Five Big Developments in Neuroscience to Watch

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Image via Wikipedia

Neuroscience is in many ways a discipline still in its infancy, making it ripe for claims that veer closer to science fiction than science. In this post I've taken a cut at describing five real-deal developments in neuroscience that are going to heat up in the years to come, along with implications pro and con.

Boosting Thought Control with Real-time Brain Feedback

Research conducted this year shows that people control their thoughts more effectively when they can see how their brain reacts. While in an fMRI machine, study participants were told to complete a set of mental tasks that either raised or lowered introspective thought (introspection requires higher-order, abstract thinking; non-introspection focuses on bodily sensations). They were simultaneously shown a real-time scan of their brains and could clearly see how part of their prefrontal cortex reacted when they worked on a task.

Participants with access to the brain scan significantly improved their brain regulation to successfully perform the tasks. A control group without access to the scan showed no improvement.

This is a development with a lot of upside. It's plausible that we'll eventually have a brain feedback app that clues us in when we're losing focus or need to change mental direction. We're obviously a long way from there, but the first step has been taken.

Changing Behavior with Non-invasive Brain Stimulation

Researchers in Taiwan recently found that applying a weak electrical current over the front of study participants' scalps for just ten minutes significantly improved their ability to control their behavior. The current is thought to somehow "jump start" impulse control in part of the prefrontal cortex.

The research also showed that the opposite effect can be induced by using the electrical current to suppress impulse control. Brain stimulation is not new (deep brain stimulation has been around a long time), but non-invasive stimulation or suppression of behavior that actually works is cutting edge.

On the positive side, this could be the beginning of new therapies to treat a buffet of impulsivity disorders and ADHD without medications and their side effects. The fear is it could also be the beginning of non-invasive mind control techniques; plenty of fodder here for conspiracy theorists.

Erasing Targeted Memories

We've heard about memory manipulation for ages, but in the last couple of years it has made the transition from theory to practice. A handful of credible studies have shown that memory can indeed be erased using procedures that involve removal or manipulation of specific proteins in the brain. Down the road, it's possible that we'll be able to target specific memories for erasure.

In very recent research, Israeli scientists showed that they can erase memories linked to drug addiction, thereby removing one of the most confounding factors in addiction treatment. That study speaks to the upside of memory erasure, along with the benefits of erasing traumatic memories. The fear is that targeted memory erasure brings up a slew of ethical questions, not the least of which is whether we're ready to accept the consequences of neutralizing part of what makes us human.

Changing Moral Judgments with Magnetism

Research of the last couple decades has shown that injuries to a part of the brain called the right temporoparietal junction (RTPJ), located at the brain's surface above and behind the right ear, can change a patient's moral judgments. When these patients are asked to answer morally challenging questions that weigh the life of one person against others, they consistently make utilitarian decisions without feeling the least bit uneasy. Their moral judgments about life and death, so vexing to most of us, become clinical and routine.

Researchers have recently found that they can induce a similar effect using magnetism (transcranial magnetic stimulation, or TMS) to disrupt RTPJ activity. When participants were exposed to magnetic "bursts" from a TMS device, their judgments about what is morally permissible significantly changed. For example, they were more likely to say that intending to

harm another was morally permissible if the other person luckily avoided becoming a victim; they considered the intention of the first person to be irrelevant. The effect was only temporary, but the implications are massive. Most of us consider moral judgment a higher order thought process, but this research shows that it can be tweaked by a weak magnetic field in a matter of minutes.

This development stirs multiple fears, but one that immediately comes to mind is the possibility of tuning down moral apprehension even lower and creating synthetic psychopaths. On the other hand, perhaps there's a good case to be made that some of us could use a little tuning down.

Controlling microRNA to Make Brain Cells Resistant to Death

Like tiny toggle switches, microDNA are powerful molecules that silence the activity of as many as two-thirds of all human genes. In recent years they have emerged as key players in neurobiological development and disease. This year, researchers at the University of North Carolina, Chapel Hill, made the remarkable discovery that microDNA may also be able to make brain cells resistant to programmed death, or "apoptosis."

A huge amount of the human brain's neurons die as we undergo normal growth and development. A portion, however, do not die, and they live on for the long haul. No one has been sure why those neurons survive the destructive "pruning" phase that eliminates droves of other neurons. The current research indicates that microRNA are at the heart of neuron survival, acting to essentially turn off the apoptosis mechanism that leads to cell death.

The upside is that if microRNA can be controlled in the brains of patients with neurological disease such as Alzheimer's, ALS and Parkinson's, then we may be able to halt the cell destruction those diseases cause and effectively stop the disease before the damage is done. It's important to note that this research was conducted using mice, but it's also the first to make this discovery in any mammalian brain and a promising first step.
