

Scholarly Commons @ UNLV Boyd Law

Scholarly Works

Faculty Scholarship

2007

Functional Neuroimaging and the Law: Trends and Directions for Future Scholarship

Stacey A. Tovino

University of Nevada, Las Vegas – William S. Boyd School of Law

Follow this and additional works at: <https://scholars.law.unlv.edu/facpub>



Part of the [Health Law and Policy Commons](#), [Law and Psychology Commons](#), and the [Medical Jurisprudence Commons](#)

Recommended Citation

Tovino, Stacey A., "Functional Neuroimaging and the Law: Trends and Directions for Future Scholarship" (2007). *Scholarly Works*. 77.

<https://scholars.law.unlv.edu/facpub/77>

This Article is brought to you by the Scholarly Commons @ UNLV Boyd Law, an institutional repository administered by the Wiener-Rogers Law Library at the William S. Boyd School of Law. For more information, please contact youngwoo.ban@unlv.edu.

Target Article

Functional Neuroimaging and the Law: Trends and Directions for Future Scholarship

Stacey A. Tovino, Hamline University School of Law

Under the umbrella of the burgeoning neurotransdisciplines, scholars are using the principles and research methodologies of their primary and secondary fields to examine developments in neuroimaging, neuromodulation and psychopharmacology. The path for advanced scholarship at the intersection of law and neuroscience may clear if work across the disciplines is collected and reviewed and outstanding and debated issues are identified and clarified. In this article, I organize, examine and refine a narrow class of the burgeoning neurotransdiscipline scholarship; that is, scholarship at the interface of law and functional magnetic resonance imaging (fMRI).

Keywords: neuroethics, neuroimaging, fMRI, brain, thoughts, law

Scholarship exploring the ethical, legal and social implications of advances in neuroscience comes in many forms. Under the umbrella of the burgeoning neurotransdisciplines, including neuroethics, neuroeconomics and neuropolitics, clinicians, investigators, lawyers, ethicists, economists, social scientists, and humanists are using the principles and research methodologies of their primary and secondary fields to examine developments in neuroimaging, neuromodulation, and psychopharmacology. Their work product is published in a variety of fora, including medical and scientific journals, law reviews, bioethics and other interdisciplinary journals, social science and humanities journals, stand-alone texts, edited collections, journal symposia, weekly and monthly periodicals, and daily newspapers. The path for advanced scholarship at the intersection of law and neuroscience may clear if work across the disciplines is collected and reviewed and outstanding and debated issues are identified and clarified. In this article, I organize, examine and refine the issues raised within a narrow class of the burgeoning neurotransdiscipline scholarship; that is, scholarship at the interface of law and functional magnetic resonance imaging (fMRI).

Now in its second decade, fMRI localizes changes in blood oxygenation that occur in the brain when an individual performs a mental task (Illes and Racine 2005). Physicians and scientists use fMRI not only to map sensory, motor, and cognitive function, but also to study the neural correlates of a range of physical and mental health conditions, behaviors, preferences, and characteristics (Le Bihan et al. 1995; Brown and Eyler 2006). Functional MRI raises a number of important legal issues due to its recent move outside

the clinical and research contexts (Garland 2004; Zeki and Goodenough 2006).

Spurred by the increasing complexity of the law, many lawyers and law professors practice and teach in highly specialized areas. As a former regulatory health lawyer and current teacher of health law, I can attempt to apply traditional health law principles to advances in fMRI. But the legal issues raised by functional neuroimaging extend far beyond the law of physician–patient relationships, confidentiality and privacy, and research ethics. By fine-tuning the legal issues raised by fMRI, I hope to receive commentary from individuals with expertise not only in health law, but also areas not traditionally linked with health law, including property law, intellectual property, tort law, truth-in-advertising and consumer law, the First Amendment, criminal procedure, employment and disability law, and evidence. Because many of the statutes, regulations and common law principles discussed in this essay incorporate medical and scientific concepts and terminology, the perspectives of clinicians and investigators also are needed.

