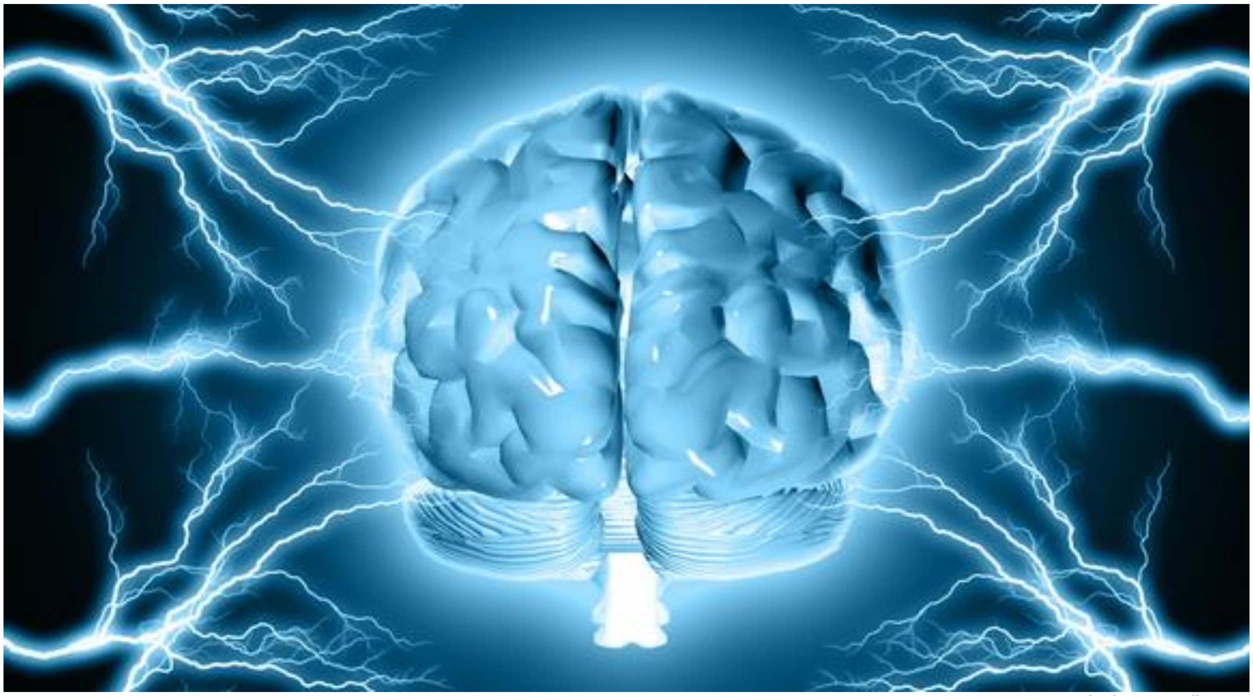
Electroceuticals: the Shocking Future of Brain Zapping



GSK launches US$50m VC fund

09.08.2013 - British drug major GlaxoSmithKline has set up a US$50m venture capital fund to boost bio-electronic medicines.

So-called electroceuticals use electrical impulses to modulate the body's neural circuits as an alternative to drug-based interventions. Glaxo SmithKline (GSK), which launched a US$1m prize in April for mapping disease-associated neural circuits, has now set up a strategic venture capital fund to invest into interesting programmes. GSK's ultimate goal is to bring the first electroceutical within one decade onto the market.

GSK said the new fund's first investment would be in SetPoint Medical, a California company working on implantable devices to treat autoimmune diseases such as rheumatoid arthritis or Crohn's disease by stimulating the vagus nerve, which then triggers release of immune-modulating cytokines. The company will receive US$5m from GSK's new US50m Action Potential Venture Capital Fund.

GSK's believes that it will be possible to use electrical impulses to address a range of diseases, from high blood pressure to brain disorders such as multiple sclerosis by targeted electrical stimulation. The bioelectronics concept is approximately 20 years old but could profit from recently announced R&D programmes such as the US$100m human brain mapping project in which disease-specific neural signatures will be mapped. Because of the complexity of the brain, the lowest-hanging fruit in the electroceuticals space will be interventions that target the peripheral nervous system.

Written by

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It's all in your head—those icky feelings, all that fog—and chemicals just aren't that great at cutting through. That's why scientists are experimenting with changing the brain game by tweaking its circuitry, rather than the chemical processes.

It might be a bit unnerving to us seasoned pill-poppers, but some believe that electrical currents could be the new wave in everything cerebral, from treating depression and addiction to enhancements that would enable those seeking that mental edge to learn new skills faster or remember more.

While pharmaceutical companies rake in nearly $90 billion a year from global sales of mental health meds, psychopharmacology research and development has slowed to a crawl. With about 20 percent of Americans taking prescription medications for psychiatric and mood disorders, there's a lot of room for growth.

