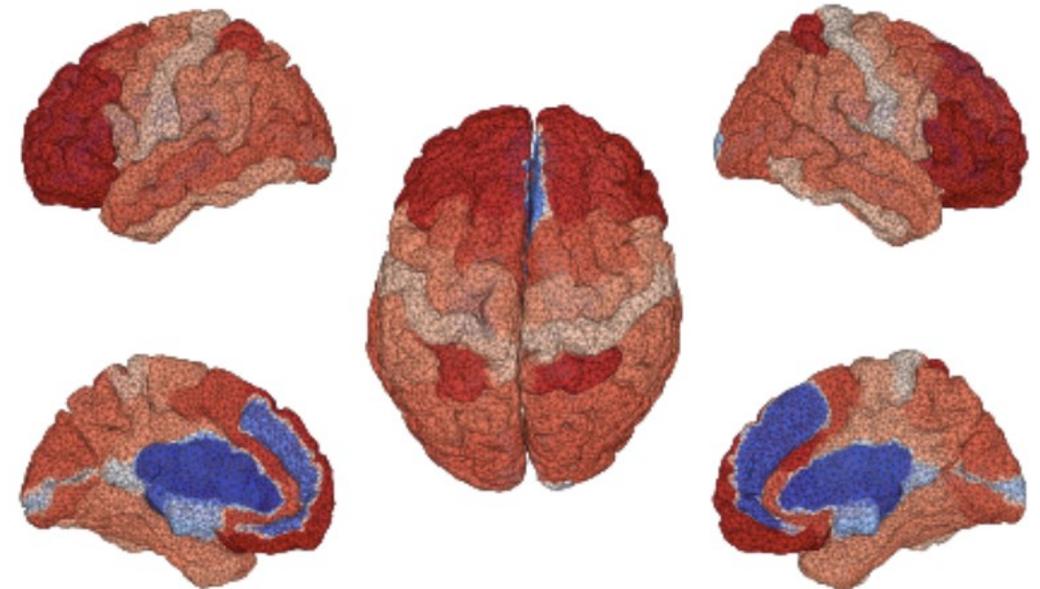
- The **Virtual Brain (TVB)** is an open-source platform for constructing and simulating personalized brain network models.
- Used to develop potential medical treatments, therapies or diagnostic procedures.

THEVIRTUALBRAIN.

The **Showcase** simulates full brain activity during spontaneous activity and after stimulation in a variety of different brain states:

- **Physiological:** sleep or awake
- **Drug-induced:** anesthesia levels
- **Disorders of consciousness:** traumatic brain injury

These simulations **illustrate** how emergent patterns of activity can be reproduced *in silico* and how they can be directly compared to the activity recorded during different brain states in actual human subjects.

