Understanding ourselves

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Consciousness

by J. Allan Hobson

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People are fascinated by consciousness. After all, it is the basis of being human. It enables awareness, abstract thought, symbolism, communication, emotion and belief—without consciousness there would be no religion, no poetry and we would not be able to embark upon a quest to understand ourselves. J. Allan Hobson, Professor of Psychiatry at Harvard Medical School, is a leading expert in sleep research; in simply calling his book *Consciousness*, he is evidently confident that his particular discipline, neuroscience, is capable of investigating and explaining it single-handedly. We are also led to expect a definitive work. Sadly, the book rarely satisfies such expectations.

First, Hobson ducks the question of whether animals have consciousness by defining two types. The first, primary consciousness, is that possessed by animals. He then introduces mankind's secondary consciousness, and defines it as the ability to 'represent our own mental processes to ourselves via the abstractions of language and thought'—in other words, the awareness of being aware. Obviously, describing consciousness is problematic; if we have trouble even defining it, what hope does science have

in pinning down this elusive wonder of evolution?

There is a certain arrogance prevalent in science in believing that, given enough effort, all questions will eventually be solved. Neuroscience's adoption of the reductionist method—taking something apart and examining the pieces in order to understand the whole—is a prime example of this attitude. By analogy, studying the parts of a car with an electron microscope and a mass spectrometer will not help us understand how it moves.

So, neuroscience teaches us that the reticular formation, particularly the part of it that extends to the thalamus, is a kind of on-off switch for consciousness. When activation levels of the brainstem fall, even a little, the circuits in the thalamus begin to oscillate to their own rhythm, resulting in a loss of 'sensible' input to the cortex. Indeed, brain rhythms are associated with conscious states, e.g. beta and gamma electroencephalogram (EEG) waves with waking, delta and theta waves with sleep. But this is simply descriptive and does not define consciousness. Can it be defined in terms of pharmacology? There are different neuronal systems, the aminergic and the cholinergic systems, active in waking and rapid eye-movement (REM) sleep, respectively. This means that, in principle, different brain states could be mediated by different neuronal systems, each with its accompanying biochemical and physiological state. If behaviour is determined by the activation of different neuronal systems, free will and morality are under threat. Thankfully, Hobson says not. Then, maddeningly, he spends only a single paragraph defending them.

There is no God and 'clearly no Little Person inside us' states Hobson. His perception is that consciousness arises as a property of the whole machine, emergentism, but that the machine is modularised. Although the 'learning' module is shared by snails and humans, ours is in part voluntary and verbal and the snail's association is exclusively automatic and non-verbal. Indeed, language and memory are important components of secondary consciousness. However, this

line is not developed further. A pity, because there is much evidence that, raised in the absence of language, humans do not develop conceptual thought processes.

Instead, the second half of the book is concerned with Hobson's three-dimensional A-I-M model to describe conscious states. This represents 'activation' level, information source and modulation as the three axes of a cube—a reasonable, though entirely qualitative model. He uses it to define consciousness, by comparing dreaming, non-REM sleep and waking consciousness and asking what is subtracted from brain activity if one compares these states. But this approach is hopelessly limited if the goal is to understand consciousness. Having defined the model, Hobson then stretches it to breaking point. He uses it to describe psychopathology, neurodegenerative disorders, the artistic temperament and to justify pharmacological and other interventions in brain disorders—most disturbingly, electroconvulsive therapy (ECT) or, what the Americans more euphemistically call, electric shock therapy (EST). He rubbishes Freud but he excuses Moniz, who invented lobotomy, on the grounds that a metal instrument inserted into the brain and wiggled around produced results. Of course it did. This shameful episode in scientific history is one of the cautionary tales that all neuroscientists should commit to heart. He extols the virtues of Prozac, demonstrating how it works in terms of his model, bringing the disordered brain back into the 'correct' state-space in his three-dimensional consciousness cube. Hobson seems to have written his book before the catalogue of negative side-effects and long-term psychophysiological problems of the drug became known.