That's where "electroceuticals" come in.

“People find electricity being applied to treat depression very bizarre, but they find swallowing a pill to treat depression or anything else very natural,” said Marom Bikson, a professor of biomedical engineering and founder of a company that develops brain stimulation hardware.

Zapping your noggin may seem like the new wave of masochism rather than the cutting edge of medical tech, but the brain is essentially an electrical organ; altering the currents alters the signals. This has been the basis for psychopharmacology all along, but pills are slow, and expensive to produce. According to Bikson, our reliance on drugs is “more cultural than scientific.”

Using electrical currents to stimulate specific elements in the brain to alter their functions sounds like an idea direct from the future, but people have been therapeutically shocking their bodies and brains since we first harnessed electricity. One of those early adopters was the Roman Emperor Claudius, who pressed electric eels to his temples to ease headaches.

While electrical brain stimulation never went away, it fell out of favor as big pharma rose to the fore. In modern times, the thought of applying electricity to the brain has been met with all sorts of creepy feelings a la *One Flew Over the Cuckoo’s Nest*, but brain stimulation has evolved a lot since then. In 2000, Michael Nitsche and Walter Paulus, two German scientists, looked at how targeting electricity to certain areas of the brain affects the functions of specific lobes, and brain stimulation as we know it began to take shape.

Now, some researchers believe this evolving science of what has come to be called “electroceuticals” might reinvent the entire field of medicine as we know it.

“What if electroceuticals could be as effective as drugs? What if electroceuticals could be one-hundredth as effective as drugs?” Bikson ponders. “It would mean that electroceuticals are going to change the world.”

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Curious to see the new technology for ourselves, we stomp through a sludgy March afternoon to meet Bikson his City College of New York office. His research focuses on transcranial direct current stimulation (tCDS), a non-invasive procedure that involves placing positive and negative electrodes over the scalp to target specific parts of the brain and bring about different neurological effects.

Unlike the rambling, breathless lists of side effects at the end of Prozac commercials, there’s only one with tDCS: mild irritation on the skin where the electrical nodes are placed. To prove it, Bikson suggests we give it a go.

Eric volunteers, and is feeling just a touch nervous about the whole thing, although the biomedical engineer assures us nothing can go wrong. That sounds like precisely what a mad scientist might say.

Bikson adjusts a sponge-lined strap over Eric's forehead and connects it to a beige box covered with dials and knobs. For this demo, Bikson placed the electrodes on Eric's head to impact an area that relates to depression.

"This is the current and the light is flashing which means that we're going up slowly," Bikson starts to count off the current level until it reaches the initial target of one milliamp. "And we're stimulating."

He adjusts a sponge-lined strap over Eric's forehead and connects it to a beige box covered with dials and knobs

He bumps up to "the typical high dose of tDCS" which, at a whopping two milliamps, isn't actually much at all. For perspective, it would take 500 milliamps to power a 60 watt light bulb. Electroconvulsive therapy (ECT) is about a thousand times more intense than tDCS and floods the entire brain with currents, rather than just the parts of the brain that impact certain moods or cognitive abilities.

The electrodes send off a bit of a prickly heat sensation for the first few minutes, but Eric says he doesn't feel much of a difference in terms of emotional state. Bikson says that's to be expected with the first few rounds. Initially, the effects are limited, but over time, the impact accumulates and the effects last longer.

"There's already technology available today that can, with limited discomfort or no discomfort, deliver much higher intensities than people are using. And there's no theoretical—not even real—reason to think that this might be hazardous," Bikson says. "We're at baby aspirin levels right now. [Researchers] are going really slow with this stuff."

So why not ramp up the experiments? Researchers have to be especially cautious because of how new the science of tDCS is—and perhaps to avoid the horrors that have been observed to coincide with ECT.

"Part of the reason why people are on the fence is because the effects are small, [but] of course they're small. The dose has not increased in 15 years," Bikson says.

But Bikson says that might be keeping them from making real headway—and from having the sort of impact on test subjects that would get the medical community engaged with this stuff.

One specific type of brain stimulation—and there are a lot of different types—is already being used to treat Parkinson's disease through a surgically implanted device that works much like a pacemaker. That same technology is also being used to help treat neurological disorders like epilepsy and even the after-effects of strokes. A different sort of stimulation that uses lasers shows promise in helping rats kick a coke habit.

Researchers believe tCDS can have broader applications than what's currently being considered because of its precision in location and intensity, and the ability to stimulate an array of brain regions at once. According to Bikson, doctors may eventually to mix up perfect "cocktails" of stimulation for individualized treatments of multiple psychological issues. With all the unknown variables of drug interactions, the ability to personalize treatment is something drugs simply don't offer.

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Given just how big the potential is, it seems like big pharma would be interested—or perhaps a little intimidated—but few seem fazed.