A note of limitation: This essay responds to a call made at the second annual Neuroethics Affinity Group meeting at the 2006 American Society for Bioethics and Humanities (Denver, CO; October 26–29, 2006) annual meeting for a review of the literature at the interface of law and functional magnetic resonance imaging. As such, this essay does not address the legal issues raised by other advances in neuroscience, including neurosurgery and psychopharmacology, or non-legal issues raised by advances in functional neuroimaging. Some of the legal issues omitted from this essay may come to be the most important legal issues

Received January 2, 2007; accepted April 17, 2007.

Address correspondence to Stacey A. Tovino, J.D., Ph.D., Health Law Institute, Hamline University School of Law, 1536 Hewitt Avenue, Saint Paul, MN 55104. E-mail: stovino01@gw.hamline.edu

raised by functional neuroimaging. The questions posed in this essay also must be revisited as fMRI technology advances, as organizations that offer commercial fMRI services continue to develop their products and marketing materials, and as courts, legislatures, and regulatory agencies respond to advances in neuroscience. Finally, I want to be clear that I am not saying that the current or future uses of functional neuroimaging technology identified in this essay are appropriate; however, given that these uses have been proposed by others, now is the time to examine them.

PROPERTY AND INTELLECTUAL PROPERTY LAW

Property may not be the first area of the law that comes to mind when thinking about advances in functional neuroimaging, but recent scholarship (Clifford 2005; Greely 2004; Stake 2006) suggests several interesting applications.

One traditional view of property is its dependency on the law for its existence. Jeremy Bentham in 1802 stated: "there is no such thing as natural property: it is entirely the creature of the law. . . . Property and law were born together, and would die together. Before the laws property did not exist; take away the law and property will be no more" (Bentham 1802 [1914], 145–147). In recent scholarship, Jeffrey Evans Stake proposes an alternative possibility, which is that fundamental principles of property preceded formal institutions and might be encoded in the human brain (Stake 2006, 185).

One common law property concept is 'first in time, first in right,' which is the notion that the first individual to possess a thing owns it (Stake 2006, 187). A second property concept involves possession, which is said to require both physical control and intent to assert control (Stake 2006, 188). A third concept is adverse possession, which involves the reallocation of legal title from the record title holder to the current possessor without the consent of the record title holder (Stake 2006, 191).

One question is whether neuroscience in general, or neuroimaging in particular, can or could provide insight into these and other property rules. Are fundamental principles of property encoded in the human brain? Can or could functional neuroimaging reveal the neural correlates of behaviors that follow from these principles? If so, is the property instinct nothing more than a natural inclination to learn the rules that other humans used to resolve coordination problems inherent in resource disputes (Stake 2006, 186)? Or, is the ability to recognize and adhere to specific conventions part of our behavioral repertoire (Stake 2006, 186)? Do we have a natural feeling that we can transfer things to other people (Stake 2006, 186, 190–191)? What about a natural instinct of how to transfer or dispose of property (Stake 2006, 186, 193)? Can the recognition of a deep property structure, akin to a deep language structure, assist in understanding the rules of property and applying them to new situations (Stake 2006, 187, 201)?

Moving beyond traditional property law, scholars have identified several intellectual property implications of ad-

vances in functional neuroimaging (Greely 2004). For example, can the first person to make a particular use of functional neuroimaging technology patent that use even without owning a patent on the MRI machine itself (Greely 2004)? Can a person patent a particular blood-oxygenation-level-dependent (BOLD) signal based on the claim that the BOLD response could be used to diagnose or predict a particular physical or mental health condition, behavior, preference or characteristic (Greely 2004)? Or, is there no "composition of matter"—no structure or molecule in BOLD activity—that can be patented (Greely 2004)? Finally, how does the 1996 Ganske-Frist amendment, which exempts certain health care entities from liability for infringing a patent during the performance of a medical activity, apply to BOLD signals (Greely 2004)? For example, if an individual claimed a patent in the use of a particular BOLD response to diagnose a particular physical or mental health condition, would a physician who uses those signals be exempted from liability (Greely 2004)?