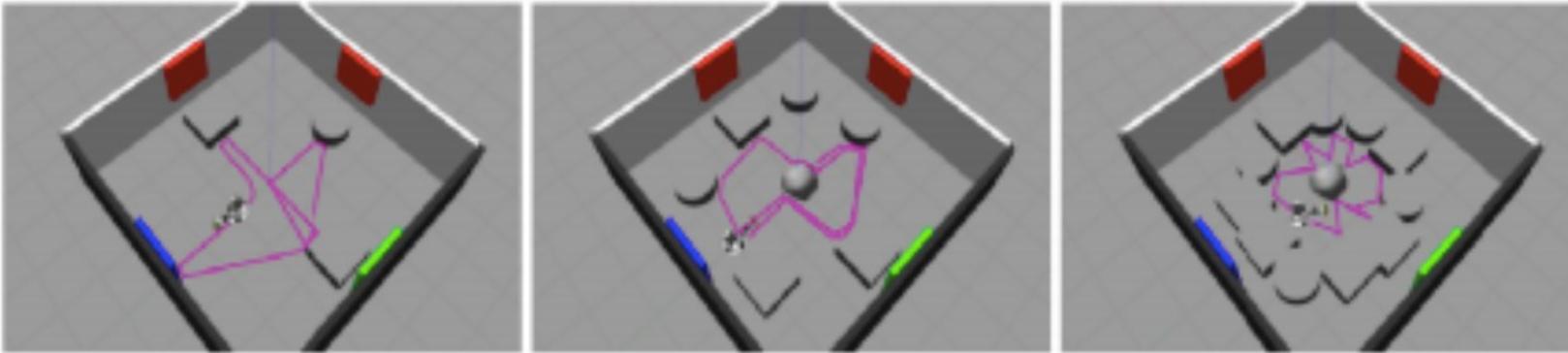


Showcase: Perception and Recognition of Objects and Scenes

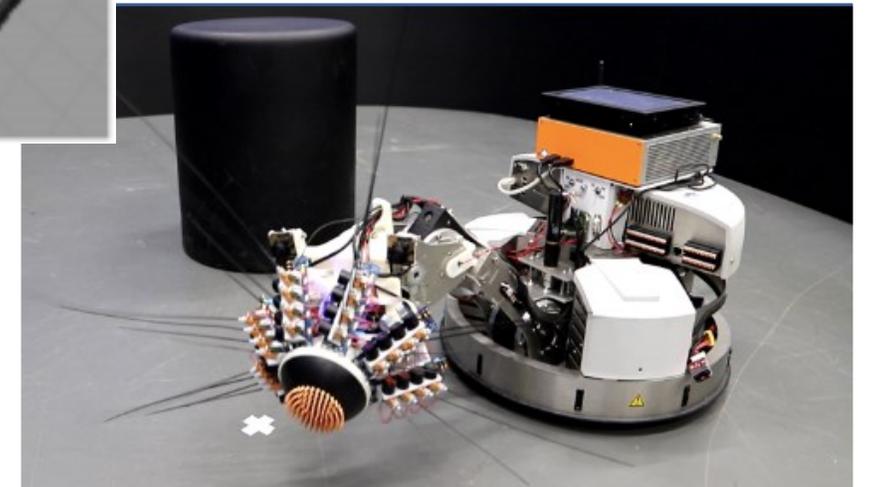


The Neurorobotics Platform (NRP) is an integrative simulation framework that enables in silico experimentation and embodiment of brain models inside virtual agents interacting with realistic simulated environments.

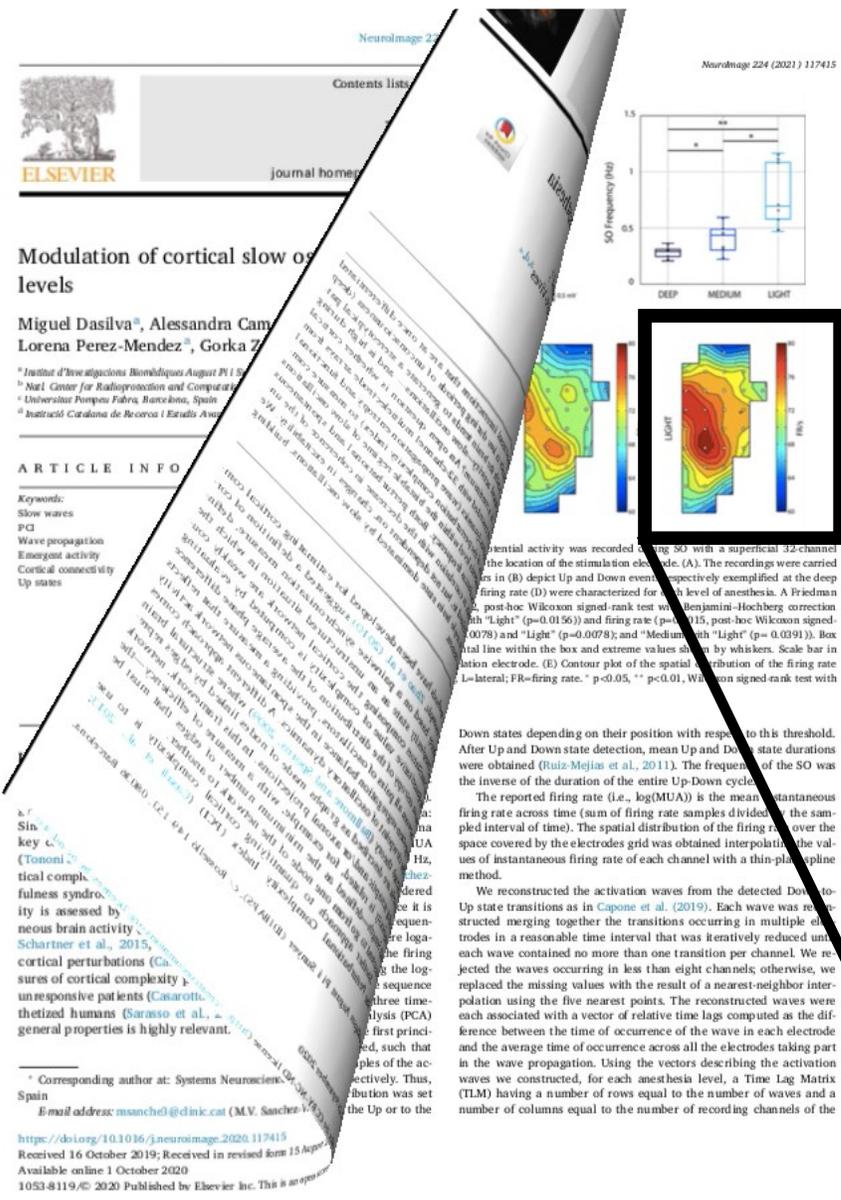
The **Showcase** presents a deep predictive coding network integrated in a robotic model of a rat: The WhiskEye.



