

Neuroethics

A literature review prepared for Toi te Taiao: the Bioethics Council

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Preface

Neuroscience is a rapidly developing area. Equipped with new tools and technologies for investigating the brain and the wider neural system, scientists are expanding their understandings of how the brain develops, how it functions, and some of the underlying changes that lead to some forms of mental illness and degenerative conditions such as Alzheimer's and Huntington's.

As this knowledge develops, so too there come possibilities for new treatments for disease and damage, and applications for use outside the traditional medical arena, including applications that interface for machines and computer technologies.

Various communities of interest are involved in conversations about emerging possibilities. Philosophers, bioengineers, computer scientists, futurists, post-humanists, legal minds and policy makers are all beginning to consider the possible implications of the technological possibilities of neuroscience.

Bioethicists are also joining the conversations. In the last few years, the bioethics literature has begun to pay attention to the field of neuroscience, and there has been a small surge in papers addressing the issues.

This report reviews the current literature on neuroethics - the ethical issues arising from advances in neuroscience and associated technologies. It identifies the areas of science and technology that are raising ethical issues, and the current landscape of the resulting discussions.

The scope and methodology of the review are described in Sections 1 and 2. Section 3 provides some context for the debates and discussions that are outlined in section 4. This section, the substantial body of the report, summarises the key conceptual issues that permeate the discussions, and then explores the practical and philosophical ethical issues arising from neuroscience. The report finishes with a brief conclusion.

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Executive summary

Neuroethics has emerged as a separate area of study over the last decade. It has developed in response to rapidly increasing understanding of the biological function and activities of the brain, the development of technologies that enable imaging of brain activity, medications to treat brain-based diseases, and the linking of brain and machine. All these developments offer the promise of new means to not only treat human disease, but also to enhance human capacities – whether that of children, the ‘well’, or the military.

The body of literature is still quite small. A few authors appear frequently, and many of the articles offer an overview of the field and endeavour to alert readers to the new concerns. Only some of the papers are within the bioethics literature. Ethical issues are being drawn to the attention of the neuroscience and medical communities.

Authors come from a range of disciplines, and frame the issues accordingly. Some have identified ethical issues within their professional practice and write from that perspective. Others are responding to the issues from experience in other fields of bioethics, philosophy, or sociology.

Running through much of the literature is a concern with the language used to describe the relationship between the biological brain and the sense of self, mind, identity or personhood. Conversations about self, mind, identity and personhood long pre-date the biological understanding of the brain, but now there is a struggle to bring together the language of philosophy and science, when similar (or at times the same) vocabulary is used, and the bioethics conversations require attention to both.

A number of the issues discussed are not new to bioethics but may be new to a community of professionals (e.g. managing incidental findings through use of scanning technologies), or there may be new dimensions to older issues (e.g. innovative treatments, or cognitive ‘privacy’).

The technology that is the major concern is neuro-imaging. Challenges from this technology include: how to interpret brain scans, the translation of research to clinic or court, and whether or not better understanding of brain activity and function will challenge legal understandings of responsibility.

There is considerable anxiety about the potential for neuroscience (particularly pharmaceutical treatments and mind/machine interfaces) to be used to enhance rather than to treat. There are pragmatic concerns about the safety of these interventions, but also about threats to autonomy – will people be allowed to choose to use these technologies for enhancement or have their autonomy constrained; will it become acceptable for the military to require the use of these technologies by their soldiers, or the courts be able to require their application in some situations? Others discuss whether and to what extent enhancement will affect our sense of self and identity, and others how it will play out in the social arena, for instance how uptake and benefit will interact with social inequalities.

Finally, there is some limited discussion about who needs to be involved in conversations about the emerging possibilities of neuroscience.

1 Introduction and scope of review

This literature review has been prepared for Toi te Taiao: the New Zealand Bioethics Council. Its purpose is to identify key publications in the peer reviewed medical and bioethics literature and from international Neuroethics research groups, and review the issues raised and ethical approaches used. Neuroethics is understood as the study of the ethics of neuroscience.

The boundaries of ‘neuroethics’ are not clearly defined, and it is important to note some exclusions in this review. This paper does not review

- The neuroscience of ethics – studies of the neural basis of ethical thinking
- The ethical literature within the philosophical literature (which would have required searches of additional databases)
- Papers focussed on neuroscience, but which review long-standing, and well discussed ethical issues e.g. informed consent for participation in research trials. Papers which cover long-standing discussions are only included if they explore ethical dimensions of the issue that are particular to neuroscience.

2 Method

The New Zealand Health Technology Assessment Clearing House (NZHTA) was commissioned to carry out the literature search. It was asked to search

- a. the wider medical and social science literature (e.g. Medline and Science and Social Citation Index) against key words (bioethics/ethics/ethical AND neuroscience/neurology/brain scanning/brain imaging/brain/ plus neuroscience AND society)
- b. key bioethics journals for any articles around neuroscience per se (which may identify a broader range of issues than those captured in a. above.) Suggested journals were: Hastings Center Report, AJOB, Journal of Medical Ethics, Biosocieties, Journal of Law, Medicine and Ethics, Bioethics, Journal of Clinical Ethics, Journal of Medical Humanities, Kennedy Institute of Ethics Journal, Bioethics Review (formally Monash Bioethics Review), Science Technology Studies, Science and Engineering Ethics, Theoretical Medicine and Bioethics
- c. from 1995-(May) 2006.

Further details of their search strategy are recorded in Appendix 1.

In addition, web searches were carried out to identify neuroethics research centres, and other research activity in the area.

The abstracts of the papers were reviewed, those deemed relevant to the search identified, and then sourced by the Bioethics Secretariat. Those that were available were then forwarded to the author for further selection, then review and analysis.

In selecting papers, the following exclusions were applied:

- neuroscience of ethics – the material/biological basis of moral thought

- applications of well-discussed/rehearsed issues in bioethics, applied to neuroscience situations e.g. informed consent requirements for research or for organ banks
- description and discussion of the science or clinical interventions per se
- papers in languages other than English
- professional codes and expectations for groups or health professionals.

In addition, news reports and editorials on the subject were read, but only included in the reference list when they contained data or issues not reported elsewhere. The reference list contains a full list of papers reviewed. A number of books read as background to the project are also referred to within the text and included in the references.

3 The Context for Neuroethics

3.1 Introduction

Neuroethics is emerging as an area of interest where many streams of thought and research are converging and mixing. Neuroscience itself is becoming a discipline that incorporates different scientific traditions. Genetics, development studies, immunology, bioengineering, as well as traditional anatomy and neuroscience are all becoming important, and bring their own particular sets of analytical tools and conceptual assumptions. Scientific thinking about the brain and associated neural systems in not settled territory but is constantly developing, and increasingly multi-faceted.²

That said, the literature reviewed for this paper identified particular scientific developments that require ethics attention. These include brain scanning technologies, implantation of stem cells or neural tissues in the brain (and the possible future scenario of brain transplants) and drugs able to target particular brain activity or functions. (The writing on implantation of stem or neural cells into the brain largely dates from the 1990s, and the trialling of techniques to treat Parkinson's disease.) In addition, some established scientific understandings or technologies were recognised to have implications that are specific for the use in association with brain function e.g. genetic testing for mental or degenerative cognitive conditions.

Bioethics is a discourse that has always drawn on multiple theoretical disciplines – philosophy, law and theology were the early ones, but now also disciplines such as sociology, feminist theory, history of science and philosophy, political studies, anthropology, and public health. Since its early days in the 1970s bioethics has moved well out from the initial focus on protection of individuals in the research context, and attention on the doctor-patient relationship. Thinking has been extended by developments in genetics, the challenges of new birth technologies and stem cell research, threats of global pandemics, and the moral demands to address health inequalities, particularly in the developing world. It has however, largely remained focused on research with human subjects, and health applications of biotechnology.

² This review does not attempt to cover neuroscience research per se. However, two review articles of interest are Walton 1997, and Greenfield 2005. See also Rose 2005.

In addition to conversations in bioethics there are conversations in philosophy (that have been running in parallel with bioethics) that are now being brought into the bioethics discussions about neuroscience – in particular understandings of free will and responsibility, and how (if at all) this thinking is affected by material understanding of the brain, and the relationships between brain, mind and ‘self’. Neurophilosophy has emerged as an area interested in neuroscience and philosophy of mind – looking for a unified theory of mind and brain (Evers 05).

This confluence of so many strands of thought therefore requires analysis of multiple discourses – scientific, ethical, socio-cultural, and philosophical (Illes and Racine 05, Evers 2005, Singh and Rose 2006) – each of which comes to the discussion with its own history, and all of which play a part in shaping the current landscape of the bioethical discussions of neuroscience.

This review reports predominantly on those strands of the conversation that are found in the bioethics and medical literature captured within particular databases. However, it does signal areas (referred to in that literature) that are explored in other communities of knowledge and investigation, particularly in philosophy and sociology.

It is also important to note that only a very small proportion of the papers reviewed for this literature survey came from the peer reviewed *bioethics* literature per se. Neuroethics has only a small (though growing) presence in the bioethics journals. There is a small cluster of papers from around 1996 (at the time when fetal transplants into the brain for the treatment of Parkinson’s disease was being trailed), and then later clusters of papers as journals such as the AJOB run special issues, and invited commentaries on lead papers. These lead writers (e.g. J Illes, M J Farah, and P R Wolpe) often turn up in the general medical literature, and/or are to be special editors of forthcoming special issues in other journals.

Thus, a great deal of this literature is in the wider medical literature captured by the Medline database. Much of it is of a preliminary nature – alerting readers to the developing technologies and possible ethical implications, and inviting professionals to become involved in the discussions.

3.2 Describing the Landscape (The geological history!)

Neuroethics is situated in an historical and political landscape with at least three key features that affect how current conversations are pursued in different contexts.

- The history of the neuroscience, and its use for political agenda
- The history of other disciplines concerned with related areas e.g. philosophy, sociology – how certain language and ideas have been used and developed
- Other areas of science (genetics) and of ethics enquiry (e.g. human enhancement) that raise similar or parallel concerns

It is at the confluence of these and other streams of thought that ‘Neuroethics’ is developing as a particular conversation – the territory is being mapped out, and certain participants are choosing to join. This is not necessarily happening in a coherent or self-conscious way. The conversations are as yet quite tentative (and largely descriptive of the issues that need to be discussed rather than in-depth

discussions), and led by a small number of writers. But indications are there of the fault lines of enquiry.

