Human Brain Project
Stanislas Dehaene and Jean-Pierre Changeux

EDITOR’S NOTE
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The **Human Brain Project** wins the competition of the largest European science fund and includes two Collège de France professors: Stanislas Dehaene (Experimental Cognitive Psychology) and Jean-Pierre Changeux (Cellular Communications).

The European Commission officially selected the Human Brain Project (HBP) as one of its two Future and Emerging Technologies (FET) Flagship projects. The HBP brings together scientists from across the continent around one of the greatest challenges facing contemporary science: understanding the human brain.

The aim of the HBP is to gather all current knowledge on the human brain so as to reconstruct it piece by piece in computer models and simulations. These models will open new perspectives to further our understanding of the brain and of neurological diseases. The aim is also to develop innovative technologies in computer science and robotics. On Monday 28 January 2013, the European Commission confirmed its support for this approach by announcing that it had selected the HBP as one of the two projects funded by its new FET Flagship Programme.

The Human Brain Project, federating over 80 European and international research institutions, is scheduled to last ten years (2013-23) and to cost an estimated 1.19 billion Euros. The project will also involve several leading North American and Japanese partners. It will be coordinated by the École polytechnique fédérale de Lausanne (EPFL) in Switzerland, and by the neurobiologist Henry Markram, with co-directors Karlheinz Meier of the University of Heidelberg and Richard Frackowiak of the Centre hospitalier universitaire Vaudois (CHUV) and the University of Lausanne (UNIL). France coordinates three sections of the project: theory of neuronal networks (Alain Destexhe, CNRS), cognitive neurosciences (Stanislas Dehaene, Collège de France, INSERM, CEA), and ethical aspects (Jean-Pierre Changeux, Collège de France, Institut Pasteur).

The “bottom-up” component of the project is designed to characterize the arrangement and the integration in functional circuits of all the components of the brain. The project draws to a large extent on the field of integrative and computational cellular neurosciences, which are well represented in France, especially in the Ile-de-France area (CNRS-UNIC, ENS, Paris V, Institut Pasteur, INRIA). The “top-down” component of the project aims to shed light on the neuronal circuits underlying cognitive functions, based on sophisticated experiments in cognitive neuropsychology and cerebral imagery, completed by mathematical modelling. The recognition of objects and actions, self-awareness and awareness of the body, decision making, and spatial navigation are all functions that will be analyzed by means of cerebral imagery and that will be reproduced in simulations. Particular attention is paid to the as yet unsolved question of what is peculiar to the human species: language, symbols, representation of other minds, and the appearance of new areas in the prefrontal cortex.

High-resolution functional mapping of the human brain will be carried out in tandem with that of the main fascicles of fibres that enable these modules to communicate. The project seeks to develop a model of the appearance of these structures during cerebral development. Here too, with the CEA, INSERM, INRIA, the CNRS and the NeuroSpin facilities, France will play a leading role. The multi-scale maps of the brain inferred from these data will be shared with the international community with a view to developing a common frame of reference for research on the structure and the functioning of the brain.
As regards theory, the HBP will set up the European Institute for Theoretical Neuroscience (EITN), which will be located in the Paris area, due to the strong theoretical and mathematical community there. This Institute will be designed to become a hub for the diverse theoretical approaches proposed to explain the dynamics of the brain, the emergence of consciousness, and cognitive processes. It is expected that, from the first phase of the project, it will play a key part in research on the mechanisms of neuronal encoding, which is closely linked to the experimental data and numeric simulations, and in the establishment of these mechanisms in “neuromorphic” circuits (specialized chips for the simulation of neurons and of their connections). It is hoped that the neuromorphic simulation will eventually strengthen relations between the translational teams of the CEA-LETI in France and of the German (BrainScales-Heidelberg and Dresden) and British (SpiNNaker) facilities of the HBP. The HBP must be seen as an ongoing process of iteration and interdisciplinary integration, the ultimate convergence of which is expected to afford an integrated understanding of the mechanisms and principles of the brain’s functioning.

Advances in knowledge on the brain and its applications to medicine, information technology and robotics raise thorny ethical questions that will be dealt with by a specialized “Ethics and Society” section of the HBP. The function of this section will also be to inform the public and launch a citizen’s debate.

The choice of the Human Brain Project as a FET Flagship project is the fruit of a long process of preparation and rigorous evaluation carried out over a period of more than three years by a team of independent scientists chosen by the European Commission. In the past months, the various partners have negotiated a detailed agreement with the Commission on the two-and-a-half-year inception phase (from 2013 to mid-2016). The project has started at the end of 2013.

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