However, Hobson is a star in his particular firmament and moulds himself on William James (brother of Henry, the novelist, and seen by some as the father of modern psychology). As a résumé of modern thought on consciousness, the result here is not encouraging, disappointing even, and the last chapter dealing with the functions of consciousness

is a sad reflection of the limits of the scientific imagination. This is not to say that he has not contributed to the understanding of neuronal mechanisms in consciousness. An intriguing observation made by Hobson during his 'experience sampling' research, in which he has volunteers record their thoughts and emotions when 'beeped' at random intervals during the day and night, is that consciousness may edit behaviour and memory. People tend to forget quite how frequently they recorded negative thoughts and emotions when asked to look back on the whole day.

Who should read this book? Its style and content are not too technically demanding and make it a textbook suitable for science undergraduates and the interested layman. But those expecting to gain a comprehensive understanding of consciousness will be disappointed. After reading this book, I am convinced that it will take more than neuroscience to unravel the mysteries of consciousness. What is presented here is a descriptive account of what happens to some of the structures and processes associated with neuronal activity in sleep, when awake and in certain pathological states. But just summing up these happenings does not provide an explanation of consciousness. Nevertheless, neuroscience deserves its due: it has demonstrated that the reductionist approach can and will, explain many interesting aspects of the brain's activity. But it should be left there.

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Transplants of the future?

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Xeno: The Promise of Transplanting Animal Organs into Humans

by David K. C. Cooper and Robert P. Lanza
Oxford University Press, New York, NY
274 pages, US\$ 30.00
ISBN 019 512 8338

The prospect of xenotransplantation brings into profile a number of fascinating facets of modern medicine: hi-tech surgery and immunology, genetically modified donor animals, the threat of unleashing new zoonoses (animal-to-human infections) and a number of legal, health economics and ethical issues. All these points and more are brought together in this popular scientific book. *Xeno* is written for the proverbial 'intelligent layperson', and molecular biologists can surely be included in that definition.

David Cooper and Robert Lanza, physicians from Harvard Medical School and Advanced Cell Technology, respectively, know their field intimately and give a readable and exciting account of the developments and prospects for xenotransplantation. They are enthusiasts, but they do not skip lightly over the uncertainties or dangers. They have a gift for describing the life of a transplant surgeon, from scrubbing up for theatre to explaining the complexities of immune rejection. My only reservation is that the figures and photographs could have been displayed more imaginatively.

Xeno explains the reasons why pigs are the animals of choice as donors (in the UK, we are admonished for using the word 'donor' because the pigs have not given their informed consent!). The

various types of immune rejection across discordant species barriers are beautifully elucidated, including a chapter on tolerance named the 'Immunological holy grail'. While the authors are right up to date, they also have a sense of history about the pioneers of transplantation and immunological rejection. I had previously thought there were only three major immunological barriers, but I learned in chapter 6, 'A spoonful of sugar', that there are four: hyperacute rejection, delayed antibody-mediated rejection, acute cellular rejection and chronic rejection. The first two are unique to xenografts (and ABO blood group mismatched human transplantation), while the latter two are in common with human-to-human allografts.

If xenotransplantation becomes a reality, it is likely to begin with cellular therapies rather than whole organs, which are the main emphasis of *Xeno*. Pig islet cells could help millions of people with insulin-dependent diabetes mellitus; extracorporeal pig hepatocyte perfusion could tide a patient over until her or his own liver recovers or a human donor becomes available. Cellular therapies also hold promise for degenerative neurological diseases such as Parkinson's disease and stroke. But the authors of *Xeno* make little reference to alternative therapies, such as human stem cells or mechanical devices to aid the heart. It remains an open question, not least because of infection hazards, whether xenotransplantation will become as routine as the authors suggest.

For those who prefer a more academic book, *Xenotransplantation* edited by Jeff Platt (ASM Press, Washington DC, 2001) provides a learned, multi-author volume. At the other end of the spectrum, *Organ Farm* by Jenny Bryan and John Clare (Carlton Books, 2001) is based on a series of superb British television programmes on xenotransplantation. It has more personal anecdotes and numerous daring colour photographs of xenotransplantation in action—a more handsome volume than *Xeno* at less cost. But I would recommend *Xeno* to the readers of *EMBO reports*.

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