

[More from The Economist](#)[My Subscription](#)[Subscribe](#)[Log in or regi](#)**The
Economist**[World politics](#)[Business & finance](#)[Economics](#)[Science & technology](#)[Culture](#)[Blogs](#)[Debate](#)[Multimedia](#)[Special report: The brain](#) ▼[Timekeeper reading l](#)[Print](#)

I think, therefore I am, I think

Consciousness awaits its Einstein

Dec 19th 2006

[Like 36](#)[Tweet](#)[Advertisement](#)

IN A building that looks, from the outside, like the villain's lair in an early James Bond film, a robot moves around. Called Darwin XI, it is the brainchild of Gerald Edelman. The building is the Neurosciences Institute in San Diego, California, and Dr Edelman is one of an eclectic group of researchers—some of them neurologists and some philosophers—who are trying to explain what is, perhaps, the biggest mystery of the human brain: the nature of consciousness. His approach is to build machines run by computer programs that work the way he thinks that brains work, and then see what happens.

Consciousness is the core of an individual's sense of self, yet, paradoxically, it is the most elusive concept in biology. Even framing the questions is difficult. Broadly, though, researchers have taken three approaches. One is the experimental method embraced by Dr Edelman. A second is to look for consciousness directly in the brain. The third is merely to sit and think about the question. Though empirical scientists sometimes scoff at it, this third method is not to be despised. After all, it was by sitting and thinking about some paradoxical results in physics that Albert Einstein was able to break out of the mental mould of classical physics and invent the non-commonsensical but scientifically successful theory of relativity.

Dr Edelman refers to his theory of consciousness as neural Darwinism. It combines two

maps themselves are mapped by other groups of neurons. It is this phenomenon of different groups of neurons watching each other that he refers to as re-entrant mapping.

Whether neural Darwinism is truly a theory of consciousness is moot. It may not, for example, fully account for the feeling of actually experiencing things such as emotions that most people would think central to conscious experience.

(Philosophers refer to such consciously experienced feelings as qualia.) As a theory of how brains work, though, it seems to have a lot going for it, for Dr Edelman has used it to construct a series of ever more complex robots that behave, in many ways, like animals. The latest, Darwin XI, has a range of senses: vision, hearing, touch and what Dr Edelman refers to as taste (but which is actually sensitivity to the electrical conductivity of what its “taste” organs are in contact with). It also has whiskers.

Darwin XI can do a lot. It can, for example, learn to navigate mazes in search of rewards, in the way that a laboratory rat does. It can develop preferences, thanks to a pleasure centre that generates what Dr Edelman calls good taste in response to those rewards. And it can forget those preferences if they are no longer rewarding.

Other robots are able to perform similar tricks, but they have to be trained specifically to do so. The computer that runs Darwin XI can work things out for itself. It is loaded with virtual neurons, the initial strength of whose synapses with one another is allocated by a random number generator, and left to get on with things. It does have a bit of pre-ordained neuro-anatomy (in particular, it has been fitted with the equivalent of a hippocampus) but, like the local specialisation in a real cortex observed by people like Dr Kanwisher, most of the specialisation in Darwin XI simply emerges. This happens through the formation of specialised groups of neurons that resemble the specialised locations seen in real brains. The researchers know this because they can track changes in the way the virtual neurons connect to each other.

So is Darwin XI conscious? Well, it cannot speak, so no one can ask it. But the answer probably depends on whether you think a rat is conscious. That illustrates a big part of the problem of consciousness: no one can agree on who has it, let alone what it is. In fact, the

As others see us

I think, therefore I am, I think

Sources & acknowledgments

Reprints

Follow *The Eco*

Latest updates »



Daily cha
Britain's n:
Graphic detail



Taking ba
Republic's

ability to recognise themselves in a mirror, whereas monkeys and various other reasonably intelligent species, such as dogs, do not. A few species that are not apes have also passed the mirror test, including elephants and dolphins. But most animals fail it.

