Part 2: Implications, questions and concerns

6. Brain gain

Steven Rose

'Better Brains', shouted the front cover of a special edition of *Scientific American* in 2003.[1] The titles of the articles inside formed a dream prospectus for the future: 'Ultimate self-improvement'; 'New hope for brain repair'; 'The quest for a smart pill'; 'Mind-reading machines'; 'Brain stimulators'; 'Genes of the psyche'; and 'Taming stress'. These, it seems, are the promises offered by the new brain sciences, bidding strongly to overtake genetics as the Next Big Scientific Thing.

The phrases trip lightly off the tongue. There is to be a 'posthuman future' in which 'tomorrow's people' will be what one author describes as 'neurochemical selves'. But just what is being sold here? How might these promissory notes be cashed out? Is a golden 'neurocentric age' of human happiness 'beyond therapy' about to dawn? Will implanted microchips turn our offspring into cyborgs? And if these slogans do become practical technologies, what then? What becomes of our self-conception as humans with agency, with the freedom to shape our own lives? And what new powers might accrue to the state, to the military, to the pharmaceutical industry, to intervene yet further in our lives?

Of course, one is entitled to be a little sceptical. Biological visionaries promising new utopias have been around for many years. Since the 1980s, geneticists have been promising the elimination of disease and the engineering, if not of happiness, then at least of improved health. Some have called this first decade of the new millennium the 'decade of the mind'. Certainly the neurosciences have become growth industries: 30,000 of us meet each year in the US, a more modest 8000 biennially in Europe. With the World Health Organization (WHO) suggesting that psychiatric distress, notably depression, has become a worldwide epidemic, and the incidence of dementias such as Alzheimer's disease increasing inexorably, the pressures to find treatments, probably drug-based, have mounted.

Meanwhile, in the panicky environment of the so-called 'war on terror' there is increasing military interest in the development of techniques that can survey and possibly control and manipulate the mental processes of potential enemies. And as politicians lament the rise of anti-social behaviour and the loss of 'respect' there is a groundswell of interest in the question of whether these social disorders may have biological causes. Might there be neurologically predisposing factors that brain imaging could reveal and pharmacological intervention prevent?

When I entered into it four decades ago, my science was, at its most ambitious, an enquiry into the relationships between brain and mind. More modestly, it attempted to explore the molecular and cellular processes involved in nervous function. Somehow, and quite suddenly, it has moved to the front line of moral and political concern. This is not, by and large, because of new theoretical insights, but instead from technical developments in many areas. Brain researchers are magpies, seizing on methods ranging from genetic manipulation to informatics and imaging in their efforts to comprehend the most complex structure in the known universe. The problems are formidable. Packed into the 1.5 kilos of the human brain are a hundred billion neurons (nerve cells) with possibly a hundred trillion connections (synapses) between them. Most are generated within the nine months from conception to birth, the product during this period and more dramatically in the decades that follow, of the ordered interplay of genes and environment. 'Understanding' the brain requires study over many orders of magnitude from molecules to cells to systems, and ultimately behaviour. It means asking why, and how, brains have evolved in the interests of the organisms, both human and non-human, that possess them. To many of these questions we still have no answers; we are data rich and theory poor. But in the headlong expansion of the last decades, neuroscience has become neurotechnology. What are the promises, threats and implications of this transition? What can we expect over the next two decades?

Curing brains and minds

To begin with the up-side, which most neuroscientists would choose to emphasise, there is now the prospect of treating or even curing brain disorders. The direct threats to the brain are from damage and degeneration. Unlike other body tissues, the central nervous system does not regenerate – hence the disastrous consequence of spinal cord injuries or stroke. For many years now, the neuroscience community has felt itself to be on the brink of solving the problems of regeneration, only to be defeated. The assumption that stem cells derived from human embryos will succeed where earlier attempts have failed is the source of much of the current hype, and has contributed to the UK government's bulldozing aside of the ethical objections felt by many. However, even putting aside these concerns, more than 20 years of experimenting with the use of such embryonic tissue in animal models has so far done little more than reveal the huge problems that need to be solved before human use could reasonably be considered. Even then it may be that adult stem cells, preferably harvested without such ethical dilemmas from the individual who is to be treated, will prove most effective in treating spinal injury and possibly Parkinson's disease. In the light of recent work from the National Institute for Medical Research there are grounds for cautious optimism here.

