



Artificial vision

Optical illusion

A brain implant bypasses the eye and creates the simplest form of vision

RESTORING sight to the blind was once the preserve of miracles. These days it is increasingly the stuff of medical technology. Cloudy lenses, for instance, known as cataracts, are routinely replaced with clear, artificial ones, and many elderly people see all the better for it.

The lens, though, is a simple bit of the eye. Recreating the upper layers of the retina is more difficult. In 2002 six people from Los Angeles had electronic sensors implanted in their retinas that replaced the photoreceptor cells they had lost to a disease called retinitis pigmentosa. Those implants contained 16 electrodes, or pixels, that enable the patients to detect a light source and distinguish simple objects such as cups and plates. Now a trial of a 60-electrode implant is about to begin.

Even more impressive is the idea of restoring sight to people who have lost their eyes. This is an ambition held by John Pezaris and Clay Reid of Harvard Medical School. It is a long way from being realised. Nonetheless, as they describe in this week's *Proceedings of the National Academy of Sciences*, the two researchers have shown how to do it—for a single pixel and in monkeys.

In normal sight the eye relays coded impulses to the brain. Hence, in artificial sight, scientists can bypass the eye altogether and go straight to the business end

of vision.

The brain is as complicated as organs get so, to keep the task simple, Dr Pezaris and Dr Reid fiddled with a region called the lateral geniculate nucleus (LGN), which receives coded impulses and shifts them on to other regions for processing. At the LGN stage of the brain's visual pathway, the function of every nerve cell is largely determined by anatomical position. In other words, its nerve cells are arranged as a map of the retina.

Specifically stimulating

Dr Pezaris and Dr Reid inserted tiny electrodes into the LGNs of two monkeys. These allowed nerve cells in those areas of the brain to be activated by the researchers, as though the impulse had come from a part of the retina.

First Dr Pezaris and Dr Reid ran an experiment ignoring the electrodes. It measured the monkeys' tendency to focus on objects of interest. One at a time, the two monkeys sat in a dark room in front of a computer screen. As would any primate in an inquisitive mood, they tended to move their eyes rapidly to look straight at a dot of light whenever one flashed up at a random position on the screen, so that the light impinged on the most sensitive part of the retina. By the time the monkeys stared directly at the light, it had been extinguished.

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Measuring how accurately the monkeys could move their eyes in the direction of the flash gave the researchers data that could serve as a baseline in their next experiment. This time flashes appeared on the computer screen just as before but the odd one was missed out at random. In its place an electrode briefly excited nerve cells in the monkeys' LGNs. Knowing which part of the LGN they had activated, Dr Pezaris and Dr Reid knew which position on the computer screen the monkey would have perceived a flash as having come from. The artificial twinkles seemed to make no difference. Both monkeys moved their eyes as accurately and rapidly in response to the imagined flashes as they had done to the real ones.

*To check the electrode impulses were not themselves causing the eyes to move (because the LGN is also involved in orienting the eyes), Dr Pezaris and Dr Reid paired computer-screen flashes extremely close together in time, and also showed a true screen flash just before a fake one. Had the electrodes directly spurred eye movements (rather than that movement responding to where the brain had processed the flash as coming from) the eyes would have moved between the flashes but confused the order of the real and the artificial flash. They did not.

Dr Pezaris and Dr Reid believe their proof of concept will eventually be developed into a wireless device with many electrodes touching different parts of the LGN at the same time. That implant could receive a signal from spectacles containing a digital camera. Thus, in the future, someone who had lost his eyes could see using a camera. For this, of course, a hundred or more pixels would probably be needed. Still, one is a start. ■