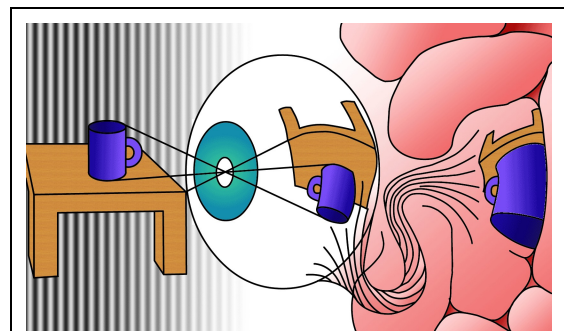


Giving sight to the blind is a mug's game

It's late; there's more to do. You reach for your coffee mug; it's on top of the table. But is it really on top of the table? How do you know? Light from the mug and the table falls on the back of your eye making images of the table and the mug, one above the other. The light triggers electrical signals. What happens next? Pulses from the back of the eye travel into your brain and a cascade of electrical activity begins.

We know the start of this story, we know the end (you get your caffeine hit), and neuroscience has given us tantalising glimpses of the bits in the middle. If you could look at the surface of your brain at the very back of your head and see the pattern of the electrical activity you would see your hand reaching towards the mug. It would be distorted, like you were looking at it through a wine glass, but still recognisably a mug, as if the back of your brain were a cinema screen. All those nerve fibres that bundle together as they leave your eye spread out again in just the right pattern to perform



As electrical activity passes from the back of your eye to the back of your brain, the images of objects in your vision are flipped and distorted but neighbouring objects stay next to each other (artist's impression - anatomical details simplified).

this projectionist's trick. We don't know why; some people have suggested that this is the most efficient way for the brain to do the processing that it needs to do. However we do know that the brain is very good at doing some things, like allowing us to pick up objects that we see. So perhaps by imitating the way the brain is built we can understand it better and learn how to build better computers.

This is the approach taken by Neuromorphic Engineers. Starting in the '80s, researchers tried to design computer chips completely unlike anything which had come before. Instead of storing numbers and adding them together, one-by-one and very fast, these chips were more like brain cells. The tiny electric currents that flow through the skin of a brain cell as it prepares to send a pulse to

its neighbours were represented by currents that flow across the surface of a silicon chip.

Neuromorphic Engineers designed convincing brain cells and realistic connections between them. They designed protocols to connect these "neural chips" together; some have even tried to link these artificial brain cells to real ones to get them to communicate; and some have built camera chips that work a bit like an eye. Now researchers at Edinburgh University are working on the "Coffee Mug" problem. Simeon Bamford from the EPSRC and MRC funded Neuroinformatics Doctoral Training Centre explains:

"As the cells from one area of the brain reach out their nerve fibres to connect to cells in another area they manage to find the right place even though it's the cell equivalent of hundreds of miles away. Imagine reaching your arm out from Edinburgh all the way to London and then trying to shake hands with the right person."

Neuroscientists have found that the cells manage this very well even when parts of the brain areas are missing and that the patterns of connections can change over time to make the most of the available information. For example if only one eye can see, then the connections from the blind eye die away and those from the working eye can take over. This is an enviable ability. Imagine computers that could rewire themselves to carry on working even when some of their parts break down.

By copying the methods that cells seem to use to connect themselves up, the Edinburgh researchers hope to demonstrate a system where a group of cells make a pattern of connections that can change according to the activity of the cells. Unlike in the brain, the silicon chips don't physically rewire themselves. Rather the signals are re-directed to get from one cell to the next.

There's a history of this work at Edinburgh and there's good co-operation amongst the Neuromorphic community. The researchers are using a cell design from a group in Zurich and a cell-to-cell communication system that was developed in Pennsylvania.

Bamford sees potential for this work in prosthetics. As he explains:

"There has been lots of work on systems that can replace damaged parts of the body, for example, implanted silicon chips that can give sight back to the blind by using the output of a camera to stimulate the brain. In such systems it's better for the patient if it can work quickly without the brain having to reconfigure itself. Our system may allow prosthetic implants to adapt themselves to the brain rather than the other way around."