Alzheimer's, an increasingly familiar disease in an ageing population, is a different story, though also a modestly optimistic one. Despite frequent claims, stem cells are almost certainly irrelevant to its treatment. Genetic and biochemical research has identified the molecular cascade that leads to the neuronal death and cognitive decline that are characteristic of the disease. None of the current generation of drugs are very effective in stabilising – still less reversing – this decline. Novel compounds, based on increased biochemical understanding of the disease, should be available within three to five years, though their use as potential 'smart drugs' poses new dilemmas. Such drugs are likely only to delay an otherwise inexorable decline. The ideal would be to prevent the degeneration rather than ameliorate its symptoms, but that lies further into the future.

When one moves from brains to minds – to psychiatric distress – the picture is a great deal bleaker. The WHO estimates that depression will be the major epidemic disease of our century, affecting up to 20 per cent of the world's population. Women are three times more likely to be diagnosed with depression than men. Mainstream psychiatry tends to ignore this suggestive epidemiology and to 'molecularise' the condition. Successive generations of drugs have culminated in the widespread use of SSRIs (selective serotonin reuptake inhibitors), which boost the function of a particular neurotransmitter, serotonin. Yet despite the publicity that has surrounded them, Prozac®, Seroxat® and their relatives are not much more effective than the drugs they have replaced, and can even be dangerous.

The pharmaceutical industry now pins its hopes on developments in pharmacogenetics, which are based on the idea that people differ in their response to drugs because of small genetic differences. If these differences can be identified, drugs could be individually tailored to match a person's unique genes. However, the rush of optimism about pharmacogenetics that followed the 'reading' of the human genome has been tempered by caution. First, genetic information may not be sufficient in the absence of much greater knowledge of the interactions of genes with one another and with the environment during development. And second, the industry depends on having a mass market for its products; if this market is fragmented by genetic or developmental differences resulting in the need for many different drug types, the economics become trickier.

The mysterious condition known as schizophrenia presents even sharper problems. Although estimated to affect between 0.5 per cent and 1 per cent of the population worldwide, its aetiology is obscure and the claims for genetic causal factors disputed. It affects men and women more or less equally, but working class people are considerably more likely to be diagnosed as schizophrenic than middle class people, and, in the UK, people of Caribbean origin more than those whose biogeographical ancestry lies in Britain. Current drugs are only modestly effective, but a recent Foresight survey[2] of the pharmaceutical industry concluded that there were few prospects for new drug treatments in the immediate future.

Medicalising social problems

One of the most conspicuous features of current social thinking is the tendency to transfer complex social problems to the level of the individual. The person, and not their social context, becomes the focus of treatment. Women are much more likely to be diagnosed as depressed as men, yet this is regarded as a given, not the starting point for questions about gender disparities in power in society. Similarly, the psychiatric disorders listed in the US ‘bible’, the *Diagnostic and Statistical Manual*, include categories such as ‘conduct disorder’, ‘oppositional defiance disorder’ and ‘anti-social behaviour disorder’. The paradigm case is ‘attention deficit hyperactivity disorder’ (ADHD), which supposedly characterises children, mainly boys aged between eight and 13 who are unruly, inattentive and disruptive. Estimates for the prevalence of this condition vary widely: up to 10 per cent in the US for instance. An almost unrecognised disorder in the UK in the 1980s, it is now supposed to affect 1–3 per cent of children here too. The most commonly prescribed treatment is the amphetamine-related drug methylphenidate (Ritalin), which interacts with receptors for the neurotransmitter dopamine in the brain. Drug prescriptions for ADHD in the UK have increased from some 2000 a year in the early 1990s to some 150,000 a year today. Methylphenidate is supposed to make children more tranquil in class and to improve learning. In the US, a diagnosis of ADHD in a child is said to be predictive of delinquent behaviour in adolescence and adulthood. Methylphenidate is thought to reduce this risk.

