Stanford Scientists Take Next Step in Brain-Machine Interface Research

In 2005, scientist and futurist Ray Kurweil raised eyebrows with his explosive book *The Singularity is Near*. Concerning the possibility that humans will “transcend biology,” Kurzweil noted: “The singularity will be a merger of our bodies + minds with our technology. The world will still be human, but transcend our biology’s roots. There will be no distinction between human and machine — nor between physical and virtual reality. If you wonder what will remain unequivocally human, it’s this quality — our species inherently seeks to extend its physical and mental reach beyond current limitations.”

Such claims had been made before, but Kurzweil foresaw it coming not in some distant future, but in the relative near term. Since publication of the book, artificial intelligence and several related technologies have made dramatic and sometimes troubling advances, and Kurzweil himself is now working on a follow-up book titled *The Singularity is Nearer*, set to debut in 2021.

It is debatable if Kurzweil’s singularity is achievable within the next few decades, but scientists are, in fact, making discoveries that seem to augur for the eventual merger of human biology with machines. An example is recent work carried out by researchers at Stanford University and described in a paper published in the journal *Nature Materials*. The paper describes the creation and testing of technology for artificial neural networks (ANNs) aimed for use in brain-machine interfaces, specifically the creation of “hardware ANNs that can both directly interface with living tissue and adapt based on biofeedback.”

Describing the research, *Stanford News Service* said the research was focused on testing a “biohybrid version” of an artificial synapse to demonstrate that it can communicate with living cells.

“This paper really demonstrates the unique strength of the materials that we use in being able to interact with living matter,” Alberto Salleo, a professor of materials science and engineering at Stanford and co-author of the paper, told *Stanford News Service*. “The cells are happy sitting on the soft polymer. But the compatibility goes deeper: These materials work with the same molecules neurons use naturally.”

In biological systems, neurons communicate across synapses using chemical signaling that triggers and modifies electrochemical activity in neurons. The “biohybrid” developed by the researchers integrates with this biological system.

“In a biological synapse, essentially everything is controlled by chemical interactions at the synaptic junction. Whenever the cells communicate with one another, they’re using chemistry,” Scott Keene, a graduate student at Stanford and co-lead author of the paper, said, according to *Stanford News Service*. “Being able to interact with the brain’s natural chemistry gives the device added utility.”

The researchers tested their approach using rat neuroendocrine cells that release dopamine, a neurotransmitter. They also stressed that their research remains at a very early stage.

"It's a demonstration that this communication melding chemistry and electricity is possible," Salleo admitted. "You could say it's a first step toward a brain-machine interface, but it's a tiny, tiny very first step."

Still, in their paper, the researchers emphasized the future impact of their discovery.

"By mimicking the dopamine recycling machinery of the synaptic cleft," they wrote, "we demonstrate both long-term conditioning and recovery of the synaptic weight, paving the way towards combining artificial neuromorphic systems with biological neural networks."

There are many, many steps to go before Kurzweil's predicted "singularity." This, however, appears to be one such step.

Dennis Behreandt is a research professional and writer, frequently covering subjects in history, theology, and science and technology. He has worked as an editor and publisher and is a former managing editor of The New American.