Science

Our current understanding of the brain as central to our human abilities and identity is of recent origin. Only in the seventeenth century were the connections made between the soft matter in the head and our ability to think and reason (Zimmer 2004). In subsequent centuries this progressed into craniometry and phrenology (study of the shape of the skull as a measure of the development of ‘organs’ within the brain – which in their turn enabled the determination of character and intellect). In addition to being used to detect the character of the individual, measurements were also used to create intelligence hierarchies within and between races.

Surgical techniques were developed last century, including the infamous lobotomy, devised as means of controlling aggressive or violent behaviour. In more recent decades there have been surgical interventions for obsessive- compulsive disorder and for Parkinson’s and other movement disorders. And of course there has been the development of pharmaceutical interventions for treating a range of psychiatric disorders (Finns 2003, Illes and Racine 2005, Williams 2002, Wolpe 2002b). Most recently, the development of various scanning techniques has allowed insight into the biological activities of the brain, and with fMRI the ability to follow these in real time.

The future directions of science are always difficult to predict, but some look forward to greater ability to treat mental illness and enhance human mental capacities, including through neurotechnology. Some hold very high hopes. The emergent technologies will create new industries and products, provide competitive advantage (both via treatment of mental illness and through enhancement of mental capacities of workers) and drive a debate about the right of individuals to enhance themselves. There is also the possibility of new behaviours, as we learn to ‘see things differently’ through shifts in mental perspectives. There will be a new type of human society, a post-industrial, post-informational neurosociety (Lynch 2004)!

Philosophy

Philosophy has long concerned itself with ethics, and with broader analysis of concepts such as self, identity, freedom and responsibility. Philosophers have also been concerned to understand the nature of the mind, mental events, mental functions, mental properties and consciousness, and of the nature of their relationship with the physical body: the so-called ‘mind–body’ problem. This area of work (philosophy of the mind) and neuroscience converged in the field of neurophilosophy in the 1980s, which draws together the methods of analytic philosophy with empirical neuroscience methods to seek a unified theory of mind/brain (Evers 2005).

Other areas of bioethics enquiry

Bioethics as a discipline or area of study, is of relatively recent origin. Its early work focused on the ethics of research with human subjects (driven in large part by various scandals where vulnerable populations were exploited in research, but building on reflections on research carried out in Nazi Germany), and the use of innovative clinical technologies such as organ donation and end of life decision-making (Rothman 1991). In the last 10-15 years, bioethics’ attention has widened out from the doctor-patient relationship to encompass the ethical, social and legal challenges raised by genetics, and the public health issues of HIV and other potential pandemics.

There is also increasing recognition of the need to address issues specific to particular countries or political dynamics e.g. ethics of research in the developing world.

There is thus a track record now of bioethics considering both the research and clinical implications of new technologies, and their social, ethical, legal, policy and political ramifications.

'Neuroethics' history

References to 'neuroethics' and neuroethical issues made their first appearances in the late 1980 and early 1990s, around issues to do with the role of the neurologist at end of life decisions, philosophical perspectives on the brain and the self (possibly in association with trials of transplantation of brain tissue to treat Parkinson's disease), and the neurophysiological and neuropsychological influences on child rearing and education (Illes and Raffin 2002).

But a new level of activity and intensity of focus seems to have emerged since 2002. The Economist picked up on the topic in 2002, as did Francis Fukuyama in his *Our Posthuman Future*. A first world conference, *Neuroethics: Mapping the field* was held in the US in that year and later initiatives have included a special conference on Neuroscience and the Law in 2004, and the US President's Council on Bioethics attention to the topic in 2004 (Illes and Raffin 2002, Kennedy 2004, Farah 2002).

By 2002 the field was being divided into 'the ethics of neuroscience' (both ethical issues raised in the course of designing and instituting neuroscientific studies, and the evaluation of the ethical and social impact of the results of those studies) and the 'neuroscience of ethics' – what can be learnt about traditional philosophical notions such as free will, self-control, personal identity, and intention by studying the brain (Roskies 2002).

Neuroethics is now expanding as a sub-field with established journals extending their coverage to deliberately include neuroethics (e.g. the *Journal of Cognitive Science*), or putting out special issues (e.g. The *AJOB* will be devoting 3 special issues to neuroethics in 2007). Special neuroethics research centres have been established (for example the Centre for Cognitive Neuroscience at the University of Pennsylvania³, and the Stanford Center for Biomedical Ethics⁴). The (US) President's Council on Bioethics website holds transcripts of discussions held on neuroethics⁵, and a European initiative, *The Meeting of the Minds*, is a two year project to help citizens learn about the impact of brain science and support greater involvement of the public in the debate on future research, technological decision making and governance.⁶

However, it will be interesting to see to what extent the bioethics community shapes the discourse of neuroethics. The discussions are being profiled in other bodies of literature, and the discourse being strongly shaped by individuals and institutions whose training is in neuroscience (e.g. Farah) or who are grounded in other disciplines such as sociology (e.g. Singh).

³ <http://ccn.upenn.edu/>

⁴ <http://scbe.stanford.edu/>

⁵ http://www.bioethics.gov/topics/neuro_index.html

⁶ http://www.meetingmindseurope.org/europe_default_site.aspx?ID=13&SGREF=13

4 Fault lines in the conversations

The ethical issues in neuroscience relate to researcher obligations, the clinical and non-clinical impacts of the technology, and the philosophical and theoretical issues (Illes et al 2006). These overlap and inform one another.

This section firsts discusses conceptual issues (the fluidity of language and concepts running through the discussions), and then the key issues – those that are familiar within bioethics, and those that are recent or new to bioethics.

4.1 Conceptual issues

4.1.1 Fluidity of language and concepts

The field of neuroethics is characterised by a lack of tight boundaries at a number of different levels. The territory is fluid and ever changing.

The areas of science that neuroethics covers are increasingly diverse as neuroscience draws on knowledge from areas such as genetics, immunology, anatomy, stem cell and developmental work, psychology, and medical engineering.

Older categories of thought such as human/non-human are gaining an ethical significance as new re-arrangements of biological material becomes possible – there are interfaces between humans/animals (chimeras), and also between humans and machines (cyborgs). These interfaces are both in the form of prosthesis that can be controlled by neural impulses, and machines that are embedded in the brain.

The language used in the discussions can have different meanings and/or connotations when used by people in different communities of knowledge or practice, and there are long standing discussions that remain unresolved; and the significance of the line between human and not-human is also under discussion.

The science

The science that is the focus for neuroethics is diverse.

Pharmaceutical research is identifying drugs that can treat mental disorder of emotion, cognition, behaviour and perception. Some of these drugs may also be of value for enhancing so-called ‘healthy’ people.

There are major conversations around the use of brain imaging technologies- an area where the technologies are developing rapidly, and raise the possibility of being able to ‘read’ the mind in various ways and for diverse social and medical purposes.

Not only are a range of biological sciences being brought to bear on understanding and manipulating the brain (e.g. stem cells and tissue regeneration, pharmacology, immunology, development and genetics) but engineering and IT are also involved in developing the scanning techniques and prosthetics that interface with the neural system.

Human or not?

The ‘boundaries’ between human and machine, or human and animal, are increasingly permeable. Prosthesis can be embedded in the neural system, either within the brain itself (e.g. a cochlear implant), or via control mechanisms mediated through the peripheral nervous system. And discussions proceed about to what extent it is ethically acceptable to implant animal neural tissue in human brains, or human neural tissue in animals (Greene et al 2005, Karpowicz et al 2005, Moreno 2003). The

attention here is on such concerns as; whether introducing human cells into non-human primate brains affects moral status, arguments for deciding what (human) mental capacities are significant in determining moral status; and whether the grafting of human cells into non-human primate brains could result in significant changes in morally relevant moral capacities.

Overlapping language conversations

The conversations about all these issues are embedded in various forms of language, and there remains considerable diversity of working assumptions about what the language may mean or imply.

There is a metaphorical landscape of how one conceives of the brain itself - as a biological organ (the anatomic brain) or the brain as concept (the metaphoric brain) (Gindro and Mordini 1998). Metaphors operate at a different level when thinking of the brain as a biological ‘thing’ (neural pathways and network, blood flows, bridges, channels and docking sites), images that themselves need to relate to the rest of the body – is the brain separate, embedded, interconnected?⁷ Then how does one relate all that structure to function, and then to behaviour (Singh and Rose 2006)? What is the relationship between psychological and physiological processes, and how that relates to brain structures? What is the significance of any thing one measures (Hancock and Szalma 2003)? And what are the implications of different ways of relating each to the other? These issues become critical when considering the interpretation and uses of imaging technologies (see section 4.2.2.2.2 below).

And then there is the language landscape, which requires attention not only to the way in which key notions and terms are used in different contexts and disciplines (Evers 2005), but also to the social and political contexts that shape the meaning of the words and how they are interpreted. For instance, individual capacities can be conceptualised as internal to or belonging to the individual – memory, cognition, emotion, desire or the effects of drugs. Or they can be seen as distributed functions – “shaped, organised, facilitated and given meaning and salience by the particularities of their interactive, spatial, pragmatic and linguistic context” (Singh and Rose 2006:97).

Certain concepts, and the relationships between them, come up in discussions again and again. Brain, mind, person, self, personal identity can all come loaded with different assumptions about what they refer to and how they could or should function in a conversation.

For some, the brain is the “defining organ of human behaviour and personality” (Mahowald 1998:50), or personal identity is the person-of-the-living-brain (Gillon 1996). Yet, what is it about the brain that makes it so, and why? In exploring this (and similar issues), the difficulty is that people refer to other terms, that themselves have multiple meaning and usages – terms such as personhood, or identity.

A number of issues raised in the literature are related to the use of language to do with brain, mind, identity and personhood.

There is a concern with ‘identity’. What sorts of brain interventions will change *identity*? In general we are comfortable with temporary interventions (e.g. Prozac)

⁷ It is notable that a 1996 paper is still able to imply that the brain is something other than the body (Gillon 1996) – a position less likely now as the science has made it clearer that the brain is embedded in the wider body and its function inextricably linked to the immune and hormonal systems.

but what about permanent changes, such a permanently altering the brain stem to produce more serotonin? Or psychosurgery or brain trauma (it would seem that some does and some does not affect identity, but what is the important difference)? (Moreno 2003). Is identity about biological continuity, or psychological continuity (Budford and Allford 2005)?

People talk of identity as '*brain identity*' or as '*personal identity*'. Northoff (1996) demonstrates the complexity of the issues in his detailed exploration of the language used to describe 'identity' in relation to brain and/or tissue transplantation. When thinking about transplanting brain tissue from one person (or fetus) to another person, multiple questions arise: how much change in the brain changes its (the brain's? the person's) identity? A whole brain transplant would, but if not a whole brain is transplanted, how much is sufficient to change identity? Does adding tissue to a brain make a different sort of change to brain identity than taking tissue away? Does the location of new tissue within the brain have any influence on whether or not brain identity is changed? What is the line between brain preservation and the alteration of brain identity? Does it rest on biological material present, or functionality?

