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Ed Boyden's blog

Ed Boyden is an assistant professor in the MIT Media Lab. His lab broadly invents new tools to engineer brain circuits, in order to treat intractable disorders, augment cognition, and better understand the nature of existence.

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Monday, September 17, 2007

In Pursuit of Human Augmentation

The journey toward making "normal" obsolete.

When you're sick, it's obvious that you and your doctor should work, if possible, to help you get better. Nobody would argue against a treatment that restores normal function to a sick or disabled individual. But the consequences of going further than that--going beyond "normal"--are not commonly studied, nor endorsed by many in medicine. Indeed, in any medical procedure, there is risk. If you are already normal, then conventional wisdom dictates that that's enough. "Do no harm," the old aphorism says--we should focus on altering the body and mind only when the risk of the alteration is justified, preferably by the hope of solving a deficit of vastly greater magnitude.

Science has endorsed something of a parallel attitude in its pursuit of biological and biomedical research. Namely, in biology, many key insights have emerged via study of the absence of the phenomenon of interest. For example, throughout the 20th century, many insights about the brain arose from the knocking out of specific genes, or the ablation of specific neurons in animals, or the examination of human patients who have suffered the loss of brain regions from conditions such as war or medically mandated surgery. In this way, we learned that patients without their hippocampi become unable to form new memories; humans and experimental animals with prefrontal-cortex damage make bad decisions and lack impulse control; subjects without dopamine-producing neurons exhibit symptoms of Parkinson's disease. These studies are good at demonstrating the necessity of a specific neural circuit, or brain region, to the normal state. The idea that biomedical science is supposed to bring us up to normal is embedded, to a degree, in the very structure of the experiments we commonly do in the laboratory.

There is nothing wrong with this line of thought. This angle of research is fully consistent with our medical goal. It has brought us many of the triumphs of the last century, and it continues to yield insights into the vast range of diseases that plague us throughout life. When researchers leave this line of thought, though, they point toward the possibility that going beyond normal may change us in new and unprecedented ways, improving our lives in ways that are hard to even imagine. One fascinating line of research over the past few decades has revealed that life span, which long appeared to be solidly set in stone, can be lengthened through pharmacological and genetic manipulations--at least in worms, yeast, and, most recently, mice. This work

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may someday (quite possibly soon) lead to drugs that can extend human life span. Or note that this past summer, double amputee Oscar Pistorius won second place in a race against able-bodied runners, racing with his prosthetic carbon-fiber legs. Now he is hoping to take on the Olympics, which has led international athletic bodies to worry that augmented humans may be better at running than normal ones are. As a final example, cognitive-augmentation drugs such as modafinil, which enhances alertness even after long hours of wakefulness, are becoming widespread. (Broadly interpreted, good ole coffee might be considered the original neurotechnology, having augmented attention, alertness, and memory in tired humans for millennia.)

It's arguably time for a discipline to emerge around the idea of human augmentation. At the MIT Media Lab, we are beginning to search for principles that govern the use of technology to augment human abilities--that make the idea of normal obsolete. As a codirector of the Center for Human Augmentation, I lead a lab, the Neuroengineering and Neuromedia Lab, that is developing devices that will hopefully eventually allow us to enhance memory, creativity, and happiness in humans. One interesting observation that has emerged is that it's much easier to know when something is gone than it is to characterize it in its intact state. For example, it's far easier to demonstrate that an animal can form no new memories than it is to characterize the trajectory that memories take as they are learned, consolidated, and forgotten throughout the lifetime of that animal. And whereas many measures of depression and sadness have been defined, a coherent description of happiness remains elusive. How can you augment something if you can't define it? One of the first things we are doing is developing better, measurable definitions of such phenomena. Another issue is that radically new tools are needed to augment the mind. We are developing new kinds of neural stimulators, for example, that enable highly targeted manipulations of the brain. Some of our inventions, like the ability to turn specific sets of neurons on and off with brief pulses of blue and yellow light, may be used chiefly in animals for the next few years, but I think they will find many compelling uses in humans in the years to come, as their power becomes manifest through the efforts of a great many neuroscientists and engineers.



Cognitive augmentation will require new technologies.

One argument in favor of going for optimality, and forgetting about normal, is that it's becoming harder and harder to know what *is* normal. For example, it's been demonstrated that two-thirds of all people have at least one copy of a DNA sequence that makes them more likely to become depressed after a stressful life event. The rest of all people, a minority of one-third, are more resilient to stress than the other two-thirds are. Thus, it could be argued that becoming depressed in response to stress is the normal state. As a neuroengineer, I think it's easier just to develop neurotechnologies that will enable us to make people as happy and intelligent as possible, and perhaps to even go farther: taking on the questions that philosophy struggles with, such as how to find meaning in one's life. (More on that last point in a future post.)

What is a problem, and what is a feature of the human condition? They are not necessarily distinct. But that doesn't mean we shouldn't continue to find better ways to make life better. In that way, we'll hopefully move, in the century to come, from "Do no harm" to "Do good."

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[Military already doing this](#)

The military waded into this territory a long time ago. It started with drugging soldiers with amphetamines; modafinil is just a safer replacement of that.

Then they started giving certain special forces "super vision". Normal guys with 20/20 vision, undergoing surgery to obtain 20/40 vision.

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[gabriellg01](#)

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[Early use of Augmentation](#)

How about a tip of the hat to perhaps the first notions of computer-based human augmentation, by Douglas C. Engelbart, director of the Augmentation Research Center of SRI International, in the 60s. He envisioned the use of personal computers (a radical notion then) to augment a person's and a group's capabilities for solving complex problems. His team created and demonstrated basic techniques for personal and group computing that are now commonplace.

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[jgoldberg](#)

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[Doing lots of good](#)

As we attain the ability to do a full readout of every person's dna, we will be able to determine the dna factors that correlate with traits that one can characterize as 'good'. Combine this with genetic therapy techniques and we will soon be doing lots of 'good'. The result will be a massive transformation of the human race within just a few generations.

At the same time, the ability to integrate non-biological enhancements within humans will proceed in parallel with the result being communities of cyborgs.

These trends should produce a powerful social reaction that will make the current cloning debate mere small potatoes.

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[jacklewisr](#)

09/18/2007

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[The Greater Good](#)

So, at what point will "good" be done unto you for the "greater good" of society at large? If its possible to "fix" you, what rights do you retain to remain unenhanced?

Time for some techno-ethics?

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[blunney](#)

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[Re: The Greater Good](#)

here's some prime ethics for you:

It needs to become the moral imperative of every member of our species to do what ever is necessary to both improve the species, and provide a higher standard of living for every member of the species.

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