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## WILL THE MIND FIGURE OUT HOW THE BRAIN WORKS?

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By Steven Pinker

### **Understanding how neurons operate is one thing; understanding how they make us the conscious beings we are is another matter**

Imagine this scene from the future. You are staring at a screen flickering with snow. Scientists have hidden one of two patterns in the dots, and eventually you spot one. But you don't have to tell the scientists what you are seeing; they already know.

They are looking at the electrical signals from one of the billions of cells in your **brain**. When the cell fires, you see one pattern; when it stops, you see another. Your awareness can be read from a single neuron. Now, in an even more unsettling trick, they send an electrical current to the neurons in that part of your **brain** and, with a push of a button, make you see one pattern or the other.

These feats of pinpoint **mind** reading and control are not fantasies. They have already been performed by Stanford University neuroscientist William Newsome. Not with people, of course, but with monkeys. Yet few scientists doubt the trick would **work** with us.

This is just one example of **how** much we have learned about the workings of the **brain** in the past 10 years--a period of intense research proclaimed by the U.S. Congress and the President as the Decade of the **Brain**. Every facet of **mind**, from mental images to moral sense, from mundane memories to acts of genius, has been tied to tracts of neural real estate. Using fMRI, a new scanning technique that measures blood flow, scientists can tell whether the owner of the **brain** is imagining a face or a place. They can knock **out** a gene and prevent a mouse from learning, or insert extra copies and make it learn better. They can see the shrunken wrinkles that let a murderer kill without conscience, and the overgrown folds that let an Einstein deduce the secrets of the universe.

**How** far **will** this revolution go? **Will** we ever understand the **brain** as well as we understand the heart, say, or the kidney? **Will** mad scientists or dictators have the means to control our thoughts? **Will** neurologists scan our **brains** down to the last synapse and duplicate the wiring in a silicon chip, giving our **minds** eternal life?

No one can say. The human **brain** is the most complex object in the known universe, with billions of chattering neurons connected by trillions of synapses. No scientific problem compares to it. (The Human Genome Project, which is trying to read a long molecular sentence composed of billions of letters, is simple by comparison.) Cognitive neuroscience is arming so many brilliant **minds** with such high technology that it would be foolish to predict that we **will** never understand **how** the **brain** gives rise to the **mind**. But the problem is so hard that it would be just as foolish to predict that we **will**.

One challenge is that we are still clueless about **how** the **brain** represents the content of our thoughts and feelings. Yes, we may know where jealousy happens--or visual images or spoken words--but "where" is not the same as "**how**." We don't know **how** the **brain** holds the logical connections among ideas that spell the difference between "Burr slew Hamilton" and "Hamilton slew Burr," between the image of a person winking to realign a contact lens and that of a person winking to flirt. These distinctions don't appear as blobs in a **brain** scan. They arise from the microcircuitry of the living human **brain**, and most people don't want to donate their **brains** to science until they're dead. (As Woody Allen said, "It's my second-favorite organ.") For a long **time** to come, the content of our thoughts may be the province of psychologists studying the **brain's** software, rather than neurobiologists studying its hardware.

Another challenge is understanding **how** the mere darting of ions and oozing of neurochemicals can create the vivid first-person present-tense subjective experience of colors, sounds, itches and epiphanies that make up the self--the soul, if you **will**. There's no doubt that physiological **brain** activity is the cause of experience. Thoughts and feelings can be started, stopped or altered by electricity and chemicals, and they throw off signals that can be read with electrodes and other assays. I also have little doubt that we **will** crack the mystery of

consciousness, in the sense of which **brain** events correlate with experience. Just compare **brain** activity when a person is awake or anesthetized, or when a novice is thinking about his golf swing and when a pro does it automatically.

But why some kinds of **brain** activity feel like something to you--or, more accurately, are you--is another question, and scientists disagree about **how** to answer it. Some say that subjective experience is unobservable and not a proper topic for science. Some say that once we can distinguish conscious **brain** processes from unconscious ones and show **how** they interact to cause behavior, there is nothing left to explain, and that people who are looking for some extra ingredient are just confused. Some concede that sentience is still a mystery but expect that an unborn genius **will** someday explain it to us. Still others suspect that the **brain** did not evolve to grasp the answer, any more than it can visualize what came before the Big Bang or the shape of a curved 4-D universe.

If you think the answer is obvious, you are prepared for the ultimate triumph of the **brain** science of tomorrow. The synapse scanner has been perfected, and you can download a backup copy of your **mind** into a chip that **will** outlast your **brain**. Unfortunately the scanner destroys the tissue it scans, so you have to choose between your old **brain** and a new one. The new **brain will** react and behave exactly like you--but would it be you? If you say yes, are you confident enough to step into the scanner?

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By Steven Pinker

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