By combining whisker tactile and visual data in the WhiskEye Robot, the showcase aims to illustrate how the brain may achieve **image and scene recognition** through the process of learning to construct internal models of objects and the environment.



Live Papers



Optimal illustration of the use of EBRAINS regarding data storage, modelling and analysis

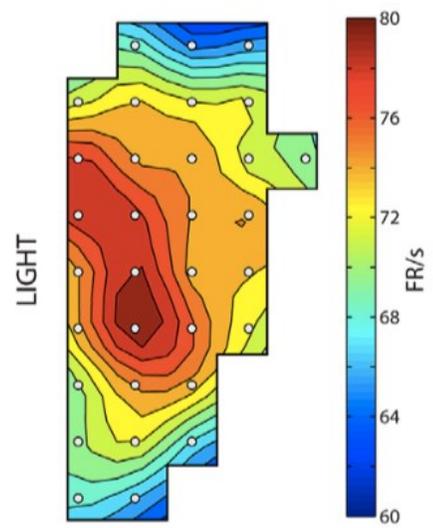
Collaboration of different laboratories to respond to relevant scientific questions while integrating scales, species, methodologies, modelling, etc...

Re-run the analysis through EBRAINS

Follow the analysis and feel free to change any given parameter

Reproduce the figures of the paper

Find the Data and Models in the EBRAINS Knowledge Graph



Share your Data



SUBMISSION

Fill out the [request](#) to begin the process of sharing your data through EBRAINS

You will be notified within 5 working days - Curation is expected to take 2 to 4 weeks



ACCEPTANCE

You will be assigned a personal data curator to follow you through the process

Integrate Metadata, Data descriptor and file upload to the long-term storage at CSCS



PUBLICATION

After your approval, a DOI is assigned and your data is published in the EBRAINS KG



REVIEW



INTEGRATION

ADVANTAGES

1. Receive Data Management Support
2. Get a citable DOI and ensure proper credit
3. Store your data in a long-term repository
4. Enable data reuse
5. Get new funding opportunities
6. Foster new collaborations

Find and use existing Data

Navigate to <https://kg.ebrains.eu/search/>

a) Perform a direct search in the Search Engine:



A search bar with a magnifying glass icon on the left, the placeholder text "Search (e.g. brain or neuroscience)", an information icon (i) on the right, and a "SEARCH" button.

b) Or filter the data by Category, Species, Modality, Methods, Keywords, ...

CATEGORIES

Project	117
Dataset	980
Subject	2981
Sample	2382
Model	92
Software	134
Contributor	1104

FILTERS

SPECIES

<input type="checkbox"/> Homo sapiens	676
<input type="checkbox"/> Mus musculus	162
<input type="checkbox"/> Rattus norvegicus	113
<input type="checkbox"/> Macaca mulatta	13
<input type="checkbox"/> Macaca fascicularis	6
<input type="checkbox"/> Mustela putorius furo	3
<input type="checkbox"/> Chlorocebus pygerythrus	2

Reset

MODALITY

<input type="checkbox"/> anatomical approach	606
<input type="checkbox"/> neuroimaging	576
<input type="checkbox"/> microscopy	503
<input type="checkbox"/> histological approach	492
<input type="checkbox"/> neural connectivity	174
<input type="checkbox"/> electrophysiology	88
<input type="checkbox"/> molecular expression characterization	74
<input type="checkbox"/> multimodal approach	70
<input type="checkbox"/> behavioral approach	60
<input type="checkbox"/> molecular expression approach	34

Find and use existing Data

Once you find the dataset:

- Navigate through it
- Find related information
- Read the Data Descriptor
- Download the Dataset

DATASET

Propagation modes of slow waves in mouse cortex

Sanchez-Vives, M.