One of the pharmaceuticals behemoths that has jumped into the electroceutical fray is GlaxoSmithKline.

"We believe bioelectronic medicines could allow us to address some diseases that have so far been untreatable, and others with greater precision and fewer side effects than with conventional molecular medicines," the multinational company said on its website.

The pharma company announced its entry into the world of electroceuticals with a $50 million dollar venture fund in 2013. But that sum is paltry compared to the $5 billion it puts into research and development each year—and doesn't signal that it's going to switch sides in the electricity versus chemistry debate anytime soon.

Pfizer, Novartis, and other pharma giants haven't been as open about their positions on electroceuticals. They've been less inclined to publicize the investments they have made, which have gone mostly to individual researchers looking into ways to stimulate the brain that require surgery.

"To me, that's a missed opportunity," Bikson says. Especially because the cost of developing a new electroceutical is a tiny fraction of the cost of developing a new drug.

Dr. Mark S. George of the University of South Carolina's Brain Stimulation Laboratory has loftier hopes for the potential of electroceuticals.

"All brain diseases, and all human behavior, is now within the scope of treatment or improvement with some form of brain stimulation," he said in an email. "I envision a future where these tools virtually eliminate all brain diseases, including stroke, traumatic brain injury, Alzheimer's, [and] pain."

Some people have taken to raiding RadioShack to fashion homemade stimulators to zap themselves

He admits that he's a dreamer, but the possibilities do seem endless. Even beyond the psychological applications of brain stimulation that Bikson and George are working on, there's another side of brain stimulation which attempts to make its users recall more, adapt quicker, or learn faster. This area of brain stimulation study is called “neuro-enhancement,” and it’s the part of the research that companies are eager to tap into for mainstream consumer use.

Bikson recently completed a research study for a company called Thync, which is one of the most prominent companies in the “neuroenhancement” side of brain stimulation. Thync has rais ed more $13 million to develop a device that it claims will offer consumers “new possibilities to feel your best and do more.”

The Silicon Valley-based company is trying to make its product as simple as possible to use through a smartphone-based app-plus-headgear contraption that would allow anyone to infuse their brain with what they call “Vibes” which will come in two flavors: “Calm” and “Energy.”

Since few of these devices are available on the market now—and electric eels are hard to catch—some have taken to raiding RadioShack to fashion homemade stimulators to zap themselves into brainer, chipper versions of themselves. But researchers like Dr. Anand Pandurangi, director of the Brain Stimulation Clinic at Virginia Commonwealth University Medical Center, says the effects of their toils are not just slim, but hard to quantify.

To the DIYers, he says, “[Your homemade brain stimulator] might help your depression, but then again so does a placebo pill.”

But he agrees that the possibilities are vast, partly because of the many different forms of brains stimulation. Aside from just shooting currents through the skull, researchers are looking into how magnets can facilitate the flow of electrical currents within the brain, and optogenetics, a way to alter specific brain cells to make them reactive to spectrums of light that can travel through the skull and brain.

But the skull can be a tough barrier to tapping into the brain.

Pandurangi, is working on way to get around that by experimenting with direct brain stimulation (DBS). A psychiatrist by training, he monitors pacemakers that have been surgically implanted in the middle of the brain to send electrical impulses straight into the brain tissue, instead of through the skull. This direct flow of electricity, does away with one of tDCS’ biggest problems: how to stimulate without sizzling the skin.

While tDCS seems to be safely stuck in infant-mode, DBS has its own risks, related primarily to the complications of infection or bleeding caused by the surgery that sets the pacemaker into place. While its been OK'd by the FDA to treat Parkinson’s and dystonia, it’s still in the initial research runs for psychological ailments like OCD and depression.

Pandurangiworks on the latter. He estimates that only about 500 people have received DBS for depression so far in the world. He says DBS has helped return signs of life to some of his nearly catatonic patients.

"[One of my patients] got medications for 20 years and did not get better," he says. She's gotten DBS for a while now and she's not cured, but her depression has become more manageable, although she's had to continue talk therapy in conjunction with the DBS. "So if you ask her, she'll say that DBS is a reasonable replacement to pills."

Those glimmers of hope are why researchers are trying to double down—and scale up—the study of electroceuticals, though it'll mean overcoming some entrenched fears and facing off against the entrenched norms of one of the most powerful industries on earth.