Moving from patent to copyright issues, recent studies suggests that creative thoughts may result not from a startling breakthrough of new thought but, instead, from the reworking of preexisting ideas and facts as part of a new strange attractor within the brain (or, even, chance, noise or an error within the brain) (Clifford 2005, 271–279, 290). The copyright question becomes whether the copyright requirement for "creativity," or a "creative spark," within the expressive elements of a work are valid given what science may show about how creative thought actually occurs (Clifford 2005). If not, should we adopt a new test for determining whether there is sufficient evidence of creativity in a work to grant a copyright (Clifford 2005)?

TORT LAW

Torts are civil wrongs committed against persons or property other than breach of contract. Given that pain and suffering damages can account for a significant portion of personal damage awards in tort cases (McCaffrey et al. 1995), the ability to prove or measure pain and suffering (or the lack thereof) could be invaluable. In the past decade, several groups of scientists have used functional neuroimaging technology in an attempt to better understand the neural correlates of physical pain (Coghill et al. 1999; Coghill et al. 2003; Moulton et al. 2005; Peyron et al. 2000; Porro et al. 1998; Porro 2003). In some of these studies, scientists have found significantly greater activations in certain areas of the brain when subjects are exposed to painful stimuli, as well as a correlation between the amount of brain activation and the intensity of the painful stimulus (Coghill et al. 1999; Coghill et al. 2003; Porro et al. 1998; Porro 2003; Rainville 1997).

In response to these findings, at least one scholar has begun to explore the role functional neuroimaging may play in the legal evaluation of physical pain (Kolber 2007). Two threshold questions are whether plaintiffs will attempt to use neuroimaging technology to bolster their tort claims if they otherwise lack proof of their physical pain and suffering, and whether defendants will attempt to use the

technology to impugn the claims of those who may be exaggerating their physical pain and suffering (Kolber 2007). If so, will functional neuroimaging provide increasingly objective methods of assessing the severity of an individual's pain (Kolber 2007)? Stated another way, will functional neuroimaging continue to move us away from a first-person narrative approach to pain complaints and proof of pain, and towards more objective methods of pain proof in torts cases? Or, will functional neuroimaging be subject to the same subjective limitations as are patients' verbal expressions of pain?

In addition to studies of the brain activations of individuals who are exposed to physically painful stimuli, such as burn pain, other studies are focusing on the neural correlates of emotional pain (Eisenberger et al. 2003; Eisenberger and Lieberman 2004; Eisenberger 2006; Ochsner et al. 2005). These studies have prompted at least one scholar to examine the role functional neuroimaging may play in the evaluation of particular torts that are based on emotional pain, such as negligent infliction of emotional distress (Grey 2007). Not recognized at common law and still distrusted by many courts, this tort has an objective element (would the situation distress a reasonable person?) and a subjective element (did the situation actually distress the particular claimant?) (Grey 2007). Critics of the tort worry that some claimants can feign their emotional distress and that courts will not be able to quantify the distress of those claimants who truly are distressed (Grey 2007).

One legal question is whether neuroimaging might be able to contribute to either the objective or subjective elements of a plaintiff's negligent infliction of emotional distress claim (Grey 2007). If so, will the likely absence of a baseline—a scan taken of the plaintiff's brain prior to the traumatic event—be fatal to the plaintiff's claim? (Grey 2007). If neuroscientific evidence is accepted as tangible proof of a plaintiff's otherwise intangible distress, will that end the courts' distrust of the tort? (Grey 2007). Or, will courts find another reason to be skeptical of negligent infliction of emotional distress?

To turn the tables, what if a tort claimant *fails* to introduce potentially relevant functional neuroimaging evidence? Could such a failure be fatal to her tort claim? In *In re Aircrash at Little Rock*, the United States Court of Appeals for the Eighth Circuit suggested that the plaintiff's medical expert *should* have ordered a positron emission tomography or single photon emission computed tomography scan of the plaintiff's brain to succeed in his argument that the plaintiff's post-traumatic stress disorder caused physical injury to her brain: "[The plaintiff] was not given a magnetic resonance spectroscopy, a positron emission tomography (PET) scan or a single positron [sic] emission computed tomography (SPECT) scan, all tests which... could have been utilized to show the functioning of [her] brain" (2002, 507, 511).