Download Dataset

Cite dataset

Data-descriptor

Sanchez-Vives, M. (2020). *Propagation modes of slow waves in mouse cortex* [Data set]. Human Brain Project Neuroinformatics Platform. DOI: 10.25493/WKA8-Q4T

DOI:  10.25493/WKA8-Q4T

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Project: [Propagation modes of slow waves](#)

Custodians:  [Sanchez-Vives, Maria](#)

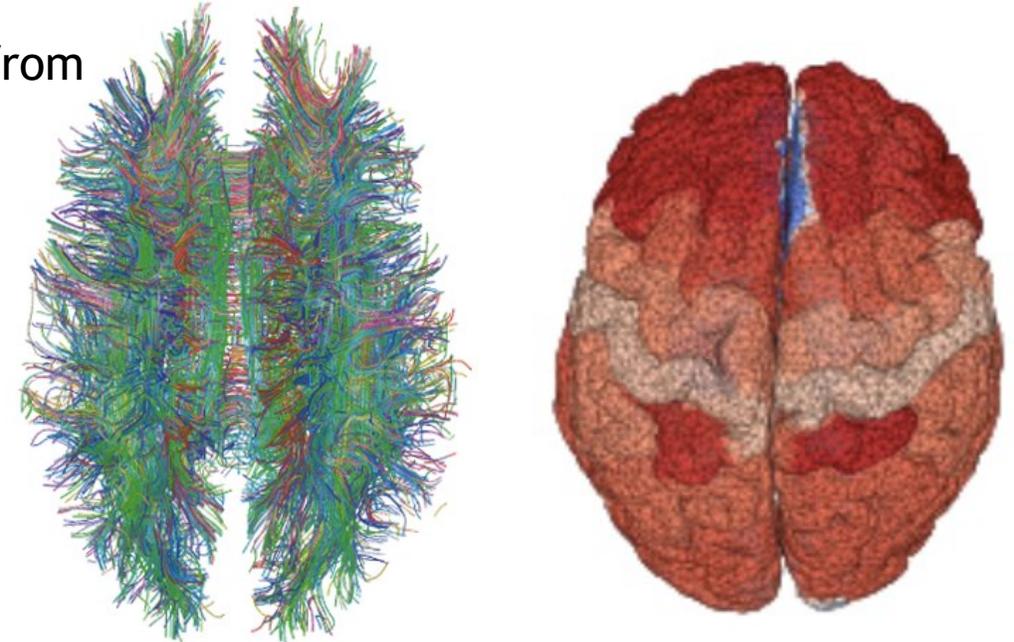
The objective of the study is to investigate the propagation modes of slow waves, their statistical properties and their transformation in varying brain states at the surface of the cortex (anesthesia levels - physiological sleep/wake). We obtained multi-electrode recordings close to the surface of the cortex. The analysis is being performed in collaboration with T3.2.1^[1] and T3.2.5^[2]. The data is being integrated in models carried out in T3.2.1^[1] and T3.2.5^[2], and we will perform new experiments suggested by the models. These data will also be used to derive mean-field and population density descriptions from point neuron models (T4.1.3^[3]) and to validate large-scale mouse network models.

The Virtual Brain: usage example



TVB provides an ecosystem of tools for simulating and analysing large-scale brain network dynamics based on biologically realistic connectivity. TVB can be operated via 1) GUI (web app) and 2) programmatic Python interface.

- Extract the connectome from your data (dw-MRI and fMRI) or from data in the Knowledge Graph
- Set up a simulation and run it using HPC systems
- Visualize the brain activity computed from the simulation
- Compute functional connectivity (FC) matrices
- Play with parameters and see how it affects the FC



Other TVB functionalities allow you to:

- Run simulations in the **mesoscopic** or **microscopic** level (TVB+NEST)
- Run simulations and extract LFP, EEG, MEG, ECOG, FMRI, ...
- Run simulation on diseased models of the brain: tumors, epilepsy, ...