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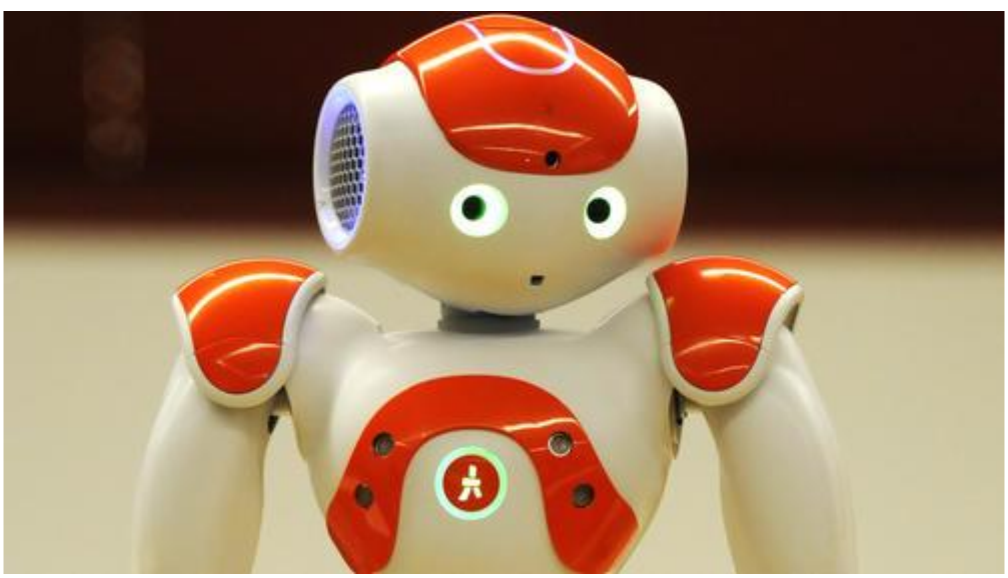
Electroceuticals, the brain/machine interface and superhumans: The future of neuroscience?

April 28, 2015 6:15 am by Meghana Keshavan |



We'll be skiing at 95, living well past 125 – with our brains controlling machinery that's symbiotic with our bodies. Or so said Geoffrey Ling, director of the biological technologies office at DARPA. He spoke about the sci-fi future of neuroscience while on a panel this week at the World Medical Innovation Forum in Boston.

Ling was joined by Ajay Verma, vice president of Experimental Medicine at Biogen (hold the Idec); and GlaxoSmithKline bioelectronics R&D vice president Kristoffer Famm. The trio was tasked with discussing disruptive technologies in neurocare, and man, did they deliver:

Electroceuticals

The role that neuromodulation, specifically in the form of electroceuticals, will play in the future of medicine sparked just a really fantastic – and perhaps fantastical – trip down the rabbit hole of neuroscience futures.

Electroceuticals are small, implantable devices – the size of a grain of rice – that are attached to peripheral nerves to modulate neural signals. Famm pointed out that these newfangled therapies may actually work inordinately better than the pill.

Your standard small molecule drug is, after all, a blunt tool when treating something as delicate as a neuropsychiatric disorder. After all, the molecule you might want to control in the pancreas may also be made in the heart – so if you treat one thing, you invariably impact the other.

Regulating the electrical firings of neural circuit, however, can be far more precise, Famm said.

“Neuroscience reaches beyond the neuropsychiatric system,” Famm said. “Many early opportunities we see for electroceuticals are in metabolic, cardiovascular and inflammatory disorders, for example.”

The brain/machine interface

The idea of implanting electrical devices to modulate the neural pathways led to a more sci-fi discussion. DARPA has a reputation for its flights of the fantastical, and science director Geoffrey Ling made no exception in his animated description of the future of neurocare:

“Think back to the major milestones in human advancement – think of the Stone Age, the Bronze Age, and so on,” Ling said. Human evolution has been all about creating tools that advance society, and making them work with our own physiology. Our ancestors used hammers as more powerful extensions of our bodies; the iPhone today is a smart extension we use with our hands to collect and disseminate information.

“Imagine Einstein if he had a laptop, not a pencil and paper, what he could do,” Ling said.

The next step, Ling said, is to just embed the technology within ourselves. Create mechanic extensions of our bodies that can be controlled by our brains. Next generation science will work synergistically with machines, he said: We'll be able to get data into the brain, and process it at extraordinary rates – without being limited by, say, your eyes.

"The brain/machine interface isn't something to be afraid of – it's something to be embraced," Ling said. "We've gotten to the threshold of just that."

Why evolve a superhuman?

"What's the average condition?" Varma asked. "Why do we get sick?"

The legacy of genetic evolution, he said, is that everything starts to decline right after most animals wrap up their reproductive years. But now, we've outgrown our genetic constraints – life expectancy and lifestyle have changed remarkably in the past 200 years.

But our genes haven't adapted. Molecular mechanisms that protected us from drought are now leading to hypertension. Genes that prevented starvation are now the spark for this global obesity epidemic.

"So we have a different equation now – why don't we superadapt?" Varma said.

Let's head back to earth, guys.

Famm brought the discussion back to reality.

"Don't get caught up in this obsession in creating some superhuman, when in reality we have the power of making much better medicines," Famm said. "We can go and make supermen after that."