When considering 'personal identity', is one thinking of a qualitative thing (not altered by fixing lesions) or a numerical thing (any new material would be a change in identity)? How is the brain/body interface affected by a tissue transplantation? Not at all if identity is not affected by the tissue transplant, but considerably if identity is affected by the presence of new tissue.

DeGrazia (2005) also notes the potential for conceptual confusion in our languages around 'identity'. He distinguishes between 'numerical identity' and 'narrative identity'. The analytical philosophical tradition, he argues, focuses on numerical identity (which allows for change over time, in the sense that a plant is the same plant despite growth, flowering and decline). But that could also rely on either psychological continuity or biological continuity. By contrast, many people would operate from a sense of 'narrative identity' where the individual's identity is linked to a story they can tell about themselves.

And at what point in development does *personal identity* appear? Possibilities include at conception (identity is genetic), at a critical stage of brain development, at sentience, consciousness, birth, or self-consciousness. That some mental states or functions have more ethical significance to personhood or identity than others is implicit in Burgess and Tawia's (1996) paper on locating the beginning of consciousness. While they deliberately step around the issue, nevertheless there is a firm implication that there is something ethically important about what ends or begins at the point of *consciousness* (a human? a person?)

There are discussions about how mind is related to body, or mind to brain (if brain is something other than body). Northoff points out the multiple positions amongst philosophers about how brain is related to mind, and whether mental states are related to the brain, or to psychological functions. There is also no agreement among philosophers about how psychological continuity relates to personal identity, nor whether a change in brain identity necessarily leads to a change in personal identity

Moreno (2003) tries to draw some distinctions between mind and brain, and explores how different understandings of the relationship between brain and mind relate to notions of free will and responsibility. Can the mental be reduced to the physical? If so, does that imply that there is no freedom of will? And if the mental can be

controlled by the physical manipulation, does that imply there is no freedom of will? He rejects all these positions, and notes that most thinkers come down on the side of 'soft determinism', the view that we are capable of entering into the chain of causes of our thoughts and actions.

Roskies (2004) takes a pragmatic approach, and rejects the idea that people on the street will believe our behaviour is determined, and argues that people will continue to maintain a person is morally responsible for their actions. She also argues that "the idea of moral responsibility is a social one, one that applies to people in virtue of their role in society and their capacities as agents and not because they exercise some sort of metaphysical freedom. Given this understanding, it is not surprising that people judge agents to be morally responsible despite a stipulation of determinism" (Roskies 2004:4).

'Personhood' is a concept that has been given ethical significance in some previous bioethics discussions (e.g. to do with end of life decision-making and termination of pregnancy). Is *personhood* tied to particular parts of the brain, or to particular functions? When discussing the significance of tissue transplants into the brain, Mahowald (1998) states that not all parts of the brain used or the site transplanted into raise the same ethical or philosophical questions. Those involved with higher functions appear more significant in some ways, and are associated with personhood. (This is a distinction already made when defining brain death, where a distinction may be made between death of the brain stem and that of the cerebral cortex or upper brain.) There would seem to be an implicit view that there is some unit smaller than the brain (or is it some functions of the brain?) that has particular (ethical) significance. There is an elision between biological description (certain tissue) and particular function (certain mental capacities) that is then used to make ethical judgements.

Zwanziger (2003) and Jedlička (2005) both point out the need to distinguish between reductionism as a metaphysical explanation (the individual is no more or less than a complete physical description of the body, and that body determines what the individual decides to do) and reductionism as a heuristic of explanation (which can tie an observation at the organism level to a phenomena at say a biochemical level, but not reduce the organism to 'mere' biochemistry.)

Functionality also surfaces in Burd et al's paper (1998) in which they tease out possible ethical questions about the research use of human brain tissue. When would growing brain tissue develop *properties of mind*? Does a brain-mind need a body to be a person? Can a person give consent to grow brain tissue in the lab if it could later develop independent capacity to respond?

4.1.2 Framing

Writers approach the issues in neuroethics from particular directions. For some, the issues are about medical ethics, for example how best to get informed consent in the context of genetic testing for risk of loss of certain cognitive functionality. For others the issue may be about whether or not a particular use of neuroscience is medicalising a human trait such as hyperactivity, significantly shifting a social practice such as the legal understanding of responsibility, or providing a tool to reinforce attitudes and behaviours that will further entrench social inequalities.

Different enquiries may require different sets of questions, and take the enquirer into quite different domains of knowledge. Understandings of legal responsibility might

be concerned with analysis of the law, or with philosophical understandings of the ‘self’ – or with both. Wondering if dosing for ADHD reinforces social inequalities and allows for amplification of certain cultural practices of competition tends more to a sociological analysis.

In the literature reviewed here, there is little coherence or consistency of approach. Rather, a rich and diverse set of concerns is approached in diverse ways, often without direct reference to one another. The writers are often embedded in quite different and at times very distinct discourses.

A small number of papers do explicitly discuss the relationships between disciplines involved in neuroethics, and/or argue for contributions from particular disciplines. Illes and Racine (2005) open up some discussions about the epistemological and ethical challenges of reading neuroimaging data, and identify the need to consider not only traditional bioethics but wider perspectives on the construction of knowledge. De Vries (2005) questions the differences between neuroethics, and a sociology of neuroscience. He argues that not only are their different disciplinary tools, but that sociology of neuroscience is more reflective – while neuroethics studies neuroscience, a sociology of neuroscience studies all of neuroscience, neuroethics and the relationship between the two, including the consequences of a separate and distinct field of neuroethics.

Sociology and bioethics are clearly in this conversation together. The new publication *Biosocieties* has made neuroscience one of its early topics of interest, and is already offering analyses informed from sociology. Singh and Rose (2006) for instance, draw on the history and sociology of the normal, and remind the reader that the lab and clinic are not empty spaces but are structured in particular ways that enable or eliminate certain interactions. Debates in neuroethics need to draw on the empirical evidence about the social, ethical, psychological, legal and governmental implications of the operation of neuroscience.

Evers (2005) is concerned that the philosophical level of analysis be sufficient in neuroethics. She notes that bioethics interprets scientific data within the ethical, legal and social contexts, but what is also needed is a general philosophical level of analysis, broad and thorough conceptual analysis of key notions. This, she thinks, will come from traditional philosophy of mind, and the more modern neurophilosophy.

4.2 Key issues

That said, some overarching themes do emerge. These are teased out below, but it important to note that these themes are an artificial construction, an imposition of order for ease of discussion. In practice, these themes are interlocked, and writers contribute in different places, in different ways. Quite a lot of papers are generic and descriptive, teasing out the landscape of the discussions in an effort to alert various readerships to an emerging area.

I have followed Farah (2004) in making a distinction between practical and philosophical issues familiar to bioethics, and those that are recent or new to bioethics, and largely of interest because of the developments in neuroscience. This is not an uncomplicated division. While there are a set of issues that are generally accepted to be ‘old’ issues for bioethics, there are others that some would see as traditional issues in a new context. Some of the so-called ‘new’ issues are also highly speculative – a scientific possibility that may not be realised for some time. It may not even be particularly useful or responsible to be teasing them out at this stage

(Schick 2005). Inflating the powers of neuroscience and speculating about their implications for free will or normalcy (with insufficient attention to the real powers of technologies or the social life of their fictions) may lead neuroethics to become “part of a culture of hype and hope, futurology and fear” (Singh and Rose 2006).

4.2.1 Practical and philosophical issues familiar to bioethics

The search explicitly excluded papers whose focus were issues that are well rehearsed elsewhere in the literature, and merely applied to a neuroscience context – for example how to get consent for people to donate tissues to brain banks, use of diagnostic tools in the absence of clinical treatment, resource allocation, and the ethics of clinical drug trials. However, there were references to such issues in many papers. There are also issues that are related to others in bioethics, but have a particular salience for brain science.

4.2.1.1 Issues new to a community of professionals

There are issues that are familiar elsewhere, but new to a particular community of professionals.

Illes (2002) is particularly concerned that practitioners in brain scanning may not be sufficiently alert to the ethical situations that may arise in the course of their research. It is possible that in the course of conducting brain scans for medical or research purposes, that incidental findings happen. How will these be dealt with? Is the possibility raised with the subject at the consent stage? Are their channels through which the subject can be referred if medical follow up is necessary? And what sort of ‘reading’ would be of sufficient concern to lead to an alert? (See also Check 2005.) Such issues have been canvassed in relation to genetic testing. The issues may not be new, but the community of practitioners likely to be dealing with them could be.

Similarly, there ethical issues associated with pre-disposition genetic testing for degenerative brain conditions with which neurologists need to be familiar (Paulson 2002), and added dimensions of care when genetics and neurology converge (Slosar 2006).

4.2.1.2 Fresh dimensions to established issues

There are issues that are familiar elsewhere, but where brain science introduces some fresh dimensions.

Novel clinical interventions in the brain

New technologies offer the promise of new dimensions to clinical treatment. There are possibilities of Central Nervous System (CNS) stem cell transplants (from humans or animals) (Burd et al 1998, Grisolia 2001, 2002) gene transfer in the brain (Lesch 1999), psychosurgery, and neuromodulation or deep brain stimulation (Fins 2003, 2004 Schiff et al 2002).

Many of these interventions are only at the innovative or research stage, and participants are likely to be people with few other clinical options, or very poor prognoses. Elsewhere in the ethics literature there are well rehearsed discussions about the ethical issues associated with innovative treatment, including in relation to research on people who are not able to give consent, and the potential risk/benefit ratio for people with different clinical diagnoses (Fins 2000). In relation to interventions in the brain, it is to be hoped that there have been learnings from earlier

experience with psychosurgery, which was poorly regulated and unresponsive to ethical and clinical criticism, but it appears that a 1977 report on psychosurgery, issued by the National Commission for the Protection of Human Subjects in Biomedical and Behavioral Research has largely been lost from public memory (Fins 2003, 2004).

However, there is also a wider question that emerges - “How much can we reweave the cerebral tapestry without creating a new self, a new identity?” (Grisolia 2002;823) Further discussion of this and related issues is in section 4.2.2.3, Neuroenhancement.

