Neural engineering

Recent advances in neural engineering have restored mobility to people with paralysis, relieved symptoms of movement disorders, reduced chronic pain, restored the sense of hearing, and provided sensory perception to individuals with sensory deficits. This progress was enabled by the team-based, interdisciplinary approaches used by neural engineers. Neural engineers have advanced clinical frontiers by leveraging tools and discoveries in quantitative and biological sciences and through collaborations between engineering, science, and medicine. The movement toward bioelectronic medicines, where neuromodulation aims to supplement or replace pharmaceuticals to treat chronic medical conditions such as high blood pressure, diabetes and psychiatric disorders is a prime example of a new frontier made possible by neural engineering. Although one of the major goals in neural engineering is to develop technology for clinical applications, this technology may also offer unique opportunities to gain insight into how biological systems operate. Despite significant technological progress, a number of ethical and strategic questions remain unexplored. Addressing these questions will accelerate technology development to address unmet needs. The future of these devices extends far beyond treatment of neurological impairments, including potential human augmentation applications.

The task, as neural engineers, is to push technology forward at the intersection of disciplines, while responsibly considering the readiness to transition this technology outside of the laboratory to consumer products $^{1)}$.

The mandate of folic acid supplementation in grained products has reduced the occurrence of neural tube defects by one third in the U.S since its introduction by the Food and Drug Administration in 1998. However, the advantages and possible mechanisms of action of using folic acid for peripheral nerve engineering and neurological diseases still remain largely elusive. Herein, folic acid is described as an inexpensive and multifunctional niche component that modulates behaviors in different cells in the nervous system. The multiple benefits of modulation include: 1) generating chemotactic responses on glial cells, 2) inducing neurotrophin release, and 3) stimulating neuronal differentiation of a PC-12 cell system. For the first time, folic acid is also shown to enhance cellular force generation and global methylation in the PC-12 cells, thereby enabling both biomechanical and biochemical pathways to regulate neuron differentiation. These findings are evaluated in vivo for clinical translation. Our results suggest that folic acid-nerve guidance conduits may offer significant benefits as a low-cost, off-the-shelf product for reaching the functional recovery seen with autografts in large sciatic nerve defects. Consequently, folic acid holds great potential as a critical and convenient therapeutic intervention for neural engineering, regenerative medicine, medical prosthetics, and drug delivery²

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