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Was Blind, But Now I See

Stem Cells, Genetics, and Bionics in the Quest for Sight

The cure for blindness has long been one of medicine's holiest grails. But unlike the ancient Egyptians, who thought a splash of lizard's blood and a dash of crocodile dung would do the trick, modern medicine's pursuit of a blindness cure has recently seen some promising results.

In 2000, doctors transplanted adult stem cells into the eyes of a man who had been blinded by a massive chemical burn as a child. One cornea transplant later, the man, who had lived without sight for forty years, can now see. Though this particular procedure works in only a very few cases (where healthy cells exist around a damaged cornea), there is good reason to believe that adult stem cells might one day lead to therapies for other kinds of blindness. In laboratory tests, scientists have cultivated neural stem cells from rats and injected them into the gelatinous ooze within rat eyeballs affected by retinal disorders. The stem cells not only assumed the characteristics of healthy retinal cells, but also moved into the optic nerve—a

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surprise that led researchers to think adult stem cells might one day be used to repair damaged or degenerating eye tissue.

Our expanding genetic knowledge might also be used for treating blindness. In a recent issue of *Human Molecular Genetics*, researchers in Oregon reported the discovery of a gene believed to be the culprit in some cases of age-related macular degeneration, a condition causing gradual loss of sight that afflicts six million Americans. Human trials of gene-based therapies aimed at both macular degeneration and hereditary blindness are set to begin in the U.K. perhaps as early as next year.

A third promising avenue of research is the emerging field of bionics: In the last two years, 26 people in the U.S. and Europe have been outfitted with new prosthetic devices designed to restore their vision. The first bionic retina was implanted in 2000. Built by the Illinois-based firm Optobionics, this tiny silicon microchip looks similar to a fly's eye, and works by converting light into electrical signals that stimulate damaged retinal cells and are interpreted by the brain. The company says it has equipped nine patients with its artificial retinas, and six of them have shown signs of improved (though still quite minimal) vision.

Another kind of artificial retina is being developed by scientists at the University of Southern California as part of a national research initiative funded by the Department of Energy. This device collects images from a small television camera mounted on a pair of eyeglasses. The video signal is sent into a small computer processor implanted under the skin behind the ear. The tiny computer then sends electrical signals to sixteen electrodes that have been surgically implanted behind the damaged retina at the back of the eye. When the electrodes are signaled, they stimulate the existing biological retina, and the brain interprets the signals as light.

Compared with the functioning of the normal eye, the image produced by the sixteen points of light is still very poor. Though some patients have been able to distinguish between different objects, researchers say that at least a 600 pixel resolution will be necessary to discern the outline of a human face. Scientists are now experimenting with a 60 electrode version on dogs, and hope one day to build a retina that can conjure an array with over 1,000 points of light. The major technical obstacle is building electrodes small enough so that many can fit behind the eye and interface with living tissue (the sensitive ganglion cells of the optic nerve tend to deteriorate when manipulated; a very finicky bunch, those ganglia).

But these artificial retinas only work on eyes with functioning retinal cells, which is why some vision researchers are hoping to bypass the retina altogether. In the 1960s, scientists discovered that electrically stimulating the brains of blind patients generates small spots of white light called "phosphenes." Although this discovery sat for a while on science's shelf of worthless curiosities, one pioneering researcher has, since the late 1970s, been trying to build an artificial vision device that directly stimulates the brain. The device developed by Dr. William Dobelle—made possible by a lot of research, and of course by Moore's Law—uses a tiny digital television camera mounted on eyeglasses. These relay information to a portable PC, worn on the patient's belt. There, the information is translated into electrical signals which are sent via wires through a small incision in the skull to a plate of electrodes attached

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to the surface of the patient's visual cortex. When equipped with the full unit, a patient sees a display of phosphenes, which looks, as the *Wall Street Journal* put it, like "the light-bulb array of a stadium scoreboard," and which approximates—very roughly—the outlines of objects.

The FDA hasn't approved the device because electrical stimulation of the brain has caused seizures in some patients. But at the Dobelle Institute in Lisbon, Portugal, eight people have been outfitted with the full system, at a cost of $115,000.

At the University of Utah, researchers are seeking to develop an electrode device which, rather than interfacing with the brain's surface, penetrates the brain's visual cortex, and is capable of stimulating individual neurons. Dobelle considers this risky; brains tend to jostle a bit in the skull, and a foreign object inserted into them could bring on hemorrhaging. But in time, such machine-to-brain connections might be more reliable, as advances in nanotechnology make possible more seamless interfaces between electronic devices and living tissue.

One artificial retina researcher, Dr. Eberhart Zrenner of Tübingen, Germany, told *Science* magazine that—beyond the obvious desire to help patients—the effort to bring sight to the blind holds a special allure: Whoever makes the breakthrough, he remarked, could be the first to say, "I'm the one who, like Jesus, made a blind man see again."

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