TRUTH-IN-ADVERTISING AND CONSUMER LAW

The association between attempted deception and BOLD signal in the executive brain regions, as well as the potential

uses of these findings in commercial and forensic practice, has received significant attention in both the scientific and popular literature (Mandavilli 2006; Spence 2006; Wild 2005; Willing 2006). Early speculation that fMRI could be used as a commercial lie detector (Moreno 2003, 152) proved not so speculative last year, when one organization began using the Internet to market its fMRI lie detection and other services directly to individuals, employers, corporations, lawyers, investors, and federal, state and international governments (No Lie MRI 2006a–f), and a second organization stated a more cautious intention to offer its commercial fMRI services as soon as its product meets its own internally established scientific standards (Cephos 2006).

The extent to which individuals and organizations actually purchase these commercial brain-scanning services is unknown. However, a continuing issue is whether these brain scans provide valuable information that could assist with personal and organizational decision-making, or whether the offering of these tests is premature and misleading to the public (Mandavilli 2006). Restated as a legal question, the issue is whether the web materials of the organization that is currently offering these services are truthful, fair, non-deceptive and non-misleading, and whether they have evidence backing their claims, as is required by laws such as the Federal Trade Commission Act, state deceptive and unlawful trade practices acts, state false statement in advertising acts, and state prevention of consumer fraud acts (15 U.S.C. § 41–58; Minnesota False Statement in Advertising Act, Minn. Stat. §§ 325F.67, Minnesota Prevention of Consumer Fraud Act, 325F.69, Minnesota Unlawful Trade Practices Act, 325D.09–16; Tovino 2007). Here, the input of scholars with expertise in consumer law is needed.

One company currently offering fMRI services to the public states on its website that fMRI is the "first and only direct measurement of truth verification and lie detection in human history" (No Lie MRI 2006a). This statement presumably is meant to distinguish polygraph, which measures a response of the peripheral nervous system, from fMRI, which involves the central nervous system. But is it fair to state that fMRI is a direct measurement of truth verification given that fMRI uses BOLD signal as a proxy for neuronal activity and usually is referred to as an indirect measure of neuronal activity (NIH 2001)? Or, is it good enough that BOLD signal has been found to be a "close approximation," or a "faithful signal," of neuronal activity (NIH 2001)? Or, would these descriptions be considered non-material because they likely would not affect a reasonable consumer's decision to purchase an fMRI test? Or, does the complexity of the science behind fMRI give these companies some legal grace in describing their tests to the public?

One company states that its fMRI tests are "fully automated" and "[o]bserver independent (objective)" (No Lie MRI 2006d). The catch here is that the concept of objective fMRI testing runs counter to the subjective traits attributed to fMRI in the popular literature. In the past two years, observers have referred to fMRI as an "interpretive practice," noting that, "Sometimes, the difference between seeing higher activity in the parietal lobe compared to the

occipital lobe is akin to deciding whether Van Gogh or Matisse is the more colorful artist" (Jaffee 2004, 64) and that, "What constitutes a 'significantly greater' activation is, in a way, in the eye of the beholder" (Donaldson 2004, 442). So, is fMRI testing an objective or subjective activity, or is it both? Does it depend on how the fMRI test is designed? To clarify the legal question, is it truthful, fair, non-deceptive and non-misleading to state that an fMRI test is objective and fully automated? Or, does the complexity of fMRI again require legal grace?