Analysis Pipelines (SWAP example)



EBRAINS

Integrating multi-scale, multi-methodology experimental data and simulation outputs in a reproducible and adaptable pipeline

- Novel Datasets

- in vivo/in vitro ECoG
- Calceum Imaging
- human iEEG
- scalp hd-EEG

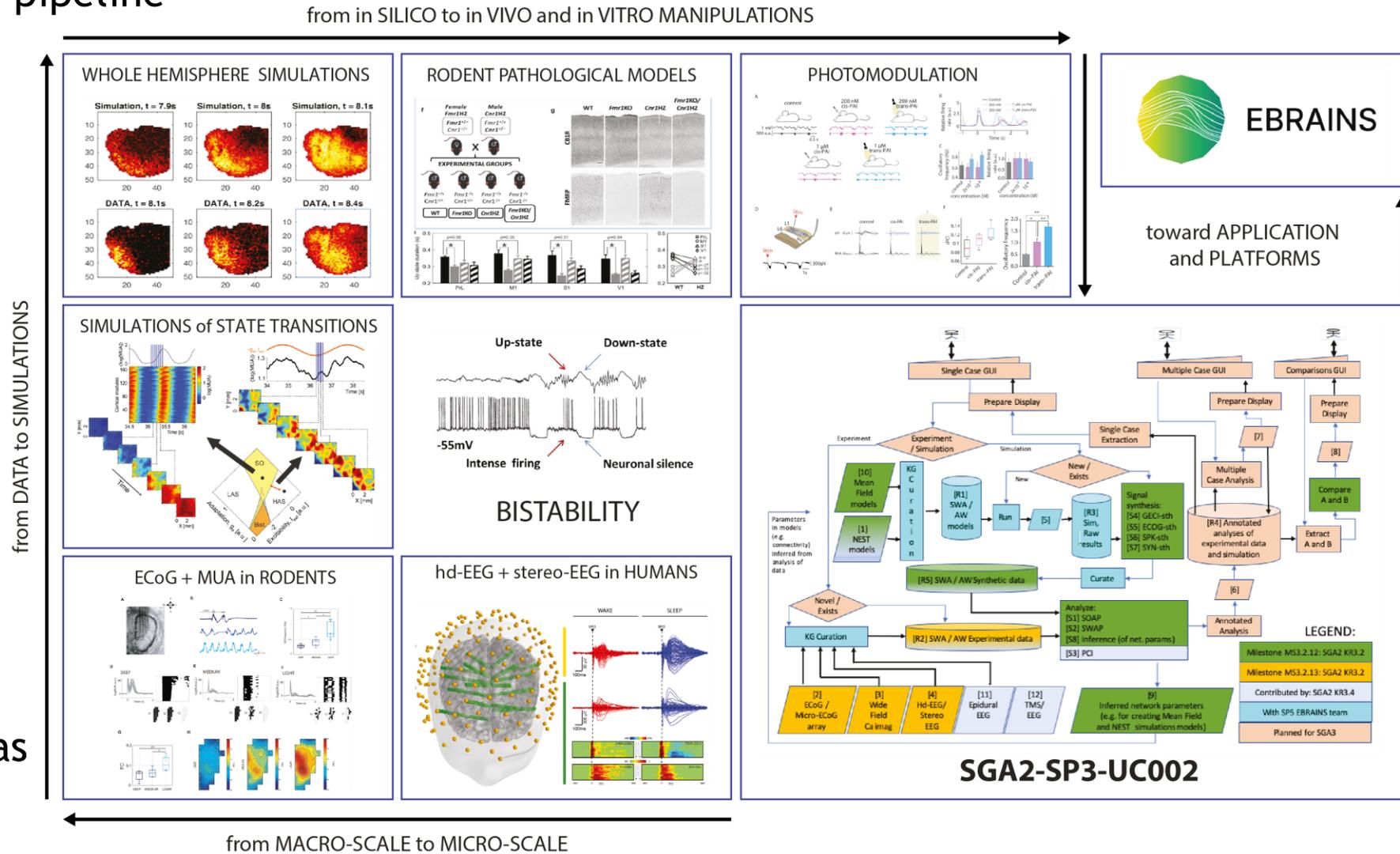
- Conditions:

- Brain state transitions
- Sleep-wake cycle
- Anesthesia levels
- Epilepsy

- Services:

- Neo
- Elephant
- NEST

- All integrated in EBRAINS as a pipeline





Human Brain Project

Thank you

www.humanbrainproject.eu



/TheHumanBrainProject



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