Such developments highlight the deep ambivalence in modern society towards the use of drugs affecting brain and behaviour, whether legal or illegal, prescription or over the counter. The growing belief in a ‘pill for every ill’ ignores the ways that a child’s discontent at school might be caused by a poor home environment, inadequate teachers, rigid syllabuses or even endemic racism. We seem to be heading towards a pharmacologically defined future, what the neurophysiologist José Delgado called a ‘psychocivilised society’ and the psychologist BF Skinner offered as ‘beyond freedom and dignity’.

On the borderline between curing and enhancing

These developments have also proved a happy hunting ground for the burgeoning profession of bioethics. Is there a moral distinction between treating a deficit and enhancing ‘normalcy’? In many ways the question is spurious, hinging on what is meant by ‘normalcy’ (which has a tricky double meaning, at once statistical and normative). Rectifying short sight with spectacles is treating a deficit, but using a telescope or microscope is an enhancement. It is true that when Galileo developed the telescope there were those among his compatriots who refused to look through it, but few today would share this ethical discomfort. Yet in the context of substances that interact directly with our bodily biochemistry, we feel a considerable unease, reflected in custom and law. It is alright to change our body chemistry by training, but to achieve a similar effect with steroids is illegal for athletes. It is alright to buy educational privilege for ones’ children by paying for private tuition, but dubious to enhance their skills by feeding them drugs.

Methylphenidate is a case in point. It is regarded as proper to compel children diagnosed with ADHD to take the drug, but if they trade it in the school playground to a ‘normal’ youngster wishing to enhance his learning skills, they are condemned. One of the widespread concerns about the development of drugs for the treatment of Alzheimer’s is that, because they are aimed at preventing cognitive decline, they are a form of ‘smart drug’, which will find their way into schools and colleges. Is it cheating to pass a competitive examination under the influence of such a drug? Polls conducted among youngsters make it clear that they do regard it as cheating, in the same way that the use of steroids by athletes is considered to be cheating. However, the military at least has no qualms about such enhancement. US pilots in the recent Iraq war were said routinely to be using the attention-enhancing and sleep-reducing drug modafinil (Provigil) on bombing missions.

Reading our minds, controlling our thoughts

We now live in a surveillance society. On the streets, CCTV cameras monitor our movements. The wonders of information technology ensure that intimate details of our habits and vices are analysed through our use of credit cards, and this information in turn is used to shape our needs and desires through appropriately targeted advertising. But recent developments in the neurosciences are offering more direct access to our most private thoughts, through the new windows into the brain provided by neuroimaging. The extraordinary views of regions of the brain 'lighting up' (albeit in enhanced false colour computer images) when a person is thinking of their lover, imagining travelling from home to the shops or solving a mathematical problem are entrancing. Such imaging techniques (first PET – positron emission tomography; then fMRI – functional magnetic resonance imaging; and now also MEG – magneto-encephalography) began as research tools. Their clinical potential is clear: to be able to identify precisely regions of brain damage, the sites of tumours or the diagnostic signs of incipient dementia.

But what if they could do more? Advertisers and marketers for major companies, ranging from Coca-Cola to BMW, are starting to image the brains of potential customers responding to new designs or brands. New fields of 'neuromarketing' and 'neuroeconomics' are emerging. These trends may be relatively innocuous, but the increasing state and military interest in these techniques is less so. Could brain imaging predict future behaviour? There are claims for instance that such imaging could reveal potential 'psychopathy', that the brains of men convicted of particularly brutal murders show significantly abnormal patterns (although this does not include politicians who send their troops into violent war). In the current legislative climate, where there have been attempts to introduce pre-emptive detention for ‘psychopaths’ who have not yet been convicted of any crime, such claims need to be addressed critically. They are and will be resisted by the judiciary, but recent developments suggest that this may be a frail defence against an increasingly authoritarian state.

