

Editorial

## Neuroethics: An emerging new discipline in the study of brain and cognition

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### Abstract

The vision for the special issue in *Brain and Cognition* is rooted in the need to bring to the foreground the state of scientific knowledge in research and clinical neuroimaging ethics. To this end, the issue highlights a broad range of relatively unexplored ethical challenges in functional neuroimaging with MR, alone or in combination with other neuroimaging modalities, from imaging the central nervous system of the fetus in utero through neural activation patterns associated with cognition and behavior in childhood and in adulthood. Theoretical, practical, and ethical considerations at the heart of imaging healthy research subjects and cognitively compromised patients are explored.

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### 1. Introduction

The 1990s represented a decade of profound accomplishment in the neurosciences. Significant strides in understanding basic brain and behavior relationships were made, new approaches for diagnosing and treating relentless neurodegenerative diseases were realized, and revolutionary new capabilities in medical imaging, biotechnology, and genetic medicine were achieved. These same accomplishments have also given rise to thorny moral and ethical quandaries not previously faced by our discipline. From questions concerning new kinds of information about personality, decision-making and emotional judgment, to questions about whether we should grow or harvest stem cells for the benefit of prolonging life in the neurologically ill, a new discipline of “neuroethics” has been born.

This special issue represents a first attempt to bring to the foreground the state of scientific knowledge in biomedical ethics and functional neuroimaging with MRI, only one of, but an important dimension in neuroethics today. The exponential growth of basic and clinical functional magnetic resonance imaging research (Illes, Kirschen, & Gabrieli, 2002) has defined MR technology as one of the most powerful tools in modern

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neuroscience. With functional MRI (fMRI), regional brain activation associated with mental events occurring over a few seconds can be studied noninvasively with a resolution of 1–4 mm. It is faster and less invasive than positron tomography (PET), and although slower than electroencephalography (EEG), it has far greater spatial resolution (see e.g., Moseley & Glover, 1995). Taking functional mapping to yet another level, diffusion tensor imaging (DTI) with MR allows the integrity of white matter tracts to be traced in an unprecedented way. With extraordinary promise, therefore, we are now seeing fMRI studies that probe into our deepest thoughts, define our engagement in complex cognitive behaviors across the lifespan, and provide measures of our ability to make judgments that invoke phenomena like rational decision-making and consciousness. The implications for this are profound, but inasmuch as knowledge may be powerful, runaway uses of this information may impose risks to investigators, patients, and society alike. What are our obligations for informing our research participants about the way that they make decisions consistent with a norm or outside it? How do we manage information about our biologic dispositions to addictive behaviors, aggression, memory loss or dementia? What are the social implications of cognitive profiling on individual employability, the health care system, in law?

To begin to respond to some of these questions, the papers in this special issue are divided equally between ethical challenges in basic research and challenges in applied clinical research: the first six papers cover legal issues in research, incidental findings, safety issues, neurotherapeutics, the potential for microstructural mapping of cognitive function, and neural maps of emotion and personality; the latter six contributions present clinical dilemmas in the fetal and pediatric clinical imaging environments, methodological considerations and responsibilities in adult clinical fMRI, and fMRI in the context of neurodegenerative disease. Many of the authors who have contributed to this special issue have tackled, for the first time, moral dilemmas embodied in their respective areas, drawing fresh perspectives from principles in *bioethics*, a term first coined by Van Rensselaer Potter in 1970 as “*a new discipline that combines biological knowledge with a knowledge of human value systems.*” (as cited in Jonsen, 1998).

## 2. Ethical challenges in neuroimaging research

In the first contribution to the research section, attorney Jennifer Kulynych’s paper, *Legal and Ethical Issues in Neuroimaging Research: Human Subjects Protection, Medical Privacy, and the Communication of Research Results*, rapidly draws our attention to issues of human subjects protections, but beyond the traditional requirements of institutional IRBs. She discusses new issues of privacy under federal medical privacy regulations, addresses responsible communication of research results, and urges neuroimaging researchers to engage in open debate about relevant legal, ethical and policy issues. In the paper by Illes et al., *Ethical and Practical Considerations in Managing Incidental Findings in Functional Magnetic Resonance Imaging*, the largely undescribed problem of incidental neuroradiologic abnormalities in human subjects presumed to be healthy and recruited as healthy controls is explored. The paper discusses the occurrences of neuroradiologic findings in anatomic images obtained for fMRI from children and adults, and examines the practical dilemmas encountered by the field as these abnormalities and potentially even functional abnormalities become exposed.

In counterpart to imaging using magnetic resonance tools, Anand and Hotson’s paper, *Transcranial Magnetic Stimulation: Neurophysiological Applications and Safety*, describes the use of TMS as a means of measuring neural conduction both for independently identifying as well as for validating cortical circuitry defined by imaging methods. Safety is a major factor in the selection and application of this neurotechnology. Taking the potential use of TMS as well as other forms of neurotechnology such as psychopharmaceuticals, brain stimulation, and implantable

brain chips outside the laboratory, medical sociologist Paul Wolpe explores a range of ethical issues that may arise if such technology is adopted for the purpose of enhancing human cognition. Self-perception is a fundamental trait of human nature, and health aids to promote the sense of better than “well” are openly available in the marketplace. Should “how we see ourselves?” ever become the responsibility of society? Should enhancement become a medical benefit if it allows a child to be a better learner or an individual a greater contributor to society? Who decides?

