

Samples of work : Comics as a tool to communicate neuroscience

The WP1 presents Inverting models: from observations to causes
 < a look into Task 1.16 >

Synapses are fundamental to the transmission of signals through the brain.

When these synapses fail, it can have serious effects on the functioning of the brain. This is called **SYNAPTOPATHY**.

Synaptopathies are found in many neurological disorders, like Alzheimer's, Parkinson, Schizophrenia and EPILEPSY.

As synapses form the connections of neuronal circuitry, understanding their disfunction can help understand the processes behind these brain disorders.

In WP1 we study synaptopathies present in EPILEPSY by taking DATA obtained from individuals and using mathematical modelling to describe the synaptic signalling taking place in the brain.

Karl Friston
University College London

From the observations, that measure the consequences of synaptopathies, we want to understand the CAUSES

Richard Rosch
King's College London

We work with data from pediatric patients; obtained as part of their on-going treatments. This gives us a unique opportunity to look into synaptopathies that unfold during neural development.

Great Ormond Street Hospital
 (One of UK's leading centers in pediatric epilepsy surgery)

cohort

NEUROIMAGING DATA

NON-INVASIVE MEASUREMENTS

BRAIN RECORDINGS (seizures, cognitive problems)

person in development

Can we infer the CAUSES?
 (a description of the synapses disfunction)

MATHEMATICAL MODEL

Dynamic Causal Model

abnormal ↔ synaptopathies brain dynamics

In a FORWARD MODEL, one tries to describe observations that are the effect of certain CAUSES

