Cambridge University Press
0521537142 - The New Brain Sciences: Perils and Prospects
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Part I Introduction: the new brain sciences

Introduction: the new brain sciences

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THE RISE OF NEUROSCIENCE

The US government designated the 1990s as 'The Decade of the Brain'. The huge expansion of the neurosciences which took place during that decade has led many to suggest that the first ten years of this new century should be claimed as 'The Decade of the Mind'. Capitalising on the scale and technological success of the Human Genome Project, understanding – even decoding – the complex interconnected web between the languages of brain and those of mind has come to be seen as science's final frontier. With its hundred billion nerve cells, with their hundred trillion interconnections, the human brain is the most complex phenomenon in the known universe – always of course excepting the interaction of some 6 billion of such brains and their owners within the socio-technological culture of our planetary ecosystem.

The global scale of the research effort now put into the neurosciences, primarily in the United States, but closely followed by Europe and Japan, has turned them from classical 'little sciences' into a major industry engaging large teams of researchers, involving billions of dollars from government – including its military wing – and the pharmaceutical industry. Such growth cannot be understood in isolation from the social and economic forces driving our science forward.

The consequence is that what were once disparate fields – anatomy, physiology, molecular biology, genetics and behaviour – are now all embraced within 'neurobiology'. But the ambitions of

The New Brain Sciences: Perils and Prospects, ed. D. Rees and S. Rose.
Published by Cambridge University Press. © Cambridge University Press 2004.

these transformed sciences have reached still further, into the historically disputed terrain between biology, psychology and philosophy: hence the more all-embracing phrase: 'the neurosciences'. The plural is important. Although the 30 thousand or so researchers who convene each year at the vast American Society for Neuroscience meetings, held in rotation in the largest conference centres that the United States can offer, all study the same object, the brain, its functions and dysfunctions, they do so at many different levels and with many different paradigms, problematics and techniques. Inputs into the neurosciences come from genetics – the identification of genes associated both with normal mental functions, such as learning and memory, and the dysfunctions that go with conditions such as depression, schizophrenia and Alzheimer's disease. From physics and engineering come the extraordinary new windows into the brain offered by the imaging systems – positron emission tomography (PET), functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG) and others – acronyms which conceal powerful machines offering insights into the dynamic electrical flux through which the living brain conducts its millisecond by millisecond business. From the information sciences come claims to be able to model computational brain processes – even to mimic them in the artificial world of the computer.

Small wonder then that, almost drunk on the extraordinary power of these new technologies, neuroscientists have begun to lay claim to that final terra incognita, the nature of consciousness itself. This of course is to suggest that there is some agreement about how such an explanation of consciousness should be framed. But there is not. The rapid expansion of the neurosciences has produced an almost unimaginable wealth of data, facts, experimental findings, at every level from the submolecular to that of the brain as a whole. The problem is of how to weld together this mass into a coherent brain theory. For the brain is full of paradoxes. It is simultaneously a fixed structure and a set of dynamic, partly coherent and partly independent processes. Properties – 'functions' – are simultaneously localised and delocalised, embedded in small clusters of cells or aspects of working of system as a whole.

Anatomists, imaging individual neurons at magnifications of half a million or more, and molecular biologists locating specific molecules within these cells see the brain as a complex wiring diagram in which experience is encoded in terms of altering specific pathways and interconnections. Electrophysiologists and brain imagers see what, at the beginning of the last century, in the early years of neurobiology, the pioneering neurophysiologist Charles Sherrington described as 'an enchanted loom' of dynamic, ever-changing electrical ripples. Neuroendocrinologists see brain functions as continuously being modified by currents of hormones, from steroids to adrenaline – the neuromodulators that flow gently past each individual neuron, tickling its receptors into paroxysms of activity. How can all these different perspectives be welded into one coherent whole, even before any attempt is made to relate the 'objectivity' of the neuroscience laboratory to the day-to-day lived experience of our subjective experience?

Is this even possible? Most neuroscientists are committed to, at the least, a psychophysical parallelism of brain and mind, and in its strongest form a fully fledged reductionist collapse which sees mind as merely the epiphenomenal product of brain. This leaves some little local difficulties, such as reconciling objective third-person data about brain states with the subjective experience that philosophers refer to as qualia, to say nothing of resolving age-old paradoxes of free will and determinism. And the hard fact remains that at the end of the Decade of the Brain, and already some way into the putative Decade of the Mind, we are still data-rich and theory-poor. For some neurotheorists, there is no real problem. Truth, ultimate explanations, lie embedded in the molecular constituents of the nervous system, and molecular biology and the new DNA technologies, will eventually be able to offer full explanations, which will collapse or dissolve the problems faced by physiologists, brains mappers and even psychologists. This is the reductionist agenda, whose full philosophical and technological flowering is celebrated in popular books and media accounts as well as in our own journals and conferences. Is such reductionist confidence justified? Or are there 'higher-level' explanations of brain and mind processes that are irreducible? This dilemma remains central to many of our debates.