Models of the self

Many authors touch on dimensions of the ‘self’ or personhood, and there is some discussion about the language used (see section 4.1.1.3). But the tension through many of the conversations is to do with the extent to which the brain holds, captures or is the site of the self/the person. The biological purpose and function of the brain was only identified in the seventeenth century (Zimmer 2004) and so philosophical thinking about the ideas of self and personhood were developed in isolation from biological considerations, and more in relation to theology and the soul. Now, scanning can give us a window into what is happening as we think and feel, and pharmacology give us new options for treating and manipulating the brain – which can also be understood as the mind, or even the self. Yet mind is both brain (and hence body) but also ‘more than the brain’. What is the true self – the person before or after treatment for brain malfunction, before or after drugs to enhance mood or cognition (Singh 2004, Northoff 1996)?

This tension permeates many of the discussions on the use of neuroscience, particularly to do with neuroenhancement, and ideas of responsibility. More futuristic discussions on potential mind-machine interfaces raise this issue in a different way – what will brain-machine interfaces do to our sense of self as our mental abilities are enhanced or networked to other humans also using machines? Will it fracture our ‘unitary consciousness (Hancock and Szalma 2003)? Concerns about models of the self also surface in discussions on informed consent from people whose mental state (biological state?) may be compromised in some way, not ‘normal’.

Informed consent and the biological model of the self

Some interventions in brain function raise issues that are consistent with those raised elsewhere in the ethics literature - for instance, questions of informed consent for participation in drug trials, or for brain or psychosurgery (Williams 2002, Alfano and Brunetti 1997, Kulynych 2002), require attention to the capacity of the participant to understand what is being proposed, and to make a choice about whether or not to participate.

But developments in neuroscience also open the possibility of a biological rather than social model of the self. We are getting a better understanding of the biological basis for changes in mental states, cognitive function, and responses to pharmacological intervention and other drugs. At times changes in brain activity in response to external events can be visualised via various brain scanning technologies.

If the person in question is understood not to be functioning in a usual or ‘normal’ way, a biological model of the self can imply that the person’s choices are a function of the state of their brain, as determined by a particular combination of neural states and connections – all of which may compromise their ability to make choices.

Several writers explore the implications for research with addicts. While there is an established concern to protect vulnerable people who participate in brain research (Cook-Deegan 2000, Gur et al 2002), questions are now being raised about the extent to which those whose behaviour is controlled by the state of their brain receptors and neurotransmitter systems (ie addicts), can give free and informed consent for research. Is the person able to make a choice, or are their choices totally shaped by the current state of their brains?

Hall et al(2003, 2004) argue (in response to colleagues questioning if or what forms of drug research can be carried out with addicts (Cohen 2004)) that the challenge is to develop theories of addiction that both take seriously the neurological basis for drug effects and addiction, while not also depicting addicts as automatons whose behaviour is under the control of the drugs. Uhl (2003) argues, in response to Hall, that addiction is not an all or nothing switch, and that research can be considered on a case-by-case basis that recognises that addicts are not devoid of free will. It is important to balance understanding of areas or circumstances where they might be impaired, with their rights of self-determination to participate in research.

Effects on public interventions to deal with addictions

A biological model of addiction also has social and political implications. While Hall et al (2004) are concerned that a biological rather than social model of addiction could result in severe restrictions on the type of neuroscience research that can be carried out, they also warn against causal accounts of addiction being used to justify legal coercion to use pharmacotherapies and drug vaccines – what they would regard as a ‘simple minded social policy’. They also recognise the potential for advances in neuroimaging that might enable identification of ‘addicts’ or prediction of future addiction, leading to concerns about invasion of privacy, third-party use of imaging data, and consumer protection against over interpretation of test results.

Similar issues arise around interventions to reduce smoking. Caron et al (2005) review the science that demonstrates an association between specific genetic profiles and susceptibility to smoking and nicotine addiction. Such work is leading to a market for pharmaceutically based nicotine maintenance, but it also raises questions about how ideas such as causality, choice and free will will be articulated in relation to smoking? A medicalised understanding of smoking sees addicts as passive agents in a disease process they cannot control, and which requires medical intervention. For others smoking is a free choice, and medical professionals have little role in breaking the habit. Different models of addiction will lead to different public health interventions, with a risk that an individualisation or medicalisation of smoking undermine current public health strategies that focus on preventing or reducing tobacco exposure.

Social and political uses of research

Neuroscience is taking research into areas that generate considerable societal discomfort. Researchers are investigating the biological basis for violence (Enserink 2000), the neurobiology of intelligence (Gray and Thompson 2004), and the neurobiology of sexuality (Wolpe 2004). While the researchers pursue these areas with the hope of finding treatments, there is the possibility the research will feed deterministic understandings of human social behaviour and abilities, and associated policy, legal, and cultural choices. For instance, if the technology claims to be able to predict future behaviour, or the risk of a condition that elevates risk of a behaviour, if or when can compulsory treatment orders be made? The courts already order social

interventions, e.g. to address violent behaviour – why not interventions directly in the central nervous system, such as drug treatments (Farah 2002)? Morse (2004) notes that the criteria for abnormality are socially decided, and we are at a time when there is a tendency to pathologise troublesome behaviour.

Anxiety about such possibilities is not totally unreasonable. Earlier biological understandings of social behaviour (such as phrenology) have had a chequered history (Enserink 2000), and the discussions have often been set up (or reported) as nature vs nurture, rather than recognising the degree to which research is uncovering some of the complex interactions between genetics and environment, and how they can play out in terms of human development (Masters 1996).

Illes (2003) recognises that there may be questions about the moral and social responsibility of some research topics and designs. For instance, are all studies of normative neurobehavioural phenomena ethically acceptable? Leshner (2004) also recognises that some may not even want to investigate some aspects of the brain, but argues that “we [the scientific community] have an obligation to apply the full power of science to solving the toughest problems facing humanity, even if they are potentially contentious...scientists have a duty to be extremely sensitive to the potential implications and uses of the results of their work, and that they need to engage fully with other members of the public...in developing a moral consensus and guidelines about how we will proceed” (Leshner 2004 p.3).

This call for the scientists to be involved in the social and ethical discussions with the wider community is present in a number of papers (e.g. Racine et al 2005, Doucet 2005, Hall et al 2004).

Privacy and confidentiality

Issues of privacy and confidentiality are also thought through elsewhere in the ethics literature. However, one dimension is new in relation to brain research and that is the issue of ‘mental privacy’.

There is well established thinking about how to deal with issues of privacy in relation to say the collection of genetic data. Here one would respect privacy by not collecting information, and confidentiality by not sharing that information, without permission of the person. Such an approach can be applied to the information gathered by neuroimaging. Farah (2002, 2005) considers information about psychological traits and states should be subject to the same sorts of protections.

But Reid and Baylis (2005) argue that potential for neuroimaging to violate our ‘privacy of thought’, introduces a new dimension to the conversations. ‘Thoughts’ are quite different constructs to ‘genes’. They regard thoughts as more central to our sense of self than genes can ever be. Thoughts are the raw materials of our stories and language, through which we construct our selves, our identities. To allow such a *process* to be subject to external reading would be of quite a different order than allowing our genetic makeup to enter the public domain. Wolpe et al (2005) talk of this in terms of ‘cognitive liberty’. Sententia (2004) explores this idea too in relation to the convergence of nano-bio-info-cogno technologies that will affect or monitor cognition. He argues:

“Cognitive liberty is every person’s fundamental right to think independently, to use the full spectrum of his or her mind, and to have autonomy over his or her own brain chemistry. Cognitive liberty concerns the ethic and legality of safeguarding one’s own thought processes, and by necessity, one’s

electrochemical brain states. The individual, not corporate or government interests, should have sole jurisdiction over the control and/or modulation of his or her brain states and mental processes” (Sententia 2004: 223).

4.2.2 Practical and philosophical issues recent or new to bioethics

4.2.2.1 Is neuroethics new or is it not?

A brief flurry of discussion on whether or not neuroethics is in fact ‘new’ can be found in the special issue of AJOB, in the responses to Illes and Racine’s (2005) paper on neuroimaging. In that paper they argue that while ethics of genetics is a legitimate starting point for considering the ethical issues raised by neuroscience, it is not sufficient. In particular they are of the view that the difficulty of ‘carefully and properly interpreting the relationship between brain findings and our own self-concept is unprecedented” (2005:6). The complexity of neuroscience research poses challenges for the integration of knowledge and meaningful interpretation, and there is a need to address the challenges of interpretation, and the cultural and anthropological frameworks that shape our understandings of self and personhood.

Respondents take various approaches.

Scheick (2005), for instance, argues that the challenges that Illes and Racine identify may not all be similar to those that have arisen in genetics, but where that is the case (e.g. the use of physiological tests of truth telling) there are other debates to draw on (such as the use of other lie-detection technologies). The difficulty of neuroethical enquiry may not arise from its newness, as much as from the need to master vast and enduring debates about the relationship between mind and body.

Knoppers (2005) is unconvinced by Illes and Racine’s arguments that neuroethics faces particular challenges, but rather is concerned that neuroethics learn from the genetics debates as it frames the issues for the neurosciences. She alerts readers to the historical parallels and challenges, including an overly simplistic approach to the science and the too easy adoption of early models of understanding genes.

Wilfond (2005) rejects the argument that neuroethics either raises new issues, or requires a different ‘approach’. The issues raised by neuroscience have parallels in various other areas, and while the context of an issue may require particular consideration, there is no need for new conceptual tools or theories. Any differentiation of sub-disciplines within an area is understandable for reason of common methodologies, or common areas of focus. It may also be useful socially (to create a professional identity or respond to needs for funding). But coining new terms such as neuroethics may be distracting, or obscure rather than clarify issues. He argues against the need to create sub-disciplines for different streams of ethics (genethics, neuroethics, etc).

4.2.2.2 Applications of neuroimaging

4.2.2.2.1 New imaging research – what it may enable

Recent developments in brain imaging techniques (e.g. functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) allow clear images of the state of the brain structures. They also enable replicable experimental designs to investigate the relationship between brain function/activity and cognitive behaviour, for instance to understand cognitive changes in people with Alzheimer’s disease (Illes

and Racine 2005, Rosen et al 2002). But the technology can also be used for similar research on the relationship between brain function/activity and social dimensions such as emotion and personality. Such work has been carried out on normal healthy people, and also those who have come to the attention of forensic services, say for violence. Investigations have been on topics such violence, racial attitudes, preferences, and specific thoughts (Canli and Amin 2002, Farah 2002).

Much work is focussed on understanding and description, with making the links between biological behaviour (neural activity) and the processing of cognitive and emotional activity.