CAUSE

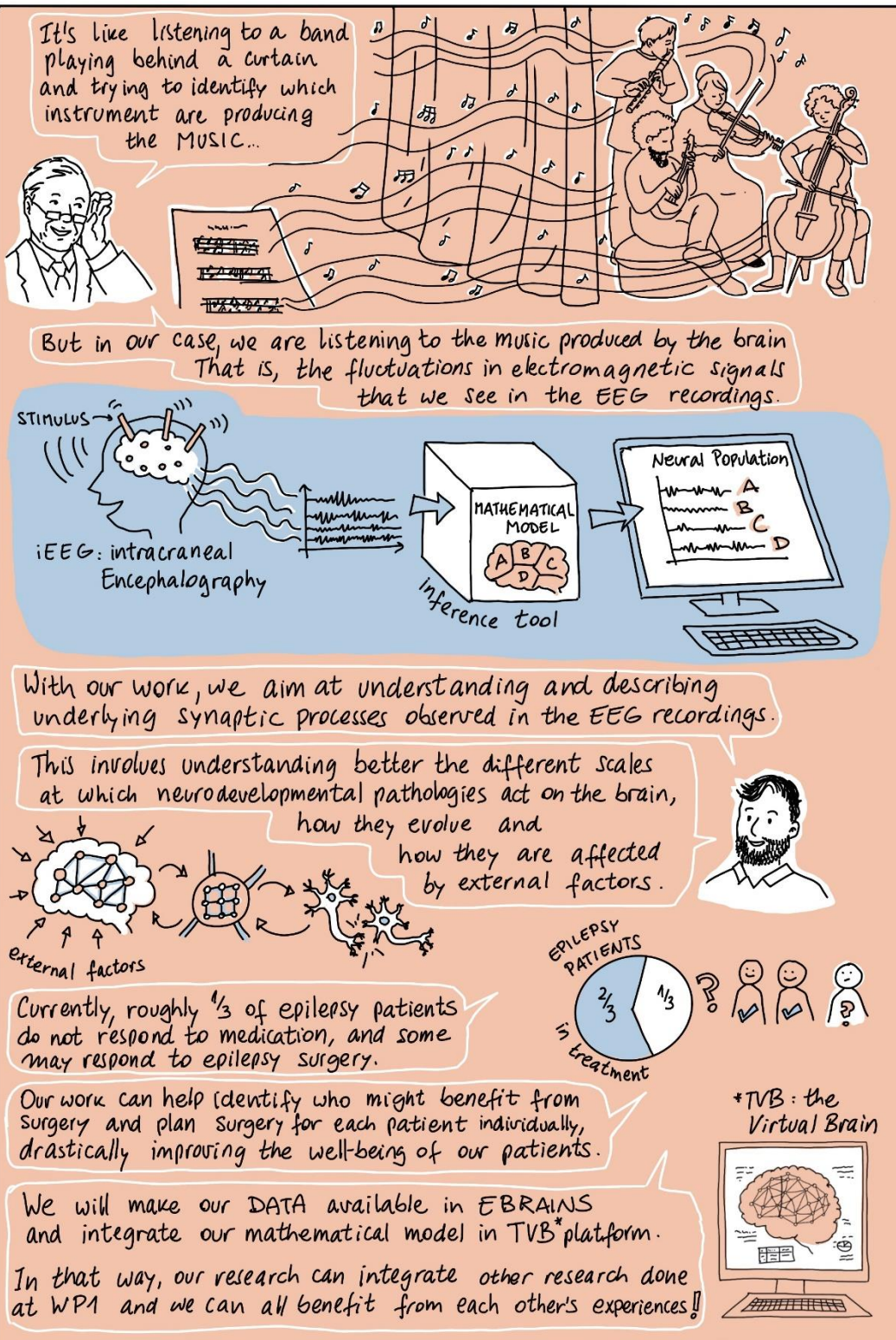
FORWARD MODEL

OBSERVATION

INVERTED FORWARD MODEL

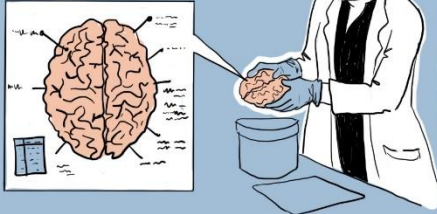
What we are doing is inverting this: we are looking for the CAUSES of what we are OBSERVING !!

To do this we use the observations to TUNE THE PARAMETERS of our MODEL



The WP1 presents color cartography of the Human Brain < a peek into Task 1.3 >

Understanding the architecture of the brain is fundamental in the HBP efforts to model the brain. This would not be complete without studying an actual human brain.

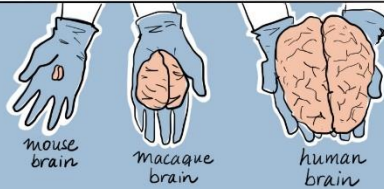


So far, most of what we know of the brain comes from mice and primates. Here we are going into uncharted territory. This is the first time that so many methods are put together to analyze a real HUMAN BRAIN.