THE PROMISE OF NEUROTECHNOLOGY

But our knowledges, fragmented as they are, are still formidable. Knowledge, of course, as Francis Bacon pointed out at the birth of Western science, is power. Just as with the new genetics, so the neurosciences are not merely about acquiring knowledge of brain and mind processes but about being able to act upon them – neuroscience and neurotechnology are indissolubly linked. This is why developments occurring within the neurosciences cannot be seen as isolated from the socio-economic context in which they are being developed, and in which searches for genetic or pharmacological fixes to individual problems dominate. Such searches both celebrate and reinforce the simplistic reductionist agendas of neuroscience and neurotechnology.

It is clear that the burden of human suffering associated with damage or malfunction of mind and brain is enormous. In the ageing populations of Western industrial societies, Alzheimer's disease, a seemingly irreversible loss of brain cells and mental function, is an increasing burden. Risk factors for the disease include possessing an inappropriate form of certain genes, and a variety of environmental hazards; treatment is at best palliative. Huntington's disease is much rarer, and a consequence of a single gene abnormality; Parkinson's disease is more common, and now the focus of efforts to alleviate it by various forms of genetic engineering.

But whilst such diseases and disorders are associated with relatively unambiguous neurological and neurochemical signs, there is a much more diffuse and troubling area of concern. Consider the worldwide epidemic of depression identified by the World Health Organisation (WHO) as the major health hazard of this century, in the moderation – though scarcely cure – of which vast tonnages of psychotropic drugs are manufactured and consumed each year. Prozac is the best known, but only one of a myriad of such drugs, designed to interact with one of the brain's key neurotransmitters, serotonin. Questions of why this dramatic rise in the diagnosis of depression is occurring are rarely asked perhaps for fear it should reveal a malaise not in the individual but in the social and psychic order. Instead, the emphasis is overwhelmingly on what is going on within a person's brain and body. Where drug treatments have hitherto been empirical, neurogeneticists are offering to identify specific genes that might precipitate the condition, and in combination with the pharmaceutical industry to design tailor-made ('rational') drugs to fit any specific individual through what is coming to be called psychopharmacogenetics.

But the claims of the neurotechnologies go far further. The reductionist fervour within which they are being created argues that a huge variety of social and personal ills are attributable to brain malfunctions, themselves a consequence of faulty genes. The authoritative US-based *Diagnostic and Statistical Manual* now includes as disease categories 'oppositional defiance disorder', 'disruptive behavior disorder' and 'compliance disorder'. Most notoriously, a disease called 'attention deficit/hyperactivity disorder' (AD/HD) is supposed to affect up to 10% of young children (mainly boys). The 'disorder' is characterised by poor school performance and inability to concentrate in class, or to be controlled by parents. The 'disorder' is supposed to be a consequence of disorderly brain function associated with a particular neurotransmitter, dopamine. The prescribed treatment is an amphetamine-like drug called Ritalin. The WHO has drawn attention to what they perceive as an increasing worldwide epidemic of Ritalin use. Untreated children are said to be likely to be more at risk of becoming criminals, and there is an increasing literature on 'the genetics of criminal and anti-social behaviour'. Is this an appropriate medical/psychiatric approach to an individual problem, or a cheap fix to avoid the necessity of questioning schools, parents and the broader social context of education?

The neurogenetic–industrial complex thus becomes ever more powerful. Undeterred by the way that molecular biologists, confronted with the outputs from the Human Genome Project, are beginning to row back from genetic determinist claims, psychometricians and behaviour geneticists, sometimes in combination and sometimes in competition with evolutionary psychologists, are claiming genetic roots of areas of human belief, intentions and actions long assumed to lie outside biological explanation. Not merely such long-runners as intelligence, addiction and aggression, but even political tendency, religiosity and likelihood of mid-life divorce are being removed from the province of social and/or personal psychological explanation into the province of biology. With such removal comes the offer to treat, to manipulate, to control. Back in the 1930s, Aldous Huxley's prescient *Brave New World* offered a universal panacea, a drug called Soma which removed all existential pain. Today's Brave New World will have a multitude of designer psychotropics, available either by consumer choice (so called 'smart drugs' to enhance cognition) or by state prescription (Ritalin for behaviour control).

These are the emerging neurotechnologies, crude at present but becoming steadily more refined. Their development and use within the social context of contemporary industrial society presents as powerful a set of medical, ethical, legal and social dilemmas as does that of the new genetics, and we need to begin to come to terms with them sooner rather than later. To take just a few practical examples: if smart drugs are developed ('brain steroids' as they have been called), what are the implications of people using them to pass competitive examinations? Should people genetically at risk from Alzheimer's disease be given lifetime 'neuroprotective' drugs? If diagnosing children with AD/HD also really did predict later criminal behaviour, should they be drugged with Ritalin or some related drug throughout their childhood?