As understanding develops, there is interest in finding clinical applications, and there are also a number of potential applications outside health – forensic uses to predict violence or future illegal behaviour such as paedophilia, to guide court directed treatment strategy, to detect lying, or to determine ability to accept legal responsibility (Canli and Amin 2002, Farah 2002, Glannon 2006, Wild 2005). There is also the likelihood of the use of scanning techniques in interrogation, possibly as an alternative to torture (Thompson 2005).

Some authors signal caution that such practical applications are near to practical or commercial reality. For instance, there is much work still to be done to understand the interactions of different parts of the memory system as well as the processes required to formulate or implement behaviours intended to mislead – yet alone how all this links to use of language. Such work would need to happen before any lie detection processes would be robust (Illes 2004).

Such caution is perhaps reinforced by research into media coverage of fMRI. Racine et al identify three trends in the press coverage – neuro-realism, neuro-essentialism, and neuro-policy. Neuro-realism “describes how coverage of fMRI investigations can make the phenomenon real, objective or effective in the eyes of the public” (2005:160). The images provide visual proof, with no recognition of the complexities and uncertainties underneath the data collection and image processing. Neuro-essentialism leads to subjectivity and personal identity being reduced to the brain (Dumit 2003), and neuro-policy attempts to use fMRI results to promote political or personal agendas, such as to ‘prove’ that pornography is addictive. All these trends overlook the complexities behind the technology and its interpretation, which challenge any simple response to or use of the research results.

4.2.2.2.2 Challenges

There are some challenges that relate directly to the research itself, for instance, selection of patients (both healthy volunteers and those with neuropsychiatric disorders, or other variations from the ‘norm’), privacy in management of data, and management of incidental findings arising from the research (Illes et al 2002, Alfano and Brunetti 1997).

But underlying these issues are wider conceptual and methodological challenges – what would ‘normal’ look like (in terms of neural activity, social behaviour, cognition, and brain images)? How to interpret images? To what extent and under what circumstances, can findings be translated to the clinic or to other practical applications?

Interpreting images, and ‘Normality’

While the technology can produce wonderful images of activity in the brain, the question remains about what the images ‘mean’, especially if the evidence from one group of people is used to generalise to other populations.

Firstly, it is important that brain images are recognised not as realities, but only as representations of reality – and as such are subject to limitations that lie in the technologies themselves, and limitations that result from the interpretation of the images and the meaning with which they are inscribed. There are epistemological limits to how the images are produced (e.g. variability in research design, statistical treatment of data and resolution), and the images can only produce a model of the brain, and any model needs to be treated with caution. Also cultural and anthropological frameworks bind any interpretation of neuroimaging studies. Ideas about emotions and the self, for instance, are culturally determined (Illes and Racine 2005).

Dumit (2003) discusses how the presentation of brain images in magazines and books can change people’s understanding of their selves, of their bodies. People with depression, who understand themselves as having neurotransmitter imbalances, must negotiate a relationship between self and brain – if there is something wrong with my brain, is there something wrong with me? Even avoiding the sense of ‘wrong’ as a moral judgement about oneself, one is left to negotiate the meaning of a sick brain for one’s autonomy, and the extent to which one becomes a “pharmaceutical self” in that one needs chemical assistance to have the brain that is one’s ‘own’.

Secondly, what is the relationship between structure and function, or brain activity and behaviour? While certain structures are usually involved in particular activities such as memory and emotion, it is also the case that the brain has enormous plasticity, some non-visible (to the scan) structures may be important to function, and it is not clear just what effects on function can be predicted from particular changes in structure (Stevenson and Goldsmith 2002, Rosen et al 2002). Nor does a correlation between activity and function, or activity and behaviour, necessarily establish causality (Desmond and Chen 2002, Canli and Amin 2002).

Thirdly, what is a ‘normal’ brain? Not only are there few normative scans available from healthy populations on which to base any comparison, it is also not clear how the normal brain changes with time, especially in relation to the development of fetuses and children. It is especially difficult to get base line normative data for children since they are not so easily or often enrolled in research. Often scans from children who have been scanned as part of medically necessary diagnostic work-ups and identified as ‘negative’ are studied as a means toward understanding ‘normal’ brain structure and function (Desmond and Chen 2002, Hinton 2002).

Not only are there few templates of normal brains with which to compare those suspected of not being normal, it is not even clear what brain *measure* should be used as a norm, and which brain *structure* one is measuring in any particular use of the idea of normality. Also, a measure of normal is statistical and not absolute (Canli and Amin 2002).

And when linking brain activity with behaviour, ‘normality’ is a social judgement. Deviance, or example, is socially constructed, and reflects social norms and values. It is not inherent in either behaviour or brain (Howard 2002).

Thirdly, Stevenson and Goldworth draw attention to how questions of interpretation can slide between bio-hermeneutics and bioethics. While interpretation of brain

images may give some indications of the current state of a brain, and possibly be used to make judgements about likely future outcomes for that person, such images do not relieve the circumstances of “the complexities or ambiguities of personal being” (2002;451) and should not be confused with the need for the interpretation of circumstances and choices that is required of bioethics.

For further discussion of normality see section 4.2.2.3 on Neuroenhancement.

Can one translate from research to clinic or court?

There are some obvious possible clinical benefits of brain imaging. It may enable clinicians to distinguish between subtypes of a condition that may present in similar ways, but have different underlying pathologies. It may enable clinicians to identify those who will benefit from pharmacological intervention or early treatment, ensure early access to treatment, and in some situations (e.g. Alzheimer’s) provide an opportunity for people to plan for later deterioration (Hinton 2002, Rosen et al 2002).

At a forensic level, techniques based on scanning may enable lie detection, provide a tool to assess the likelihood of someone re-offending, or inform a court-ordered direction for mental health treatment (Wolpe et al 2005).

But there are several issues still to be worked through before these things are practicable or reliable.

A number of dimensions need to be considered in translating scanning research from lab to clinic or court. For instance, the technology may not be able to be used with a clinical population as it is with a research population. Scanning requires that the participant be able to co-operate in particular ways, such as keeping still, but this may not be possible with some groups of people, for example those with Alzheimer’s disease. Also clinicians need to understand the limits of interpretation and the types of statistical errors that may arise, and may need education about how to interpret brain research. In addition, when caring for older patients, there may be additional safety screening requirements (Rosen et al 2002).

Farah (2002) argues that scans do not yet have a place in psychiatric diagnosis. Those abnormalities that characterise particular groups are not yet diagnostic at the individual level. In addition, there is still a limited understanding of the links between physiological and psychological data – neural correlates are only the first step in understanding.

While scans may be able to say something about the current state of a person’s brain, great caution is required in using that information to predict future outcomes. Such associations are not validated in the case of Alzheimer’s disease and much greater sensitivity and specificity is required to predict future from a current brain state and functionality (Rosen et al 2002). With neonates and young children, little is known about normal brain development and what should be regarded as within the range of normal at any particular stage of development. In addition, there is considerable brain plasticity- current brain activity may not predict future outcome (Hinton 2002, Stevenson and Goldworth 2002).

DiPietro (2005) notes that the use of neurobehavioral assessment before birth can be distinguished from clinical fetal assessment. The latter is focused on good birth outcomes, while the former is orientated towards outcomes for child and his/her development post-birth, and comes with all the challenges of prediction.

Non-clinical use of scanning may also be making assumptions about prediction. Corporates may want to use scanning one day to inform their choice of staff, and assume that certain traits are what is needed in their workplace (Moreno 2003). Or a scan might inform a decision about whether or not to restrict someone's activity, such as driving. But it is problematic to link brain activation with a behaviour of interest (Rosen et al 2002).

In a forensic environment, scanning could be used to predict violence, determine a felon's ability to control their behaviour, to monitor mental health treatment of a convicted psychopath. Or could it be used along the lines of 'notifiable diseases' with respect to psychopathy, paedophilia and related disorders that put the public at risk? However, one can not assume that certain brain behaviour will lead to actual feared behaviour e.g. not all men aroused by images of pubescent girls will go on to be sex offenders (Canli and Amin 2002, Howard 2002).

Popma and Raine discuss the implications of brain imaging for the forensic assessment of anti-social behaviour, as more links are made between biology and behaviour. They note the gaps in the knowledge about the relationship between biology and antisocial behaviour, and call for "prudence and due circumspection" in translating knowledge from correlational and risk research to clinical practice (2006:436).

In a security or court situation, there may also be interest in using some of the emerging lie-detection technologies, based on brain scanning. Indeed, in some parts of the world, security concerns may provide an incentive for (possibly too) early adoption of the technologies (Moreno 2005). Wolpe et al (2005) note the technical limitations of current technologies. For instance, the validity of the technologies is yet to be established –does the test give information about what it claims to test, and to what extent do various methods used in the test control for possible confounding effects? They note that a test developed under lab conditions may not be as reliable when transferred to different test populations, and that sensitivity and specificity may change with different sub-groups of people.

Fischbach and Fischbach (2005) point out that imaging relies on changes in blood flow as a surrogate for neuronal activity, and does not have the temporal resolution to detect what may be a fleeting brain state. But perhaps more challenging to the use of lie detection technologies is that lying is a complex activity - not only may it be morally justified in some situations, it also may involve quite different brain activities whether it involves deception, falsification, fabrication or misrepresentation. Lying is a social activity (e.g. 'of course father Christmas exists'), and cultural factors play a role in determining what is or is not a 'lie'. Could it be that what one detects is not the lie, but the thought that one should not lie (Buller 2005)?

As early as 1996, there was anxiety amongst professionals about the transition from research to practical use of scanning technologies, and the Society of Nuclear Medicine prepared guidelines that provide guidance for professionals preparing forensic reports on elements essential to a complete and useful clinical report, and provides standards to differentiate well established clinical applications from research uses (Society of Nuclear Medicine 1996).

Effect of neuroscience on legal understandings of responsibility, and court decisions

Pharmaceutical interventions, brain scan results and the possibilities of neurosurgery offer new strategies for use in the legal system – some of which have precedents. There may be changes to how the courts even understand or interpret ‘responsibility’ where some brain scans may provide evidence of abnormal brain activity; and scans may indicate what sorts of treatments may address the underlying cause of antisocial or illegal behaviour such as violence.

There are a few papers specifically examining how neuroscience will affect the law, and most are within the same publication – that of the Royal Society’s *Philosophical Transactions* special issue on Law and the Brain. Some papers fall outside the scope of this report as they look at the material and biological basis of legal thought, including neuroscientific models of normative behaviour, or evidence of underlying biological activity when we make legal judgements such as how we sort deception from self-deception or understand what is happening to decision-making under provocation (Goodenough and Prehn 2004, O’Hara 2004).