Of course, there are military as well as civil possibilities to consider. In the US (and presumably in the UK as well) such interest goes back at least half a century. A little history is important to put the current situation in perspective. Impressed by claims that the Soviet Union was developing powerful methods of psychological warfare, the CIA and the Defense Advanced Research Projects Agency (DARPA) began their own programmes, recruiting psychologists and neuroscientists to the work. Early experiments included the clandestine feeding of LSD to their own operatives and attempts at ‘brain-washing’. These were the forerunners of the hoods and white noise used by the British in Northern Ireland until judged illegal, and of course more recently in Abu Ghraib and Guantanamo.

By the 1960s, DARPA, along with the US Navy, was funding almost all US research into so-called ‘artificial intelligence’, in order to develop methods and technologies for the ‘automated battlefield’ and the ‘intelligent soldier’. Contracts were let and patents were taken out on techniques aimed at recording signals from the brains of enemy personnel at a distance, in an attempt to ‘read their minds’. Primitive at first, these efforts have burgeoned in the aftermath of the so-called ‘war on terror’. One company claims to have developed a technique called ‘brain fingerprinting’, which, according to its website, can ‘determine the truth regarding a crime, terrorist activities or terrorist training by detecting information stored in the brain’. We may be sceptical about the validity of such claims but they point clearly to the direction in which such research is currently heading.

The next step beyond reading thoughts is to attempt to control them directly. Once again, there is a long history of attempts by DARPA to develop techniques for focusing microwave beams to disorient or confuse opponents. Whether microwave technology is capable of achieving this goal is uncertain. More promising, however, is a much newer technique – transcranial magnetic stimulation (TMS). This focuses an intense magnetic field on specific brain regions, and has been shown specifically to affect thoughts, perceptions and behaviours that are dependent on those regions. Currently usable only when a subject's head is placed inside the relevant machine, TMS at a distance is now under active investigation. So is chip technology, which might provide implanted prostheses to overcome sensory deficits or control behaviour.

So what should we do about it?

This somewhat telegraphic survey suggests that among the likely benefits to emerge from neurotechnologies there will also be attempts to develop physical techniques for altering mental processes. These include techniques for direct surveillance of citizen's thoughts, which could be used for pre-emptive incarceration or medical treatment. The prospect of these developments raises sharp questions. Neither the science nor the technology (although it is increasingly difficult to make a clear distinction between them) can occur without major public or private expenditure. Their goals are set at least as much by the market and the military as by the disinterested pursuit of knowledge.

Yet they are still only goals, and they are therefore at the point where 'upstream' debate and regulation, as discussed in the Demos pamphlet *See-through Science*,[3] may be effective. They are also at the point – beyond current scientific reality, but not in the realm of science fiction – where the various experiments in public dialogue that have been tried in many European countries in the past decades – deliberative democracy, citizen's juries and the like – could have a part to play. Because the science and technology are international, so too must be these attempts to develop effective, rather than sham, forms of participation. Neuroscientists, in this context, have a responsibility to make their subject and its potentials as transparent as possible. As I write, a unique attempt in this direction is being made in the pan-European Meeting of Minds project, coordinated by the King Baudouin Foundation in Brussels, due to present its findings to the European Parliament in early 2006. Whether the voices of these citizens of nine European countries will be listened to in the cacophony of slogans about 'better brains' remains to be seen.

Steven Rose is Professor of Biology and Director of the Brain and Behaviour Group at the Open University. His most recent book is The 21st Century Brain *(London: Jonathan Cape, 2005).*

Notes

1 'Better Brains?', *Scientific American*, Sep 2003.
2 *Foresight Drugs Futures 2025?* Perspective of the pharmaceutical industry (London: Office of Science and Technology, July 2005).
3 J Wilsdon and R Willis, *See-through Science: Why public engagement needs to move upstream* (London: Demos, 2004).