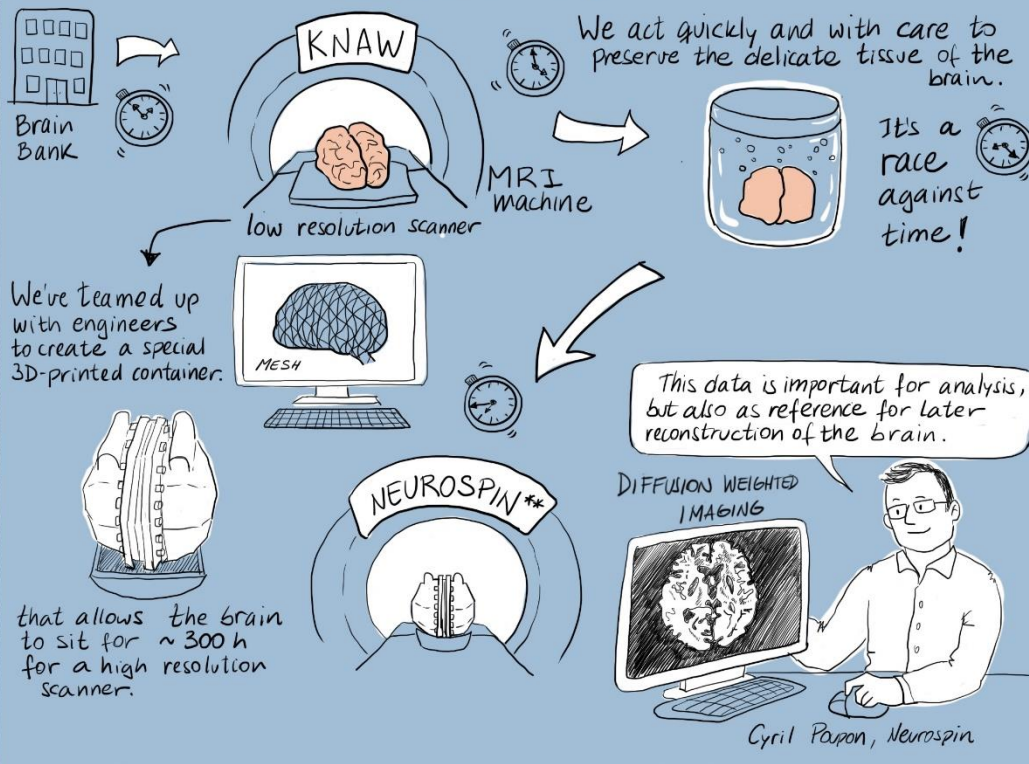


The human brain presents many challenges due to its size: it is **HUGE!**

Many of the techniques used for mice and primates become more difficult or don't work on human brains.