One company's web materials states that fMRI has "potential applications to a wide variety of concerns held by individual citizens [including] risk reduction in dating[,] Trust issues in interpersonal relationships[, and] issues concerning the underlying topics of sex, power, and money" (No Lie MRI 2006c). Employers are informed that fMRI testing "could potentially substitute for drug screenings, resume validation, and security background checks. Not only would this significantly streamline and speed up the hiring process, it would also reduce the costs associated with hiring a new employee. It would be expected to result in a more honest employee base" (No Lie MRI 2006b). Insurance companies are informed that fMRI "truth verification could significantly diminish insurance fraud and result[.] in lowering of premiums for their clients" (No Lie MRI 2006b). Governments are informed that, "accurate lie detection would be of tremendous benefit for rooting out corrupt individuals" (No Lie MRI 2006f). The accuracy of fMRI testing also is featured prominently in these web materials. According to one representation, "Current accuracy is over 90% and is estimated to be 99% once product development is complete" (No Lie MRI 2006d). The company links to a host of scientific studies that appear to back its claims (No Lie MRI 2006e).

So, is fMRI really capable of these claims? If the answer is "not right now," do the words "potential," "potentially," and "could" in the previous quotations sufficiently qualify them? Given that "[i]maging is at present very expensive and requires carefully chosen and cooperative subjects" (Morse 2006a, 403), is it truthful, fair, non-misleading and non-deceptive to state that fMRI could be used in the dating, employment, insurance and criminal contexts—contexts in which subjects may have an incentive not to carry out the assigned mental tasks? Or, are these companies harmless victims of "brain overclaim syndrome," a newly diagnosed syndrome characterized by making claims about the implications of neuroscience that cannot be conceptually or empirically sustained (Morse 2006a)? Straying momentarily from the legal to the normative, what about the urgency with which other scientists have spoken out about not putting fMRI to social, commercial, and criminal use (Mandavilli 2006, 664)?

HEALTH LAW: CONFIDENTIALITY AND PRIVACY

Although the scope, content and direction of the field of health law continues to be debated (Elhauge 2006; Greely 2006d; Hall 2006; Hall et al., 2006), many would agree that

the confidentiality of health information and the privacy of patients and research subjects are topics that fall within this field.

The confidentiality and privacy issues raised by advances in functional neuroimaging were recognized early and are discussed often (Caplan 2002; Committee on Science and Law 2005; Farah and Wolpe 2004; Farah 2006, 36; Greely 2004; Greely 2006c; Illes 2003; Kulynych 2002; Kulynych In Press; Tovino 2005; Tovino 2006; Tovino In press). These authors almost uniformly agree that the ability of functional neuroimaging to reveal the neural correlates of conditions, behaviors, preferences, and characteristics, some or all of which individuals may prefer to keep secret, "threatens to invade a last inviolate area of 'self'" (Greely 2006c, 253). These concerns have, not surprisingly, been coined "neuro-privacy" (Committee on Science and Law 2005, 407).

In examining the confidentiality and privacy issues raised by fMRI, the literature has carefully applied the health information confidentiality protections within the Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy Rule, the federal Common Rule, Public Health Service provisions establishing certificates of confidentiality, state statutes and regulations, and the common law privacy torts (intrusion, disclosure, false light, and appropriation) to a variety of possible uses and disclosures of fMRI scans and neuroimaging data, including the disclosure of raw neuroimaging data to neuroimaging databanks (Committee on Science and Law 2005; Greely 2004; Kulynych 2002; Kulynych In press; Tovino 2005; Tovino 2006; Tovino In press). The literature also has identified how certain uses and disclosures of functional neuroimaging information may fall within statutory, regulatory and common law exceptions to the duty of confidentiality. These exceptions relate to uses and disclosures of functional neuroimaging information for activities required by law, public health activities, health oversight activities, judicial and administrative proceedings, law enforcement activities, research activities, situations involving serious threats to health and safety, national security and intelligence activities, and other specialized government functions (Greely 2004; Tovino In press). The literature suggests that there are gaps in confidentiality protections for functional neuroimaging information and privacy protections for individuals whose brains are scanned (Caplan 2002, 99; Committee on Science and Law 2005; Greely 2004; Kulynych In press; Tovino 2005; Tovino In press). Among other gaps, including the fact that the HIPAA Privacy Rule will not apply to all of the individuals and organizations who are using fMRI, the HIPAA Privacy Rule and other health information confidentiality provisions generally permit employers and insurance companies to obtain health information, including functional neuroimaging information, pursuant to voluntary or compelled authorizations (45 C.F.R. § 164.508(b)(4)(ii) and (iii); Tovino 2006; Tovino In press).

