UNIVERSITÉ DE GENÈVE

PRESS RELEASE

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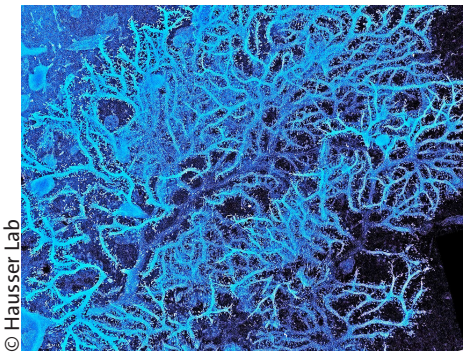
Virtual mega-laboratory is assembled to probe the brain's deepest secrets

To understand how billions of neurons work together in a single brain, twenty-one laboratories join forces under the umbrella of the International Brain Laboratory to conduct a unique joint experiment.

It is a «world premiere" for neuroscience: the International Brain Lab (IBL) will engage researchers from Europe and the United States. The aim is to understand how the brain makes choices, down to the cellular level, by studying the activity and interactions between individual neurons across its different areas. IBL is a global virtual laboratory incorporating twenty-one neuroscience labs across several countries, including the United States, Great Britain, Portugal, France and Switzerland. Half of the institutes are experimental laboratories; the other half are focused on theory. The labs bring together some of the world's leading neuroscientists in a project co-financed to the tune of CHF 14 million by the Simons Foundation in the US and the Wellcome Trust in Great Britain.

Making choices is a key function of the brain. «Life is a succession of choices, from the most insignificant to the most intricate," explains Alexandre Pouget, professor in the Department of Fundamental Neurosciences in the University of Geneva Faculty of Medecine, and an IBL researcher. "But unravelling the mechanisms that lie behind our choices is difficult, and the complexity of that task far outstrips the capacity of a single laboratory. It requires a close correlation between theory and experiments on a scale that has never before been achieved".

The laboratories taking part in the IBL project will join their skills and work on understanding how the brain solves a single specific behavioural task. "The use of identical experimental procedures will eliminate the differences that normally hinder replication of data across laboratories. In this way, we will be able to pool data as if it were a single giant experiment, even though it is in fact distributed between two continents," according to Zachary Mainen, an IBL researcher based at the Champalimaud Foundation in Lisbon Portugal. "The approach is a big departure for neuroscience, where it has been difficult to integrate results into a common theoretical framework due to differences in methodology and lack of motivation to share and standardize data", said Mainen.



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A view of a Purkinje cell.

A simple decision-making task

In more concrete terms, all the laboratories participating in the IBL project will measure neuronal activity in mice faced with a very simple decision-making task, the aim being to determine how the brain functions when it makes a choice. A visual stimulus — such as

a black stripe on a white background — will appear on a screen to the left or right of the mouse. The animal then has to use its paws to turn a small steering wheel, made of Lego, to align the black stripe back to the centre of the screen. «The mouse will have to decide whether the stimulus is on the right or the left, and will convey its decision by operating the wheel,» says Pouget.

The methodology is original in that the experiment will be conducted under the same conditions in each of the IBL labs, which will then be able to measure the activity in different regions of the brain simultaneously. All the parameters will be standardised, from the apparatus to the training the mice undergo. In fact, the protocol has to be extremely precise: the way the animals are trained for the task will determine how they react, with the slightest difference potentially altering the nature of the results. And the same goes for the behaviour apparatus or "rig", the equipment used to undertake the experiment. The instructions for assembling the rig, or for producing its parts, are highly detailed to ensure that the apparatus is identical in all the laboratories. The parts themselves are typically manufactured using a 3D printer or are assembled from commercially available parts, such as the Lego steering wheel.

An unprecedented map of neuronal activity

The IBL team will record the activity of several hundred neurons simultaneously, undertaking measurements in all areas of the brain at the cellular level: overall, the researchers will record activity from 5,000 to 10,000 neurons in animals performing exactly the same task. This comprehensive and entirely unprecedented map of neuronal activity will be made possible thanks to the precise coordination between different laboratories, none of which alone would have sufficient resources and know-how.

The theoretical laboratories will use this unprecedented dataset to develop large-scale models of the decision-making process. To do so, they will also develop innovative IT tools for collecting and processing data in a standardised manner. This will lay the technological and theoretical framework for interpreting data as it becomes available. In this way, IBL researchers hope to establish a comprehensive theory of decision-making that will explain how each part of the brain contributes to the task.

Anne Churchland, a Professor at Cold Spring Harbor Laboratory in New York and a researcher in the IBL collaboration, states: «We are excited about the potential of this open and collaborative model, which will help us understand how the brain shapes behaviour. It's a unique opportunity to bring together leading scientists to meet the challenge of neural complexity.»

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The 21 teams participating in the IBL project are drawn from the following laboratories and institutions:

- Center for Theoretical Neuroscience, Columbia University Medical Center
- Champalimaud Research, Champalimaud Centre for the Unknown
- Cold Spring Harbor Laboratory
- Columbia NeuroTechnology Center, Columbia University
- Cortical Processing Laboratory, University College London, UCL
- Department of Basic Neuroscience, Faculty of Science, University of Geneva (UNIGE)
- Department of Molecular & Cell Biology, University of California, Berkeley
- Gatsby Computational Neuroscience Unit, University College London, UCL
- Center for Learning and Memory, University of Texas at Austin.
- Janelia Research Campus, Howard Hughes Medical Institute, HHMI
- Laboratoire de Neurosciences Cognitives, Ecole Normale Supérieure de Paris
- Neural Dynamics and Computation Lab, Stanford University
- Princeton Neuroscience Institute
- Sainsbury Wellcome Centre for Neural Circuits and Behaviour, UCL
- Wolfson Institute for Biomedical Research, University College London, UCL