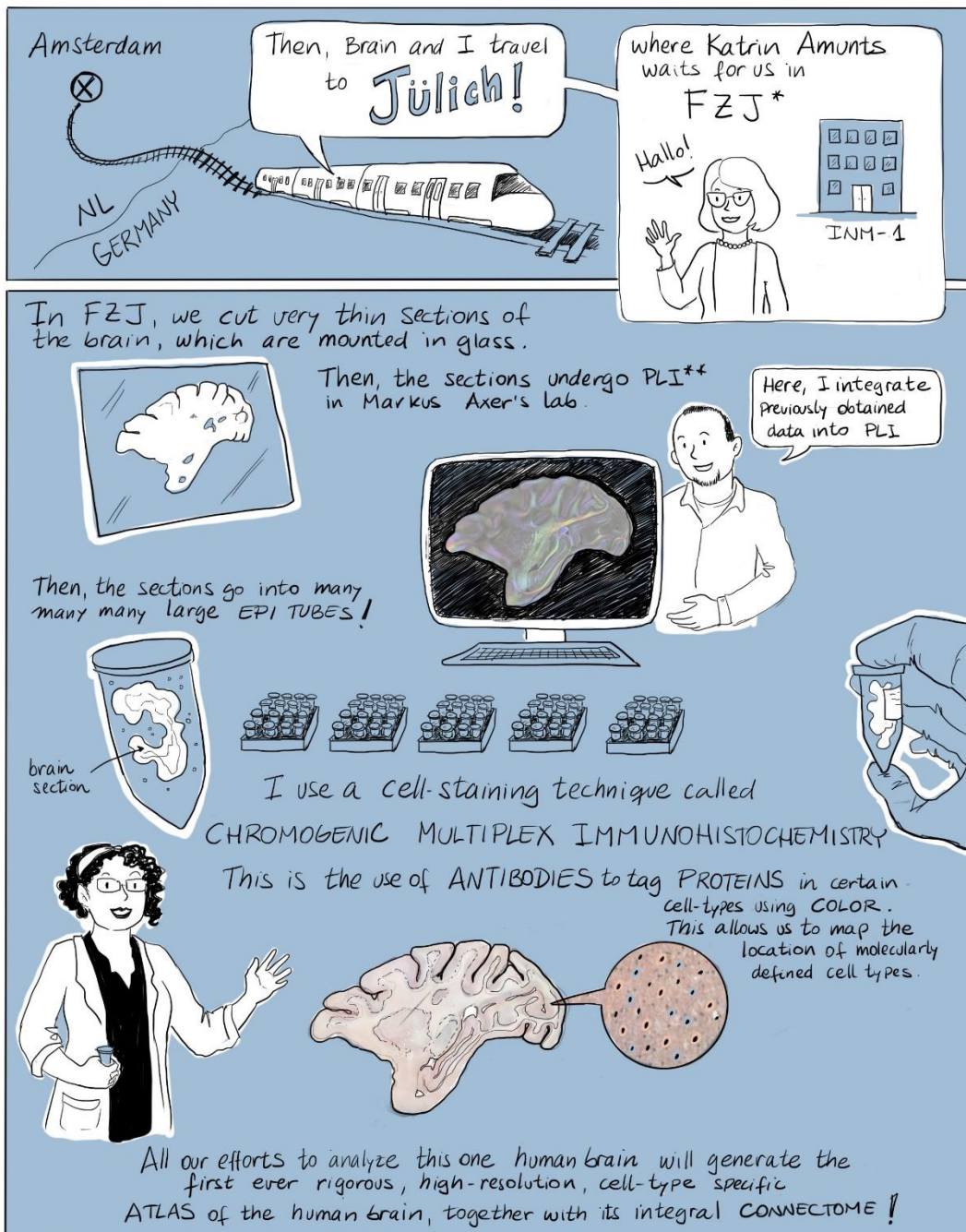


We need to come up with **NEW PROCEDURES & NEW TOOLS!**



* KNAW: Netherlands Institute for Neuroscience, Amsterdam.

** Neuroimaging Center, CEA, Paris region.



WP1 develops the brain reference framework **E BRAINS**, into which all these various pieces of information (geometry, connectivity, cyto-organization) are integrated.

They serve to constrain brain models, and are accessible to neuroscience and medical communities.

* Forschungszentrum Jülich.

** Polarized Light imaging

The WP1 presents Philosophy of science & brain modeling

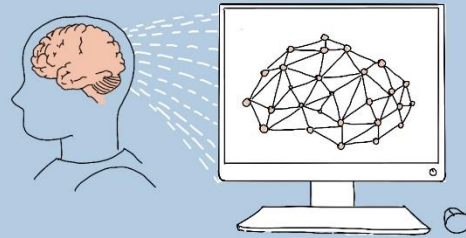
<the big questions of Task 1.9>

In the search for a better understanding of the brains' functioning via brain simulation, the in-silico experiments done at WP4 are an unprecedented opportunity to study brain diseases, like epilepsy.

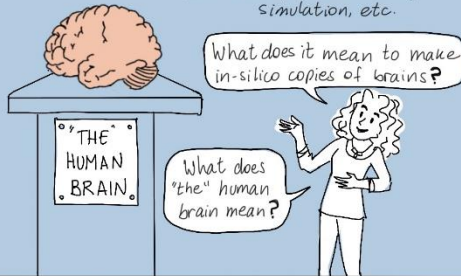
As part of these efforts, neuroscientists have teamed up with philosophers of science and neuroethicists at Uppsala University in Sweden,



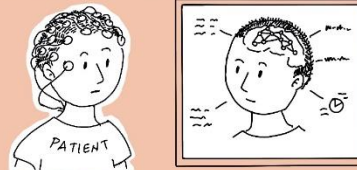
to examine the biological realism of brain simulations, and the societal and ethical aspects of building in-silico twins of human brains.



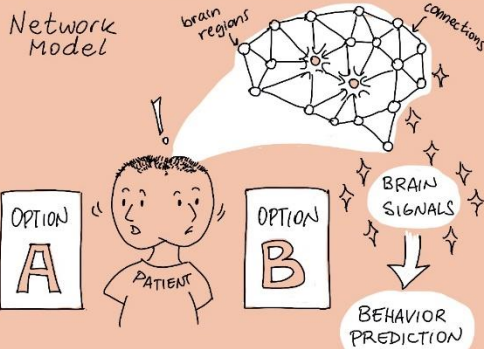
Our approach to study the brain models built in WP4 starts by defining the concepts that are used: brain, virtual brain, simulation, etc.



"The" brain exists as a CONCEPT in our minds, but in reality, each individual brain is unique in its function, behavior and how it coordinates responses to external stimuli.