The million-dollar question identified in this literature is whether functional neuroimaging information requires special, or heightened, confidentiality and privacy protections (Committee on Science and Law 2005; Greely

2004; Tovino 2005; Tovino In press). The idea that HIV and AIDS test results and genetic information require special, or heightened, confidentiality and privacy protections has been known as "HIV exceptionalism" and "genetic exceptionalism," respectively. The question thus becomes whether a third generation of exceptionalism—"neuro[imaging]exceptionalism" (Schick 2005)—should be implemented. Some have suggested that the answer is 'yes' (Committee on Science and Law 2005, 435).

In examining this question, the literature has evaluated the reasons both for and against exceptional confidentiality and privacy provisions. These include the existence of special or heightened confidentiality protections for other types of sensitive information, including alcohol and drug abuse treatment records, psychotherapy notes, mental health records, HIV and AIDS test results, and genetic information (Greely 2004; Tovino 2006; Tovino In press); the existence of state genetic discrimination legislation in health insurance, employment, and life insurance (Greely 2004); the existence of ethical provisions addressing the disclosure of genetic information to insurers and law enforcement agencies (AMA 2006a and b); the possible predictive value of some functional neuroimaging information (Greely 2004); the sensitive and potentially stigmatizing nature of some functional neuroimaging information (Greely 2004; Tovino 2005; Tovino 2006; Tovino In press); the fact that functional neuroimaging information may not now (although it could in the future) carry a stigma like genetic information (Greely 2004; Tovino 2006; Tovino In press); the fact that the public may not now (although it could in the future) regard functional neuroimaging information as unique (Greely 2004; Tovino 2006; Tovino In press); and the fact that brain scans, unlike genetic information, may be able to be separated from the rest of the medical or study record with relative ease (Greely 2004; Tovino 2006; Tovino In press). The literature suggests that some, but not all, of the reasons given for HIV and genetic exceptionalism apply in the context of functional neuroimaging. The literature also suggests, however, that some, but not all, of the criticisms of HIV and genetic exceptionalism also apply in the context of functional neuroimaging.

To refine the legal question, should a federal or state legislature or administrative agency adopt neuro-exceptional confidentiality provisions, defined as provisions that would make it more difficult for folks like physicians and scientists to use and disclose functional neuroimaging information compared to other health information? Or, should a federal or state legislature or administrative agency adopt neuro-exceptional privacy provisions, defined as provisions that would make it more difficult for organizations such as employers and insurers to obtain neuroimaging information about an individual for use in underwriting and employment decision making? If so, how would we define the neuroimaging information that would receive special protection? Would it include just the brain scans? Or, do we need to protect the related interpretation and reports too? And, what types of neuroimages would be protected? Just fMRI scans? What about positron emission tomography scans and single-photon emission computed tomography scans?

Or, should a federal or state legislature or administrative agency adopt generic (non-neuro exceptional) privacy provisions, defined as provisions that would make it more difficult for organizations such as employers and insurers to obtain or use any type of health information, including functional neuroimaging information, about an individual for particular purposes, whether it be non-job-related purposes, job-related purposes, underwriting and enrollment purposes, etc (Tovino In press). Along these lines, a law professor and a scientist already have jointly proposed that the federal government (or, barring the federal government, the state governments) should ban *any* non-research use of new methods of lie detection, including fMRI-based lie detection, unless or until the new method has been proven safe and effective to the satisfaction of a regulatory agency and has been vetted through the peer-reviewed scientific literature (Greely and Illes In press).

