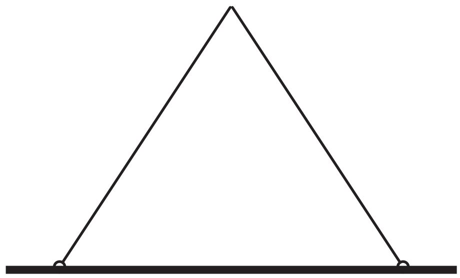
The memory fix

Implants that bridge damaged parts of the brain are no longer a distant dream, says Sally Adee



SAM DEADWYLER's work sounded a little too much like something from *The Matrix* – and that was a big problem. In the same way that Neo downloads a kung fu master's skills, Deadwyler had wired up the brain of a rat with electronics that transplanted memories derived from 30 rats into its brain, allowing it to draw on training that it had never personally experienced. The study had the potential to be a landmark finding – but "everyone thought it was science fiction", he says. "I thought, 'no one's going to believe this unless I do a hundred control experiments'."

So he did just that. Last December – 10 years after the original experiment – the paper was published at last. Instant kung fu is still the stuff of Hollywood blockbusters, but this research could nevertheless have a huge impact on many people living with brain damage. Ultimately, the same kind of neural implants that allowed memories to be "donated" from many rats into another individual could restore lost brain function after an accident, a stroke or Alzheimer's disease.

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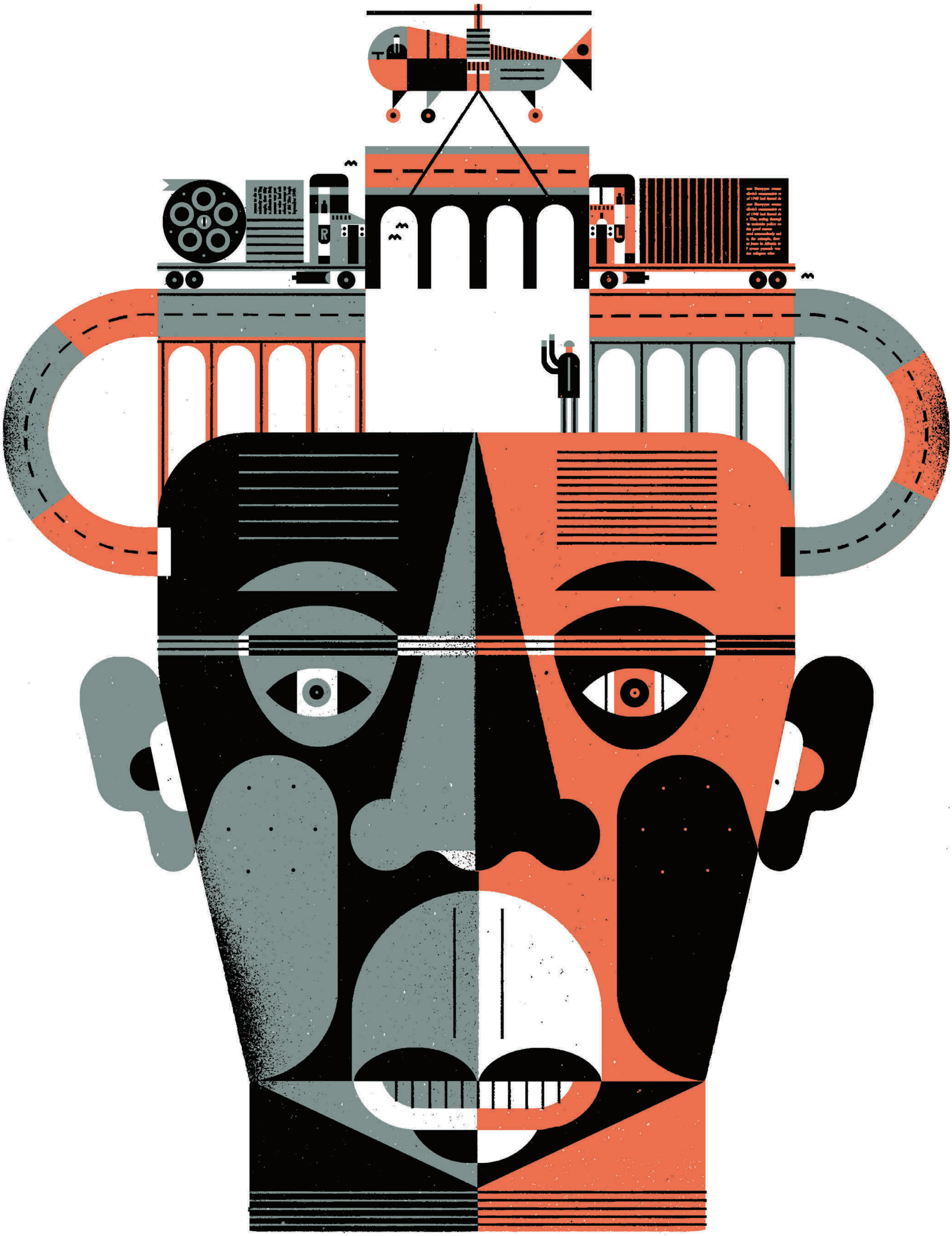
For a lot of people with memory loss, damaged parts of the brain are failing to pass information from one area to another. If you could create electronics that interpret the signals from one area, circumvent the damaged parts, and write them into the second area, you could help people regain the ability to form new memories, or even gain access to precious old ones. Such a chip would act as a kind of brain bypass.

Getting there won't be easy: such an implant requires neuroscience that is only now beginning to be understood. More than that, however, these new technologies raise ethical questions that were once the reserve of science fiction. Our memories define us, so preserving them from damage could save our identity – but when your memory is a computer algorithm, are you still the same person? It's almost time to find out: the first human studies will begin within five years.

Our ability to communicate directly with the brain has accelerated rapidly over the past two decades. The technology – known as brain-machine interfaces – has restored hearing and sight in the form of cochlear and retinal implants. It has also helped people control prosthetic limbs: one robotic arm, connected to the motor cortex, has such sensitivity that amputees can hold a cup of coffee, pick individual grapes and even play the guitar.

Impressive as they are, however, these devices have a limited job. "The prosthetic limbs are mainly about output – we read one area of the brain and use it to control a device," says Robert Hampson, who works on cognitive implants with Deadwyler at Wake Forest Baptist Medical Center in North Carolina. "And the retinal and cochlear implants are input devices. We take output from a machine and input it to one part of the brain."

When translating between two areas of the brain, however, you need a device that can do both: record activity from one set of neurons and then electrically stimulate another set of neurons to replay it whenever it is needed. Needless to say, it's an endeavour rife with challenges. "To make a cognitive device, we first have to know what a memory looks like," says Hampson. The search for a memory trace in the brain has been complicated by the fact that there are many different kinds of memories: there's the short-term "working memory" that helps you to remember a phone number before you dial, sense memories that might include the echo of what someone's just said, and long-term memories of facts, skills and experiences. It is this long-term recall, and how it emerges from working memory, that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