Legal understandings of responsibility

There is an emerging dialogue about whether or not legal understandings of responsibility will be shifted by neuroscience. As understandings of the biological base of behaviour expands, it is possible that arguments will be made in courts that a person’s understanding and/or ability to distinguish between right and wrong is compromised because of the particularities of their brain. Moreno (2003) suggests that further legal categories will need to be developed to capture different senses of culpability, as has already been done in cases that involve psychoactive drugs. And courts are likely to depend on expert advice on the state of a person’s brain. As discussed above, there are real challenges in translating research to the courts.

Morse (2004) does not think that legal understandings of the law will be compromised by neuroscience. He argues that the law “views human action as reason-governed and treats people as intentional agents, not simply part of biophysical flotsam and jetsam of the causal universe.” The law assumes adults are capable of minimal rationality and responsibility, and while that assumption can be rebutted in appropriate cases the criteria for non-responsibility are demanding and infrequently used. Morse also rejects the idea that responsibility is tied to free will. Causation per se has nothing to do with free will – it is not the same as compulsion or lack of capacity for rationality, and it is diminished rationality that concerns the law.

Green and Cohen agree that the current framework for assessment of criminal responsibility is not changed by neuroscience. But they also argue that neuroscience will affect moral intuitions that relate to the punishment that a crime deserves – “rationality is a presumed correlate of what most people really care about. What people really just want to know is if the accused, as opposed to something else is responsible for the crime, where that ‘something else’ could be the accused’s brain, genes or environment” (2004:1780). As the new science progresses it will undermine people’s sense of free will, and the idea of distinguishing between the truly guilty and those who are victims of neuronal circumstances will seem pointless. They project a move away from retributive punishment (giving people what they deserve) to a more consequential view of law – we hold people responsible because doing so seems on balance to be beneficial (deterrence, containment etc).

Morse also reminds the reader of the social context for understanding responsibility - neuroscience cannot tell us how much rationality is required for responsibility. That is a social, moral, political and legal call. And Glannon reminds readers that the main reason for questioning the use of neuroimaging to make legal (and ethical) judgements is that “it involves a move from empirical claims about the brain to normative claims about how people ought to behave. Free will and responsibility are not primarily empirical, but normative notions reflecting social conventions and expectations about how people can and should act” (2005:41).

Threats to civil liberties

Neuroscience may also raise threats to our civil liberties. If brain scanning delivers what it promises, there is the potential for invasion of privacy, the ‘reading’ of our thoughts. There may be new treatments for a wider range of brain-related ‘conditions’. What constitutional or legal limits should be placed on the use of the technologies? For what conditions and what treatments is it acceptable for the court to require treatment, perhaps so that one is capable of standing trial (Morse 2004)?

4.2.2.3 Neuroenhancement

Enhancement is frequently mentioned in the literature reviewed for this paper, and a number of themes emerge. Enhancement is not of course confined to neuroscience, but there appears to be an intuition that there is something distinct about enhancing mental, cognitive, or behavioural functions and intervening directly in the brain (Wolpe 2002a), arising no doubt from the cultural understanding of the brain as central to the self or identity or person. Many of the issues discussed, however, are generic to all opportunities for enhancement.

In general, most papers are an over-view of the area, summarising the issues and calling for discussion of the issues. A few of the papers provided an insight into the different approaches apparent within different academic disciplines (Hyman 2005, Singh and Rose 2006). One paper (Mauron 2003) approached the issue from a wider perspective, and placed the issue of enhancement within an historical and philosophical framework.

What the science is making possible

Discussions of enhancement have had some exposure in recent years – but have not been confined to neuroenhancement. The US President’s Bioethics Council, for instance released a report in that covered the full range of enhancement possibilities⁸ and Carl Elliott’s (2003) book *Better than Well* has promoted considerable discussion of technologies that include cosmetic surgery and the use of glasses as well Prozac and Ritalin.

In relation to cognition, mood or emotion, people have always sought enhancement whether through education, coffee, hard work, or alcohol. But a new range of techniques are becoming available. Drugs and prosthetic devices developed primarily for medical application now are seen to have uses that fall outside the traditional ‘medical’ realm.

In recent decades, drugs have been developed for treatment of psychiatric disorders, be they to do with cognition and behaviour, emotion or perception. Many of these

⁸ Beyond therapy: the Pursuit of Happiness http://www.bioethics.gov/topics/beyond_index.html

drugs can also be used to treat mild symptoms and improve on cognitive and emotional states that fall within the current range of ‘normal’ – e.g. drugs that improve attention and memory, mood and affect (Turner and Sahakian 2006, Hyman 2006, Chatterjee 2004a). Some are also of interest for athletic enhancement e.g. medication to enhance neural plasticity (Hyman 2006).

Positive effects on mood may also come from use of some engineering technologies. There is some evidence that repetitive transcranial magnetic stimulation (rTMS) can have a therapeutic effect on depression. Could it affect mood of normal people on ‘off’ days (Chatterjee 2004)?

Advances in machine and IT technologies also offer the possibility of human/machine interfaces that will be not only for ‘treatment’ but also for ‘enhancement purposes’. Prosthetics are being developed for hearing and vision (e.g. the cochlear implant), and techniques being developed for ‘applied neural control (e.g. Parkinson’s pace-maker like device for brain). Wearable computer-person interfaces are under development and also an implantable brain chip, which raises the possibilities of networking brains between people. Early users for some of these newer possibilities are likely to be people with a disability, but the military have considerable interest in this field (Chatterjee 2004, Maguire and Mcgee 1999, Hyman 2005, Breithaupt and Weigmann 2004). While some question whether the technical barriers can be overcome (White 1999), there is a new discipline emerging, neuroergonomics, that studies how brain mechanisms are involved in human performance in interaction with technology (Hancock and Szalma 2003).

What is enhancement (and what is treatment)?

It has proved impossible to define a clear line between therapy and enhancement. It is apparent that where one draws that line is dependent on the context and the purpose of making the distinction. The same treatment may be therapeutic in one context (severe depression, extreme behavioural difficulties) and an enhancement in another (a ‘healthy’ person wanting to feel ‘better than well, a child needing to concentrate better to achieve at school; breast surgery following mastectomy for cancer, and breast surgery to improve one’s figure).

The purpose for drawing the distinction may lie in deciding what is or is not a medical treatment, and needing to be paid for as such. (This may relate to what is obligatory for society to provide in way of care (Wolpe 2002).) While at first glance an obvious task, in practice it is a challenging distinction to. When, for instance, is a child sufficiently short that treatment with growth hormone is a medical treatment, and when a social enhancement? And there is a difficulty in even deciding what an illness is – is shyness, for instance? Not only are many mental health conditions on a continuum with ‘normal’ , but objective tests for presence or degree of illness are still missing in many cases. Direct-to-consumer marketing may also expand diagnostic zones in minds of people about what needs to be treated (Hyman 2006).

Deciding what counts as a medical treatment is not the same as what services a health professional may provide. This may well evolve into areas that have not traditionally been the domain of health professionals. Chatterjee (2006) notes that some psychologists already act as coaches in pursuit of happiness – how long before neurologists take up this role, using the tools that science provides to enhance well-being and happiness?

An alternative purpose for drawing the distinction is one of public policy – in some jurisdictions this will in part be about health funding, but it could also be to do with sport (what enhancements are acceptable for athletes to use?), education (what enhancements can assist children to concentrate or achieve success, be it medically prescribed Ritalin or off-label methylphenidate?), or policy to regulate access to drugs (whether through rules, oversight of physicians and engagement of the public on discussion of issues) (Kennedy 2004, Hyman 2006).

A third reason for drawing a distinction between therapy and enhancement is to do with deciding what is species-typical functioning. (Treatment gets one into the range of normal, enhancement lifts one above it.) This determination of what counts as ‘normal’ could either be to define what is ‘natural’, or to use as a convenient baseline to determine what society owes its members, what treatments should be offered (Wolpe 2002).

There are some challenges around defining ‘normal’. It is yet another term that can have different meanings, and where the meanings can be put to various political purposes.

‘Normal’ can describe a statistical value, the distribution of a characteristic across a population. The driver for this definition has often been to understand a continuum within a population, which can then be converted to distinct categories in the interests of managing populations. This will also interact with social understanding of where responsibility lies for dealing with those who fall outside the ‘norm’. Hyman (2005) notes that with the variation from the norm based on population statistics, health can be seen as fitness of a particular sort. Early public health, hygiene and eugenics programmes were based on population responses to dealing with variation from the norm, but these have now given way to self-help programmes, where responsibility has been shifted to the individual who can choose behaviour and practices.

But ‘normal’ can also be a social and subjective judgement. It can develop a moral value – the norm what we ‘ought’ to be, something to strive for. In this usage, average comes to be seen as deficient (Hogle 05). Treatment may be what enables one to reach one’s potential. And if one is prepared to offer the treatment (as treatment not enhancement) to those who start at the bottom or middle of the distribution curve then why not also the ‘already-clever’ people who choose to enhance (Singh 2005, Turner and Sahakian 2006)?

The difficulty of making a water-tight distinction between therapy and enhancement could lead to a view that since we cannot make a distinction between treatment and therapy, no meaningful line can be drawn. Dees (2004), however, rejects this position. Just because it is difficult, does not mean we leave it to the market or the military to decide – that is to surrender ethics to power.

Caplan (2004) argues that none of the arguments offered to resist enhancement are sufficient for an in-principle rejection. Singh (2005) rejects the adequacy of abstract philosophical reasoning in isolation from empirical studies of the particular situation. Only detailed study of the particular technology in particular contexts can uncover the drivers of and values involved in uses of enhancement.

Other considerations/issues

A number of other issues are also raised in relation to enhancement. Some of these are pragmatic concerns – for instance, lets not get carried away and forget the

practical issue of safety. Others are more philosophical – concerns about self and identity.

Some issues are mentioned, but not explored; for example, that enhancement is to be ‘playing God’ (Maguire and Mcgee 1999), or unnatural (but so are so many medical interventions) (Caplan 2003); or that there are concerns about bodily integrity and intuitions about the sanctity of the body (Maguire and Mcgee 1999).

Safety

There are a number of safety concerns about the use of drugs for neuroenhancement:

- There is little known about the long-term effects of drugs on neural plasticity, and to what extent any such effects are different than those affected by experience. (Hyman 2006)
- The effect of drugs are known on the research population (the population with the illness for which it was developed) but not necessarily on the general population or on the cognitively intact. What possible other (collateral) effects are not looked for in the development of the drug? For example, does a drug enhance memory but affect the selection process about what we remember? What effects are there on personality over time, especially with children, for which there is a general shortage of data on effects of drugs? Drug trials are usually over a short time while treatment may be over a longer period – what effects might this longer use have (Hyman 2006, Turner and Sahakian 2006, Wolpe 2002a)?
- The effects of drugs are not necessarily predictable or guaranteed. Our understanding of pharmacogenomics is still limited, and there is some evidence that optimal levels of some medications may depend on the baseline levels of performance, and that it may vary with different patient groups e.g. adults vs children. It is important to avoid unwarranted claims of efficacy results (Turner and Sahakian 2006). Chatterjee (2004a) does not think that safety issues are a great concern. There are incentives in place for treatments with minimal side effects.