In their paper, *Diffusion Tensor Imaging of Cognitive Performance*, Moseley et al. provide an elegant review of the use of diffusion tensor imaging (DTI)—a method of deriving noninvasive maps of microscopic structural information of oriented tissue in vivo—in studies of human cognition. The water proton diffusion measured by DTI is highly sensitive to subtle disease processes that impair cognitive function and that are not easily imaged with conventional MR.

Reviewing studies from the area of affective, clinical, and forensic neuroimaging, Canli and Amin provide extensive insight into research on the neural basis of emotion and personality. A person’s right to privacy and confidentiality, the tensions between individual autonomy and public safety and between free will and determinism, are at the heart of the ethical debates in this area.

### 3. Ethical issues in applied clinical neuroimaging

The move to the clinical arena begins with two papers that address ethical and imaging issues of the fetus and newborn. Levine describes the evolution of MR imaging for prenatal diagnosis of central nervous system anomalies as an adjunct to conventional sonography. This information may change patient counseling and patient management, but the difficulties of predicting a child’s neurobehavioral future, as Stevenson and Goldworth also describe, extend well beyond the technical ones. How does MRI impact maternal decision-making and fetal outcome? In utero and neonatal MR imaging may create great uncertainties that affect the way people experience pregnancy and make choices about whether to continue a pregnancy or abort a fetus and, with the potential for early labeling of a child, have significant lifelong implications. Terminating a pregnancy or withholding or withdrawing of medical support are among the many issues; akin to potential misuses of genetic testing, could such technology be adapted for the purposes of social engineering?

In *Ethics of Neuroimaging in Pediatric Development*, Hinton provides a detailed review of and critical recommendations for conducting pediatric neuroimaging studies while ensuring ethical treatment of the child. With unique developmental and psychological considerations at hand, the risks and benefit of any procedure and the complexities in interpreting data are at the same time limited and heightened.

Rosen and Gur provide an in depth discussion of the role of the neuropsychologist as a neuroimager. Without any compromise of the scientific and artful skills required by neuropsychologists for thorough evaluation of their patients, neuroimages may provide valuable complementary information for diagnosis. The authors discuss the strengths, limitations, and appropriate domains for the measurements, and the special considerations and protections that must be in place for involving cognitively impaired research participants in these studies.

Desmond and Chen have contributed a key paper on the transfer of research neuroimaging capabilities to the clinical setting and, as in the case of fetal and neonatal imaging, the increasing influence over adult patient care that the technology is likely to have. Factors impacting the interpretation of the methods, issues affecting the validity and interpretation of clinical functional neuroimaging, including effects of altered hemodynamic response function, head motion, and structural changes in the brain, are meticulously reviewed.

Finally, Rosen et al. explore the ethical dilemmas posed by functional imaging studies of Alzheimer's Disease (AD) patients. With an emphasis on fMRI and PET, imaging techniques are compared and contrasted with respect to the manner in which they can be applied to issues of clinical relevance and implications for the impaired AD patient. While functional imaging related to clinical decision-making in frank disease AD are reviewed here, the use of imaging for predicting subclinical disease in asymptomatic or presymptomatic patients does not trail far behind. The implications for the individual, for medicine and for society are profound.

#### 4. Summary

The first specific references to “neuroethics” and neuroethical issues in the literature were made a little over a decade ago, describing the role of the neurologist as a neuroethicist faced with patient care and end-of-life decisions (Cranford, 1989), philosophical perspectives on the brain and the self (Churchland, 1991), and neurophysiological and neuropsychological influences on child-rearing and education (Pontius, 1993). Beyond these writings and the neuroimaging topics raised in this special issue, many other avenues in neuroethics require exploration, discussion, and debate. In May 2002, in fact, a first world conference, *Neuroethics: Mapping the Field*, was held in San Francisco, CA, to chart the future of what has emerged into this new scholarly discipline.<sup>1</sup> Bringing together neuroscientists, scholars in biomedical ethics and the humanities, lawyers, and public policy makers, the conference covered many more aspects of the new discipline, broadly divided into the areas of *brain science and the self*, *brain science and social policy*, *ethics and the practice of brain science*, and *brain science and public discourse*. Among the specific topics, the overlapping role of the scientist as a mentor, discoverer of new information, and as a citizen consumer of this information was also highlighted. Our responsibility to the pursuit of new knowledge is a historical mandate; beyond the *neuro* science, however, with unprecedented capabilities for delving deeper into human thought in health and disease, our ethical responsibilities have reached a broad new level. With the proactive work represented by the authors here, we believe this beginning bodes well for the future of a new discipline devoted to “neuroethics.”

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