EMPLOYMENT LAW

There has been considerable speculation that employers will want to use fMRI to probe the minds of job applicants and current employees to determine whether to hire or maintain them (Foster 2003, 34; Green 2005, 54; Moreno 2003, 152). Given that one company currently is marketing its brain scanning services directly to employers (No Lie MRI 2006b), the legal question becomes whether fMRI violates applicants' and employees' interest in avoiding unwanted neurological intrusions or whether employers are permitted to obtain functional neuroimaging information about their applicants and employees (Tovino In press).

One potential source of privacy rights for employees and job applicants is Title I of the federal Americans with Disabilities Act (ADA) (Tovino 2005; Tovino In press). As one way of preventing disability discrimination, Title I regulates covered employers' use of qualification standards, employment tests and other selection criteria that screen out or tend to screen out individuals with disabilities on the basis of such disabilities (42 U.S.C. § 12112(b)(6) (2005); 29 C.F.R. § 1630.10). One specific legal question is whether functional neuroimaging has the potential to identify a disability, thus enabling an employer to screen out an individual based on that disability.

Equal Employment Opportunity Commission (EEOC) regulations interpreting Title I define *disability* to include physical and mental impairments, including neurological disorders, mental illnesses, and specific learning disabilities, that substantially limit one or more major life activities of an individual (29 C.F.R. §1630.2(g)). EEOC regulations also clarify, however, that pedophilia, pyromania, kleptomania, compulsive gambling, homosexuality, bisexuality, transvestism, transsexualism, exhibitionism and voyeurism, as well as certain other physical, psychological, environmental, cultural and economic characteristics, including "common personality traits such as poor judgment or quick temper," do not constitute disabilities protected by the ADA (29 C.F.R. § 1630.3(d)(1), 1630.3(d)(2), 1630.3(e); Appendix to 29 C.F.R. Part 1630 (identifying additional characteristics that do not constitute disabilities

under the ADA). So, does that mean that the ADA's screening provisions would regulate a covered employer's use of fMRI test results in an attempt to screen out individuals who have depression, schizophrenia or bipolar disorder if such conditions substantially limit a major life activity of the individuals tested? Would the screening provisions not regulate employer attempts to screen out individuals based on fMRI "findings" of pedophilia, compulsive gambling, or homosexuality because these qualities do not constitute impairments or disabilities?

Title I of the ADA also regulates the conduct and timing of medical examinations and related inquiries (42 U.S.C. § 12112(d); 29 C.F.R. §§ 1630.13-14). A medical examination is defined as a procedure or test that seeks information about an individual's health or physical or mental impairments (EEOC 1995, 10). Although a number of factors are relevant in determining whether a procedure or test is a medical examination, the EEOC clarifies that the term includes tests that provide evidence leading to the identification of conditions listed in the most recent *Diagnostic and Statistical Manual of Mental Disorders, DSM-IV-TR, Fourth Edition Text Revision* (American Psychiatric Association 2000), including anxiety, depression and certain compulsive disorders, all of which have been studied by fMRI. The EEOC also affirmatively states that medical examinations include "diagnostic procedures such as . . . magnetic resonance imaging (MRI)" (EEOC 2000). The EEOC further clarifies, however, that psychological tests designed and used only to measure honesty, tastes and habits are not medical examinations (EEOC 1995). The question becomes how the ADA's rules regarding medical examinations (which differ at the pre-employment, pre-placement and employment stages) will regulate an employer's use of a particular fMRI test. The answer appears to hinge on the evidence the test will provide. But can an fMRI test designed to elicit evidence of honesty or deception also elicit evidence of a mental disorder such as schizophrenia and pedophilia? If so, would the test be a medical examination or not?