How one assesses these risks will be affected by whether or not the person is ‘ill’. Hyman (2006) points out that at the population level, the greatest risk is that drugs will be underused in treatment of mental disorders. But the risk/benefit calculus does shift when a person is not already ill.

Threats to autonomy

Given the potential risks, it may be wise to restrict use of some medications and technologies until more is known. However, an argument is also made that one should allow an individual to choose based on good information. This position is based on libertarian assumptions that all have access to information, and the skills to interpret it. It also fails to be concerned about the impacts of the drugs in societies without civil liberties or good education systems, or recognise the current limited access to all clinical trial results (Turner and Sahakian 2006).

Additional concerns about threats of some of these ‘enhancements’ to autonomy are raised in the context of court mandated implants. Forced drug administration is already allowed in court systems, for example when a person is dangerous to themselves or others, and already in the US an individual has been ordered to take medication so as to be fit state to stand trial - this is a social purpose rather than one driven by concern for the health of the individual per se (Maguire and Mcgee 1999,

Turner and Sahakian 2006). Enhancement may be used on soldiers. Are there any limits on what the state can do to its own soldiers (assuming a ‘just’ war) (Wilson 2004, Wolpe 2002)?

In the case of enhancement via neural connections to machines, there may be a different threat to freedom. If the human becomes an extension of the machine, who controls the individual’s mental state – the person or external authority who has access to the machine-human interface? And what will it mean for autonomy as machines become more ‘human’, able to read human minds, adjust their interfaces with humans to make life more pleasurable, or to relieve boredom (Hancock and Szalma 2003)?

Self and identity

Discussions of self and identity in relation to enhancement run the spectrum from abstract philosophical reasoning, to empirical studies of situations where drugs are being used in a context that can be understood as enhancement. The difficulties with the language used were discussed in section 4.1.1.3.

DeGrazia (2005), for instance, teases out the language used to discuss identity in relation to enhancement. Whether or not altering a person’s identity is problematic depends on whether one is referring to numerical or narrative identity. Altering a numerical identity, with its associated psychological continuity, may be problematic, but DeGrazia sees no issue with changing one’s narrative identity – any intervention (enhancement or otherwise) will affect one’s story about oneself, one’s sense of where one fits in the world and how one got to be there. He recognises that there is some concern that enhancement might affect some ‘core’ traits that are central to a person’s narrative identity, be they psychological style (e.g. suspicious or confident), personality or intelligence. However, he argues that such reasoning is suspect and enhancement techniques are “unlikely to affect traits that are plausibly considered inviolable” (2005:280)

Singh (2005) argues for studies that identify how understandings of self and personhood are culturally shaped. There is a need to pay attention to how issues are playing out in particular situations. It is important to reconcile and understand how people think about persons and brains, and persons and physical systems (Farah and Wolpe 2004), but too often the issues are discussed in the abstract rather than in relation to a particular drug or its use, and the bioethics discussions isolated from other disciplines. This results in the ‘self’ and ‘identity’ being thought of as “identifiable, coherent and stable”, encouraging an essentialist view of the self. Singh proposes instead that self and identity are “fragile, fragmented and embedded” and empirical studies are needed to understand how these concepts play out in actual lives (Singh 2005:35).

He uncovers some of this cultural shaping in his work on ADHD, where mothers and fathers understood the treatment in quite different terms as they were asked to think about the relationship between neurochemistry and personhood. Mothers saw ADHD behaviours as ‘part’ of who their sons are, and treatment as opening the possibility for their sons of a better understanding of themselves. Mothers situated their understanding within a success narrative that itself provides a moral imperative to treat – treatment enabled the actions of a freed authentic self in a culturally valued story of male development that included success at school. But while they saw the drugs as enabling the authentic boy to act during the week, there were dilemmas for

weekend treatment – then there was a desire to let child be itself, unmodified by drugs. On weekends, however, the boys do not need treatment to be ‘free’. Through all this runs a tension about how to relate self and brain to the body, how to distinguish between behaviour and the child’s real self.

Fathers understand treatment options within a different frame. They do not see the disruptive behaviour as part of underlying pathology, but rather that ‘boys will be boys’. Their behaviour is seen as evidence of this. Fathers are sceptical of diagnosis and the use of medication, but also see how the boy’s behaviour disadvantages their sons. This is of particular concern in sports and physical activities. For fathers biology not a morally neutral zone – it can be weak and flawed (and needing medication) and thus (via genetic links) implicate fathers.

Singh also notes from his study that shifts in context will shift the moral debate e.g. as long-acting medications for ADHD become available, some of the moral dilemmas of dosing and how to involve/inform others such as teachers become less intense.

Context can shape understandings of self and identity in various ways. For instance, in a culture where identity is linked to what one consumes, combined with increased attention to bodily practice, it is a challenge to work out who is the authentic self - the one before or after one has altered the body (Hyman 2005) ?

But whether the overall effects of enhancement are beneficial or not, whether it undermines or re-enforces a sense of personal agency, is also dependent on context. For a child, for instance, who has interpreted himself through “the prism of severe symptoms, such as feelings of worthlessness, prior to treatment,...change would, to a great degree, be the long-term goal of therapy” (Hyman 2006:108). It is important to remember that not all changes in personhood are bad. It is possible to recognise great good in some religious epiphanies, the re-invention of ourselves in non-medical ways, and the ‘finding’ of ourselves through treatment of depression (Chatterjee 2004a).

It may be that in all these issues, our responses are shaped by our view of the teleology of the technology and our view of human life. Do we see humans as animals that will use any technology, or is the use of neuroenhancement an affront to our humanity (Wolpe 2002)? What kind of society should we become (Dees 2004)?

Social issues

The social practice of enhancement may have effects on both individuals, and on wider communities (Maguire and Mcgee 1999, Turner and Singh 2006). There is a concern for social justice, in relation to the unequal distribution and effect of enhancement technologies (Butcher 2003, Hyman 2002, Maguire and Mcgee 1999, Turner and Sahakian 2006). However, this is not a new issue - the use of prescription drugs to both treat and improve function already appears greater among the advantaged (Hyman 2006), and people already have access to many things that enhance inequality e.g. music camps and maths tutors (Caplan 2003). And is the issue access or availability (Chatterjee 2004a)? It is likely that the use of enhancement technologies will act to re-inforce current cultural patterns. Singh (2005) offers evidence of this in his study of the use of ADHD medications and the concerns of parents that their children be able to ‘compete’.

Others identify concerns that the availability of enhancement technologies will change values, such as the value of hard work, and applying oneself. But they note that we already have ways of moderating the ‘pain’ of living, such a taking drugs to treat

headaches, the use of heating to keep warm and healthy, and technology to travel (Chatterjee 2004a, Turner and Sahakian 2006).

And then there is the threat of social coercion, and will the possibility of enhancement promote diversity or sameness (Butcher 2003)? This might take the form of demand for superior performance by others e.g. pilots to take medication because evidence shows that those on donepezil perform better in emergencies; or doctors so they can perform better after long hours of work? The reason for coercion in such situations is not so much to benefit the taker of the medication, as the benefit of others (Chatterjee 2004a, Hyman 2006). Caplan (2003) has a different take – we owe it to our children and society to optimise abilities. The answer is not to avoid enhancement but ensure it is always a choice.

Different analytical approaches to enhancement

Apparent in all this literature is a range of analytical approaches to enhancement. Some are explicit about their approach (e.g. Degrazia arguing out of the analytical tradition of philosophy, or Singh as a sociologist), but most are not.

Hogel (2005) reviews the literature on enhancement (not confined to but including neuroenhancement) and identifies that there is no coherent body of literature, but work in areas of anthropology, social studies of science, technology and medicine, bioethics, and disability studies. The bioethics literature tends to extrapolate the situations of individuals to society and then universalise across cultures, societies and time frames – it excludes analysis of social disparities, differences in local conditions, and differing value systems. On the other hand anthropologists tend to look at the relation of modern forms of power and how they operate through bodily disciplines and modifications. They explore such things as how body enhancements are not only about commodification but also about changing ways of understanding biological and social life, and the cyborg literature challenges romanticised notions of pure or natural self that should not be tampered with – the body becomes a set of relations rather than a package with some form of agency. She also notes that cognitive enhancement relies on reductionist assumptions that all behaviour, interactions and psychological functions are related to neuronal structures – it makes the social invisible.

Hogel also identifies that the enhancement literature in general tends to focus on some technologies and avoid consideration of others. Computerised prosthetics (other than cochlear implants) are one such gap.

Mauron's paper takes a broad historical and philosophical approach as he discusses the significance of neural enhancement. He places the issue in the context not only of recent discussions of genetic determinism, but also within the wider cultural debates about humanism and the extent to which the views embedded in that tradition feed into any initiatives to biologically engineer mankind (including eugenics). To what extent is it legitimate to re-engineer human nature, whether by cultural or biological means? He goes on to argue that the link between self and the brain is much stronger than between genes and personal identity, that recent discoveries in neuroscience are more likely to bring turbulence to classical philosophical concepts such as free will and ascriptions of responsibility, and that more attention could be devoted to the "troubling implications of wilfully shaping the human brain"(2003:250).

4.2.2.4 Who should be talking about all this?

It is notable that so many of the papers reviewed for this report are authored by scientists or clinicians, or published for clinical audiences. Only a small fraction of the papers are published in bioethics journals. There is a clear call for scientists and clinicians who work in the area of neuroscience to familiarise themselves with the ethical and social issues that their work raises, and to take an active role in the wider discussions with the community.

Some writers offered an ‘alert’ or challenge to particular professional groups – to neurologists (Chatterjee 2004), to neuropsychologists (Bush et al 2002), to researchers funded by a defence agency (Anon 2003), to neuroscientists or scientists in general (Doucet 2005, Moreno 2003, Illes 2006), or to neuroimaging experts (Illes 2002). Topics cover areas as diverse as neurogenomics (Hancock and Szalma 2003), cosmetic neurology (Chatterjee 2004a), the goals of medicine (Hogle 2005), and public understandings of science, intelligence, and sexuality (Hall et al 200, Gray and Thompson 2004, Wolpe 2004).