NEUROETHICS AND HUMAN AGENCY

More fundamentally, what effect do the developing neurosciences and neurotechnologies have on our sense of individual responsibility, of personhood and of human agency? How far will they affect legal and ethical systems and administration of justice? How will the rapid growth of human brain/machine interfacing – a combination of neuroscience and informatics (cyborgery) change how we live and think? These are not esoteric or science-fiction questions; we aren't talking about some science-fiction prospects about human cloning, but prospects and problems that will become increasingly sharply present for us and our children within the next ten to twenty years.

The editors of this book believe that it is vital both to help clarify the thoughts of the neuroscience community itself concerning these questions, and also to make what we currently know and don't know about the brain and its workings accessible to a wide public in sufficient detail to kick-start a discussion of where our science is going, and above all of its medical, legal, ethical and social aspects. That these concerns are shared by many is indicated by the way in which yet another neologism, 'neuroethics', has emerged over the last couple of years, with professional ethicists and philosophers contributing to a vigorous discussion both within professional journals and at especially convened meetings.

The papers that form the chapters of the present book emerged as a result of two such meetings, held in 2001 and 2002. The first, 'Perils and Prospects of the New Brain Sciences', was convened jointly by the Wenner-Gren and European Science Foundation and took place at the Wenner-Gren Centre in Stockholm; the second, on 'Science and Human Agency', was a joint meeting of the Royal Society and Gresham College, in London. The two complementary meetings involved a range of presentations from many disciplinary perspectives, law, sociology, ethics, education, psychology, neuroscience, genetics and psychiatry. As editors, we have encouraged a subset of the speakers at these meetings to develop their presentations into fuller papers, and have then edited and reordered them so as, we hope, to make them as accessible as possible to as wide a non-specialist audience as possible, and we wish to pay tribute to the cooperation of our authors in submitting to this procedure. The contributors to the original meetings, and those whose chapters appear here, were chosen for their known critical expertise; you will find no gung-ho overoptimistic forecasts of the wondrous cornucopia of benefits that neuroscience might bring here. We are all too well aware of the overselling of the technological promise of the new genetics that began in the late 1970s. Nor, though, are our authors doom-sayers with an almost automatic rejectionism in response to new findings.

THE PLAN OF THE BOOK

The resulting sixteen chapters between this Introduction and the final summarising one, by Dai Rees and Barbro Westerholm, fall into three broad sections. The first, comprising five chapters, we have called 'freedom to change'. Here we focus on the extent to which current findings in neuroscience might cause us to revise our classical ideas about human consciousness, free will, determinism, agency and responsibility. The first chapter, by the philosopher Mary Midgley, sets the scene by asking how free we are to 'really' act? The psychologist Merlin Donald then considers the emergence of human mind and consciousness from within an evolutionary perspective.[1] He argues that the key features in the emergence of human consciousness lie in the nature of humans as social animals, but that mind and consciousness are not so much the property of individual brains but an expression of a relationship of the individual person with the social world in which that person is embedded. This theme is taken up by the feminist sociologist Hilary Rose, who looks with a degree of wry scepticism at the claims of neuroscience to appropriate consciousness from the other discourses – including those of the novel – in which it has featured over many years. Professor of technology assessment Regine Kollek, who has had a long-standing concern with developments in gene technology, revisits some of these concerns in the first section

[1] Merlin Donald was prevented from attending the Stockholm conference as his flight from Canada was blocked in the immediate aftermath of the attacks on the World Trade Center on 11 September 2001. This chapter is based on the talk he had intended to give.

of the book in the context of some of the claims of neuroethics. In particular, reinforcing Merlin Donald's and Hilary Rose's arguments, she contests the current neuroscientific attempt to reduce the concept of self to 'nothing but a bunch of neurons'. Lastly in this section, philosopher Peter Lipton turns once more to the classical questions: to what extent does neuroscience resolve traditional dilemmas of free will versus determinism, of human agency? Yes, Lipton insists, the determinism/free will dilemma is a false one emerging more from philosophical lack of clarity than from any advances in the brain sciences.

The second section turns to questions of human responsibility (agency) and the law. To what extent have the neurosciences affected our sense of responsibility for our actions, and in particular the traditional legal concept of *mens rea*? Might it be feasible to argue for instance, diminished responsibility for a criminal act on the grounds of genetic predisposition? Certainly this defence has been tried in the United States (Patrick Bateson refers to it in passing in his chapter as the 'Twinkie defence'). Professor of medical law Alexander McCall Smith, whose service on the Human Genetics Commission and the Nuffield Council's inquiry into the implications of behaviour genetics has given him a special concern with these questions, reviews the current principles involved in the concept of responsibility in law and how these might be affected by scientific advance. His paper is complemented by the practical perspective on how courts treat evidence for responsibility provided by one of Britain's leading judges, Lord Justice Stephen Sedley. Feminist sociologist Lorraine Radford analyses the evidence advanced both by behaviour geneticists and evolutionary psychologists for a genetic base for human aggression, and most specifically for violence by men directed at women, revisiting some of the issues raised in McCall Smith's chapter and their implications for governance. Lastly in this section the ethologist Patrick Bateson disentangles the tortured debate over nature and nurture, instinct and responsibility from a consideration of the processes of development.