All the species that have passed have something in common: abnormally large cerebral cortices relative to the rest of their brains. Whether self-awareness simply emerges from a large cortex or whether selection for it necessarily results in one is unclear. Perhaps it is both. What is interesting about Dr Edelman's theory is that awareness of self is built into it. That, in essence, is what re-entrant mapping is.

Such self-awareness is not, however, indivisible. One treatment for serious epilepsy is to cut the corpus callosum and the other nervous connections between the two hemispheres of the brain, which stops the fit passing from one hemisphere to the other. This does not usually affect a person's everyday behaviour, but sometimes the two hemispheres have completely different personalities, and where that happens the individual's behaviour does change—indeed, he ceases to be an individual as the hemispheres fight for control of the body. The conflict often manifests itself in the person's hands, each controlled by a different hemisphere, trying to do opposing things. One hand may try to put on a piece of clothing, for example, while the other tries to remove it.

Tales of mystery and imagination

At first sight such cases seem extraordinary. But they are merely striking illustrations of a broader point: that in the brain nothing is ever quite what it seems, and experience and common sense are little use when formulating theories about the self. Two of the lesion studies mentioned in the introduction to this survey, dealing with the inability to perceive motion and recognise faces, arise from the fact that visual experience, which for those who can see is the dominant form of conscious experience, is a complete fabrication. What is consciously perceived is not a simple mapping of the images that fall on the retina. Instead, the signals from the optic nerves are deconstructed and re-formed in a process so demanding that it involves about a third of the cerebral cortex.

Even those with healthy brains get a hint of this in the form of optical illusions. These are



THE ECONOMIST



Getting th
Christie's e
Democracy in



Jumbo be
numbered
Gulliver | Jan :

More latest updates

Most commente



- 2** India's missing m
middle class shoul
- 3** Charlemagne: If f
paradise
- 4** Synthetic biology
- 5** Daily chart: Trust

Advertisement

things that people feel that they are experiencing. Much of the philosophical side of the study of consciousness seeks either to explain qualia or to explain them away. They are, for example, at the heart of the question of dualism. For it is hard to ask what is generating them and what is perceiving them without concluding that the processes are separate.

Daniel Dennett, a doyen among philosophers of consciousness, disparagingly refers to the putative “observing self” in this scenario as a homunculus. He calls the mental stage on which the qualia supposedly act out their play the Cartesian theatre, after Descartes, the philosopher who thought the soul resided in the pineal gland. And he points out that exactly the same problem applies to how the homunculus would perceive its own qualia. Turn the theatre into a cinema, though, and Antonio Damasio quite likes the analogy. His twist is to place the observing self in the film itself, rather than in the audience. That is not a particularly easy idea to grasp, but it does seem to bear some relationship to Dr Edelman's idea of re-entrant mapping.

That something in the brain really is performing the role of an observing self is suggested by the work of Benjamin Libet at the University of California, San Francisco. Dr Libet used electroencephalography to look at brain activity during the process of making simple decisions such as when to move a finger. He showed that the process which leads to the act starts about three-tenths of a second before an individual is consciously aware of it. In other words, the observer is just that: an observer, not a decider. This may explain the feeling that most people have experienced at one time or another of having deliberately done something that they had not actually wanted or intended to.

Though Dr Libet's experiment is almost laughably simple, it pokes a stick in a very deep pond. A feeling of freedom to make conscious choices is at the heart of most people's sense of themselves. Even Freud, who popularised the idea of the unconscious, believed that conscious free-willed thought could override unconscious desires. One way of interpreting Dr Libet's work, though, could be that such free will is, like colour vision, simply a powerful illusion. An actor in a film, perhaps. But an actor reading from somebody else's script.

Products and ev

Test your EQ

Take our weekly ne
headlines

Want more from T

Visit The Economis
of carefully selectec
pleasure, Economis
more

Advertisement



Want more? Subscribe to *The Economist* and get the week's most relevant news and analysis.

Classified ads

Digital editions

Events

Jobs.Economist.com

Timekeeper saved articles

Multimedia library

Debate and discussion

The Economist debates
Letters to the editor
The Economist Quiz

Ide:
184
Roll
CQ
Eur
The
Edii
Mor

Vie