Yet other papers were reminding readers of the need for a pre-emptive public discussion about the emerging issues (Butcher 2003, Turner and Sahakian 2006, Maguire and McGee 1999, Racine et al 2005) and/or calling for scientists’ participation in the debates (Leshner 2004). Other’s focus is simply on the public communication of results (Bloom 2002, Kulynych 2002, Wolpe 2004).

And a very few papers are reminding readers that we make sense of technological possibilities in the light of our own cultural and religious traditions (Paladin 1998, Albright 1996).

5 Conclusion

Neuroscience is raising some fascinating questions. How will we integrate new neurotechnologies into our lives and social practices? How will we come to understand ourselves, our sense of agency and of responsibility as the biological basis of our mental activities is better understood? How will we come to think about the enhancement of our cognitive and emotional life as the technologies developed to treat medical conditions or disability become available for more ‘social purposes’? How will our responses to these possibilities be shaped by religious, cultural and philosophical traditions?

Many of the papers reviewed for this report are quite generic, primarily concerned to alert readers to the issues. Only a few progress the discussions beyond a general overview, or offer sophisticated arguments that place the issues within a wider cultural and intellectual tradition. It is notable that the conversations are appearing in only a few bioethics journals, and these conversations appear to be driven by the writing of a few authors. It is also clear that several of the authors leading the conversations are not primarily bioethicists, but come from neuroscience or sociology.

Early indications are that the conversations about neuroethics will involve a fresh convergence between the relatively new discipline of bioethics, and more established disciplines of philosophy and sociology. Philosophy has a long tradition of thought about some of the central issues raised by neuroscience, but has only begun to link that to biological understandings of the brain – there remains quite a lot of work to be done to bring the worlds of philosophy and brain science together. Sociology on the

other hand reminds bioethics (and philosophy) of the need to ground reflection in the lived practices of various communities of people, to describe the patterns of behaviour and interpretation that are adopted as technological possibilities open up. Bioethics is able to bring to the conversations the fruit of reflection on the ethical dimensions of other biotechnologies, such as genetics, which have already raised some similar issues.

In addition, there are new communities of scientists who have not necessarily seen their work as socially contentious, or raising ethical issues. They too are being drawn into the conversations about neuroscience, and will need to be engaged not only to ensure the public are well informed, but also to ensure they are alerted to the ethical dimensions of their own work. Conversations with scientists will also be critical if neuroethics is to be responding to the actual science, and not some abstracted or inadequate understanding about what the science is making possible.

Stories about the exciting developments in neuroscience are now frequently occurring in general media. It will be interesting to see how the less academic conversations about neuroscience and its ethical implications play out, and to what extent the technological possibilities are integrated into social practices with little fanfare or discussion.

Appendices

Appendix 1: Sources used and search strategy

SOURCES SEARCHED

Bibliographic databases

Medline
Embase
Cinahl
Current Contents
Web of Science (Science & Social Science Citation Index)
Index New Zealand
Te Puna- New Zealand Bibliographic Database

Journals

Searched via subject databases (Medline etc)- see section on search strategies

American Journal of Bioethics
Hastings Center Report
Journal of Medical Ethics
Journal of Law Medicine and Ethics
Bioethics
Journal of Clinical Ethics
Journal of Medical Humanities
Kennedy Institute of Ethics Journal
Bioethics Review/Monash Bioethics Review
Science and Engineering Ethics
Theoretical Medicine and Bioethics
Public Understanding of Science
Science as Culture
Science and Public Policy
Science Technology and Human Values (continues Science and Technology Studies)
Social Studies of Science
Bulletin of Science Technology and Society
Engineering and Technology
Science

Searched via electronic contents pages

Cambridge Quarterly of Healthcare Ethics
Biosocieties

Other sources

The President's Council on Bioethics <http://www.bioethics.gov/>
Bioethics Web Biomedicine Resources <http://bioethicsweb.ac.uk/index.html>
Stanford Centre for Biomedical Ethics <http://neuroethics.stanford.edu>
Neuroethics <http://www.neuroethics.upenn.edu>
Cardiff Centre for Ethics Law and Society <http://www.ccels.cardiff.ac.uk/index.html>
Centre for Bioethics, Clinical Research Institute of Montreal
<http://www.ircm.qc.ca/bioethique/english/index.html>
Centre for Values, Ethics and Law in Medicine <http://www.cvelim.org/index.html>
Journal of Bioethical Inquiry <http://www.jbioethicalinquiry.org/>
Biosocieties <http://journals.cambridge.org/action/displayJournal?jid=BIO>
Centre for Ethics in Medicine, Bristol <http://www.bris.ac.uk/ethicsinmedicine/>
Kennedy Institute of Ethics, Georgetown <http://kennedyinstitute.georgetown.edu/index.htm>
University of British Columbia W Maurice Young Centre for Applied Ethics
<http://www.ethics.ubc.ca/index.htm>
Center for Bioethics Columbia University
http://www.bioethicscolumbia.org/service/bioethics_resources.html
Cambridge Quarterly of Healthcare Ethics
<http://journals.cambridge.org/action/displayJournal?jid=CQH>

SEARCH STRATEGIES

Medline

- 1 Bioethics/ (3093)
- 2 Ethics, Medical/ (14217)
- 3 bioethical issues/ (1247)
- 4 Ethics, Clinical/ (1378)
- 5 exp ethics/ (47402)
- 6 exp ethics, professional/ (21917)
- 7 exp Ethics, Research/ (2032)
- 8 (bioethic\$ or ethics or ethical).mp. (40627)
- 9 or/1-8 (55610)
- 10 exp Neurosciences/ (3758)
- 11 Neurology/ (3615)
- 12 Brain Mapping/ (17470)
- 13 Brain/ (94953)
- 14 brain tissue transplantation/ (1231)
- 15 neuroscien\$.mp. (4958)
- 16 (brain adj2 scan\$).mp. (965)
- 17 (brain adj2 imaging).mp. (3049)
- 18 exp magnetic resonance imaging/ and brain/ (17185)
- 19 exp diagnostic imaging/ and brain/ (27448)
- 20 brain.ti. (57273)
- 21 or/10-20 (144146)
- 22 9 and 21 (640)
- 23 neuroethic\$.mp. (28)
- 24 22 or 23 (642)
- 25 cognitive science/es (13)
- 26 diagnostic techniques, neurological/es (16)
- 27 biomedical enhancement/es (66)
- 28 neurosciences/es (55)
- 29 biological psychiatry/es (4)
- 30 or/25-29 (127)
- 31 30 not 24 (74)
- 32 from 31 keep (selected references) (16)
- 33 truth disclosure/es (223)
- 34 21 and 33 (1)
- 35 Societies/ (2376)
- 36 socioeconomic factors/ (25474)
- 37 35 or 36 (27833)
- 38 15 and 37 (11)
- 39 from 38 keep 11 (1)
- 40 (neuroscien\$ and society).ti. (81)
- 41 from 40 keep 37,81 (2)
- 42 32 or 34 or 39 or 41 (19)

Embase

- 1 exp neuroscience/ (39618)
- 2 NEUROLOGY/ (2875)
- 3 brain mapping/ (5939)
- 4 NEUROIMAGING/ (6867)
- 5 magnetic resonance imaging/ and brain/ (1302)
- 6 BRAIN/ (18687)
- 7 diagnostic imaging/ and brain/ (189)
- 8 brain transplantation/ (212)

- 9 (brain adj2 scan\$.tw. (1568)
- 10 (brain adj2 imaging).tw. (4896)
- 11 brain.ti. (57089)
- 12 diagnostic procedure/ and brain/ (53)
- 13 medical technology/ and brain/ (17)
- 14 biological psychiatry.tw. (1713)
- 15 functional magnetic resonance imaging/ (2164)
- 16 or/1-15 (118921)
- 17 exp ethics/ (37078)
- 18 medical ethics/ (20194)
- 19 (ethic\$ or ethical or bioethic\$.tw. (18599)
- 20 or/17-19 (41739)
- 21 16 and 20 (658)
- 22 (brain dead or brain death or brain stem death).ti. (643)
- 23 21 not 22 (575)
- 24 limit 23 to english (495)
- 25 limit 23 to abstracts (367)
- 26 24 or 25 (548)
- 27 neuroethic\$.tw. (21)
- 28 26 or 27 (551)
- 29 from 28 keep (selected references)
- 30 society/ (3570)
- 31 socioeconomics/ (18122)
- 32 1 and (30 or 31) (133)

Cinahl/Psychinfo (cross database search)

- 1 neuroethic\$.mp. (29)
- 2 (ethics or ethical or bioethic\$.mp. (43604)
- 3 neuroscien\$.mp. (8172)
- 4 neuroimag\$.mp. (4650)
- 5 neuromodulation.mp. (237)
- 6 (brain adj (scan\$ or map\$ or imag\$)).mp. (4110)
- 7 (functional magnetic resonance imagine or function mri or fmri).mp. (2808)
- 8 (magnetic resonance imaging and (cognition or cognitive or neuro\$)).mp. (6561)
- 9 (magnetic resonance imaging and brain).mp. (5675)
- 10 or/3-9 (23044)
- 11 2 and 10 (247)
- 12 remove duplicates from 11 (238)
- 13 1 or 12 (249)
- 14 (brain death or brain dead or brain stem death).mp. (745)
- 15 13 not 14 (243)

Current Contents/Web of Science (Citation Indexes)

1. Neuroethics
2. Bioethic* OR ethics OR ethical
3. Neuroscien*
4. Neuro*
5. Brain SAME (scan* OR map* OR imaging)
6. Neuroimag*
7. #2 AND (#3 OR #4 OR #5 OR #6)
8. #1 OR #7
9. Brain death OR brain dead OR brain stem death
10. #8 NOT #9
11. Magnetic resonance imaging AND brain
12. Functional MRI
13. Magnetic resonance imaging AND (cognition OR cognitive OR neuro*)

14. #2 AND (#11 OR #12 OR #13) NOT #8
15. Neuromodulation AND #2
16. Society OR societal
17. #3 AND #16 NOT "neuroscience society"
18. #17 NOT #8

Please note that the Current Contents database and the Citation Indexes do not have subject indexing and do not support the complexity of searching that is available on the other bibliographic databases

Search of selected journal titles

The journals listed in the *Sources Searched* section were searched through the bibliographic databases linked with keywords *neuroscience* or *neuroethic\$*. The journal *Biosocieties* was not available through these databases and was searched through the publisher's website by scanning the contents list of the first and (so far) only issue.

Other sources of information

All other sources of information were searched using simple searches according to the level of complexity supported.

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