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Editorial

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Neuroscience as challenged factor in medicine

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Editorial

The paucity of novel drugs for neuropsychiatric indications contrasts with the remarkable recent advances in neuroscience research. We have identified 5 challenges the sector must address and recommend potential solutions. The tools that will allow these solutions to be implemented may already be in place but not routinely adopted or are still being developed. Overall, a change in mind set to adopt science- and data-driven paths is needed.

Despite strong recent advances in basic neuroscience research, the successful development of novel therapeutic approaches for neuropsychiatric indications has been limited. We are now capable of identifying the genetic, molecular, cellular, and neurocircuitry aspects governing behavior. Human beings have a powerful urge to understand their own nature, and a strong practical need to cure brain disease and develop new computing technologies.

These demands, combined with the new possibilities opened up by modern ICT and high throughput technology, are driving a rapid transformation of neuroscience in the direction of “big science” and big “data”. Delivering on the promise of neuroscience isn't just an issue of research methodology or technology – it implies a change within the structure and practices of our discipline. Big science initiatives in other disciplines like physics or astronomy or genomics involve large multidisciplinary teams, close collaboration between scientists and engineers, and widespread sharing of knowledge and tools, for example through the deposition of data in public repositories and the use of pre-print servers.

Neuroscience has the potential to make fundamental contributions to medicine, computing and our understanding of the human condition, but to do so it has to adopt forms of organization and modes of operation better adapted to the needs of big science. The way neuroscience is currently organized has many practical implications for research. Groups performing on different levels of brain organization add different areas of the brain, in several animals, at different ages. “Big neuroscience” faces challenges that are even harder than the challenges addressed by previous “big science” projects. Consider, for instance, the Human Genome Project

The key scientific challenges can be summarized as follows: mechanisms of disease, target identification and validation, predictive models, biomarkers for patient stratification and as endpoints for clinical trials, clear regulatory pathways, reliability and reproducibility of published data, and data sharing and collaboration. To accelerate nervous system drug development, the Institute of Medicine’s Forum on Neuroscience and Nervous System Disorders has hosted a series of public workshops that brought together representatives of industry, government (including both research funding and regulatory agencies), academia, and patient groups to discuss these challenges and offer potential strategies to improve the translational neuroscience.

The goal was to measure the approximately 3 billion base pairs of the human genome – a huge but not intractable challenge. The classical way to establish causation is through experimental manipulation of living brains or tissue samples combined with simultaneous measurements of the response. Neurological and psychiatric disease begins with an initial change within the brain – sometimes triggered by events within the patient’s external environment – followed by a cascade of knock-on effects.

The development of Neurosciences in the last few years has changed a set of paradigms in the production of knowledge, from which new scenarios have arisen in the understanding of the structure and performance of the human neuroscience, also as in a number of the foremost relevant diseases involved.

The society of data has expanded with information produced everywhere the planet. But unfortunately, only a little part of such knowledge has had an impression on decision-making pertaining health, and on the power to unravel specific problems during a given population.

Building upon the advances in cellular and molecular neuroscience, the field of developmental neuroscience will be enabled to describe how internal and external factors shift the trajectory of individual neurons, circuits, and the brain to alter disease risk and behavior. Neurodevelopment spans intracellular study through systemwide analysis to allow an understanding of how individual neurons acquire specific function within the nervous system as well as how the brain develops over decades. While many avenues of research will be impactful, we see single-cell characterization, study of neurogenesis, and the use of organoids as key areas of focus in the next half century.

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