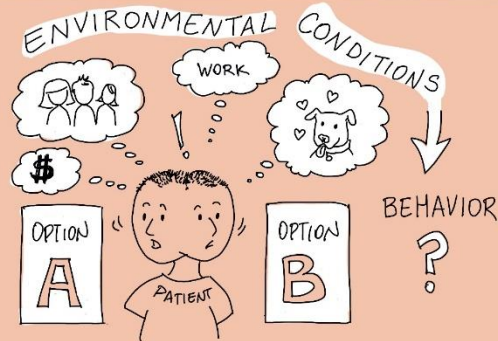


Because of this, we can identify a first key challenge: the VALIDITY of brain simulations.



Now, when we look at specific experiments, we see that there are many technological and methodological challenges to predict behavior using brain simulations.

A particularly successful method is the use of network models, that relate brain signals to behavior.

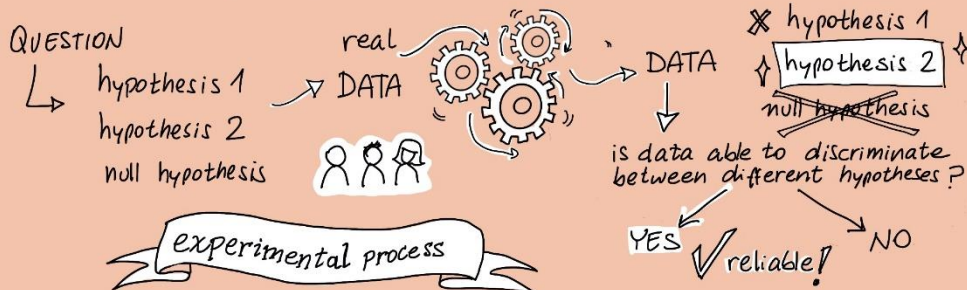


However, there are many limitations coming from environmental aspects.

How well can a brain simulation predict behavior in different contexts?

This raises the question of the RELIABILITY of brain simulations, our 2nd key challenge.

From a philosophy of science point of view, **RELIABILITY** is a **CONSTRAINT** to the data production phase of an experiment.*



While **VALIDITY** is an experiment's capacity to support the conclusions drawn from it.

inside the lab



Outside the lab

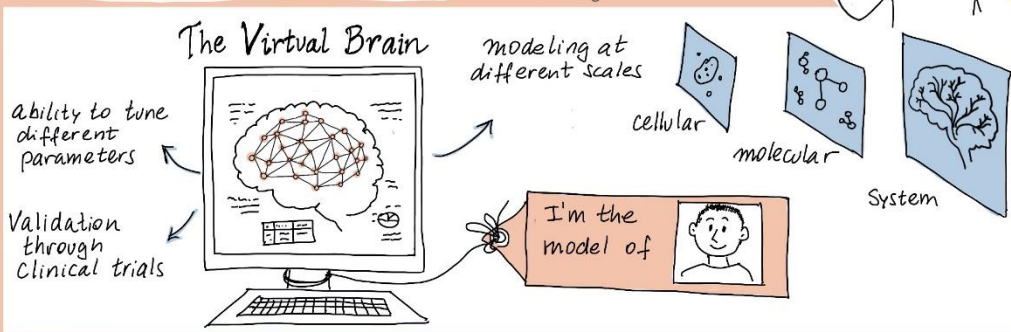


in real life situations



Complete fidelity between a virtual brain and a real, living brain may be an ideal, but still out of reach with the current knowledge and technology.

However, with the Virtual Brain, we have in front of us a unique opportunity for testing modifying different parameters in the model. This gives a sufficiently reliable framework to test hypotheses using real data!!



Now, why is it important to discuss all these concepts?



The first philosophical and scientific goal is to deepen knowledge and understanding. Additionally, clear and transparent communication is crucial to producing a realistic and meaningful discussion about the research carried out in WP4 and its ethical and societal impact.

In this context, **CONCEPTUAL CLARITY** is key for the communication of research!!

It allows to set realistic expectations and avoid unfounded concerns, hypes and misuses. Then, we can help build solid interdisciplinary collaborations as well as relationships of trust between society and the scientific communities.

* This comic is part of a series in WP4 (Human Multiscale Brain Connectome) of the Human Brain Project (HBP).