Commentary

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Trends and Challenges in Neuroengineering Models of Brain Disease

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About the Study

Computational simulation approaches are now being used to mimic neurological disease and mental disorder. These types of neuroengineering models serve as a conceptual link between molecular/cellular disease and cognitive function. Alzheimer's disease, Parkinson's disease, and schizophrenia models are all considered. Each of these disorders is characterised by a neuromodulation problem that is accompanied by neuronal dysfunction. The similarities between these models show that functional loss is caused by a consistent set of computational mechanisms across a wide range of brain illnesses.

Researchers study particularly in attractor-based network dynamics and how they emerge from brain architectures, as well as methods for linking attractor states sequences and their involvement in cognition, and the role of neuromodulators in modulating these processes. These findings indicate to a novel tool for dissecting the pathophysiology of brain disease and provide new ways to understanding the forebrain circuits that underpin cognition.

Alzheimer's disease, Parkinson's disease, stroke, epilepsy, and multiple sclerosis are all prominent neurological illnesses that pose a constant challenge to medical research. These disorders have a high frequency, cause severe morbidity and functional loss, and have a typically poor prognosis, often leading to death. Few diseases have effective therapies, and none are curable. Diseases of the neurological system account for a considerable share of human misery when considered in conjunction with mental illness, particularly schizophrenia and affective disorders.

Continuous monitoring of electrophysiological data and feedback regulation of abnormal brain processes are now possible due to advances in bioelectronics for neuroscience and neuroengineering. Despite these advances, there are still problems with long-term high-quality neural interfacing, owing to mechanical, chemical, and electrical incompatibilities between the device and the brain tissue. To resolve these inconsistencies between the biotic and abiotic systems, new approaches are necessary.

Future organ restoration and enhancement technologies will rely heavily on near-physiological and energy-efficient communication between living and artificial biomimetic systems. The interface of brain-inspired gadgets with the real brain is at the forefront of this developing subject, with the name "neurobiohybrids" referring to all systems that have such a connection. We argue that achieving "high-level" communication and functional synergy between natural and artificial neuronal networks *in vivo* will enable the development of a diverse world of neurobiohybrids, which will include "living robots" as well as "intelligent" neuroprostheses for brain function enhancement.

Artificial neuroprostheses are projected to have a significant societal and economic impact, as they will provide innovative therapeutic possibilities for a variety of disorders, going beyond traditional pharmaceutical schemes. They will, however, unavoidably raise basic ethical problems about the intermingling of man and machine, and, more especially, how much brain processing should be influenced by implanted "intelligent" artificial systems.

Current advancements and trends in the field of neurobiohybrids from this perspective also take a "community-building" approach to the topic, demonstrating how scientists working on brain-inspired devices and brain-machine interfaces are growing their relationships using a quantitative bibliographic study. Such a tendency, we believe, will clear the way for a massive technical and scientific revolution in brain-machine communication, as well as new possibilities for repairing or even boosting brain function for therapeutic purposes.

A prototype cortical neural interface microsystem with hybrid RF (Radio-Frequency) inductive and IR (Infrared) optical telemetries has been created for brain implantable neuroengineering applications. The technology converts cortical impulses to a digital stream of IR light pulses, while RF induction provides a clock signal and electrical power for neural recording in primates. The implantable unit integrates analogue, digital, and optoelectronic components on a flexible LCP (Liquid Crystal Polymer) substrate that adapts to anatomical and physiological restrictions in the environment. To create the instantaneous cortical neuroprobe device, an ultra-low power analogue CMOS chip with preamplifier and multiplexing circuitry is immediately flip-chip bonded to the microelectrode array. The probe's 16- channel version has been tested in a variety of *in-vivo* animal studies, including measures of brain activity in the rat's somatosensory cortex.