Toward the connectomic era

Dear Reader,

Neuroscience recently embarked on a new landmark era: in the wake of the Decade of the Brain (1991-2000) and the Decade of Behavior (2001-2010), it has now entered the *Decade of the Mind* (2011-2020). But what exactly is driving this evolution, and what do these labels actually mean? As we will see, this evolution is underpinned by a bottom-up process, in which science is climbing the slope leading from elementary mechanisms to understanding of the ensemble. The ultimate goal is to reach full understanding of humans and human nature in all their complexity, which means starting from molecular principles and moving toward more complex systems and thence to behavior and the mind. Clearly, this conceptual progress has a profound impact on the way the scientific community directs research interests and funding and how society perceives science: its progress and its impact on daily life.

This decade-by-decade progression of neuroscience reflects a more general evolutionary pattern, which is also, and most notably, exemplified by the field of biology, which has been through the *genomic*, *post-genomic* and *proteomic* eras. As far as neuroscience is concerned, remarkable advances in knowledge on neurons and synapses is opening up new opportunities for understanding neuronal networks and full brain connectivity. New tools are available, such as extraordinary *in vitro* and *in vivo* imaging techniques, which are promising to uncover the functional correlates of behavior and thought. We might almost say that, following the *neuronal and synaptic era*, we are now in the *connectomic era*. And just as the genomic era led to the world-famous Human Genome Project, the connectomic era is leading to important connectome projects which are expected to attract considerable funding from different sources, such as the NIMH and other federal agencies in the USA and various funding programs in the EU (for example the Flagship programs). The main connectome project in the EU will be the Human Brain Project, presently in the last phase of evaluation. These connectome projects, together with the application of the most advanced magnetic resonance imaging (MRI) and electrophysiological techniques, offer unprecedented potential not only for advancing understanding of the human brain, behavior and mind, but also for providing crucial information about the nature and therefore treatment of brain diseases.

For example, functional MRI (fMRI) is now unmasking brain connectivity and functionality in a whole new way, while transcranial magnetic stimulation can be used to excite or inhibit specific brain areas selectively and to modify circuit functioning and memory. The development of brain-machine interfaces (BMIs) and brain-computer interfaces (BCIs) is making it possible to control external devices through the recording and processing of brain signals generated voluntarily by the individual. The development of high-resolution chips is promising to extend the opportunities offered by deep brain stimulation as well as by BMIs and BCIs. Finally, computer sciences are providing the tools for large-scale brain simulations allowing mathematical reconstructions of brain activities. The future challenges are to develop and exploit all this outstanding technology to the full and to ensure coordinated progress of technology, brain science and medicine.

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