Another employment issue addressed in the literature is whether the use of fMRI as a lie detector would be regulated by the Employee Polygraph Protection Act (EPPA) (Committee on Science and Law 2005; Greely 2005). The EPPA prohibits some, but not all, employers from requiring employees to submit to lie-detector tests, defined to include polygraphs, deception graphs, voice stress analyzers, psychological stress evaluators, and "any other similar device . . . that is used, or the results of which are used, for the purpose of rendering a diagnostic opinion regarding the honesty or dishonesty of an individual" (29 U.S.C. §§ 2002(1), 2001(3)). The specific legal question is whether fMRI is a device that is used, or the results of which are used, for the purpose of rendering a diagnostic opinion regarding the honesty or dishonesty of an individual. The early answer from the law literature seems to want to be 'yes' (Committee on Science and Law 2005), although one company that offers fMRI services to employers would not agree: "U.S. law prohibits truth verification/lie detection testing for employees that is based on measuring the autonomic nervous system (e.g. polygraph

testing). No Lie MRI measures the central nervous system directly and such is not subject to restriction by these laws" (No Lie MRI 2006b).

FIRST AMENDMENT

The United States Department of Defense and the Central Intelligence Agency (CIA) reportedly have invested millions of dollars in neuroimaging technologies that might be used in law enforcement and intelligence, with a particular emphasis on brain scans that might be used to identify terrorists (Olson 2005, 1549). The Pentagon's Defense Advanced Research Projects Agency (DARPA) (Arlington, VA) reportedly has funded research at Lockheed Martin (Bethesda, MA) and Rutgers University (Camden, NJ) relating to "remote brain prints" as well as research by an Oregon organization relating to the creation of brain sensors that would detect, transmit, and reconstruct certain brain signals (Moreno 2005, 52). A broad legal question suggested by these developments is how the United States Constitution and analogous state provisions might constrain a government actor's use of fMRI to probe an individual's brain (Boire 2005; Glenn 2005; Greely 2006; Tovino 2006). More specific legal questions can be analyzed under the First, Fourth and Fifth Amendments.

Perhaps best known for its express rights of freedom of speech and press, the First Amendment also protects other, lesser-known but related interests, such as the interest of political groups and social organizations in holding physically private meetings and in maintaining the privacy of their membership lists, as well as the interest of individuals in reading books and watching movies in their own homes, regardless of the content of such books or films. These protections stem from the Supreme Court's recognition that the First Amendment protects "freedom of thought and solitude in the home" or, more generally, "privacy of thought" (Allen 2002, 92). In *Stanley v. Georgia*, its seminal "privacy of thought" case, the Supreme Court stated that, "also fundamental is the right to be free, except in very limited circumstances, from unwanted governmental intrusions into one's privacy" (Glenn 2006, 61).

The privacy of thought references in *Stanley v. Georgia* do not stand on their own. A plurality of the Court found in *Board of Education v. Pico* that the First Amendment is broad enough to encompass additional rights not enumerated in its terms, including a "right to receive information and ideas" (867). Justice Cardozo stated in *Palko v. Connecticut* that, "freedom of thought . . . is the matrix, the indispensable condition, of nearly every other form of freedom" (Glenn 2005, 61; *Palko* 1937, 326-327). The Supreme Court stated in *West Virginia State Board of Education v. Barnette* that the First Amendment gives a constitutional preference for "individual freedom of mind" over "officially disciplined uniformity for which history indicates a disappointing and disastrous end" (Glenn 2005, 61; *West Virginia* 1943, 637) and, in *Jones v. Opelika* that, "[f]reedom to think is absolute of its own nature; the most tyrannical government is powerless to control the inward workings of the mind" (618).

In his concurrence in *United States v. Reidel*, Justice Harlan found that the First Amendment protects the right of the individual "to be free from governmental programs of thought control, however such programs might be justified in terms of permissible state objectives," and to be free "from governmental manipulation of the content of a man's mind . . ." (359). In *Aboud v. Detroit Board of Education*, the Supreme Court stated that, "freedom of belief is no incidental or secondary aspect of the First Amendment's protections . . . [A]t the heart of the First Amendment, is the notion that an individual should be free to believe as he will, and that in a free society one's beliefs should be shaped by his mind and his conscience rather than coerced by the State" (234–235). And, almost four years ago, the Supreme Court stated in *Lawrence v. Texas*, the Lone Star State's anti-sodomy law case, that, "Liberty presumes an autonomy of self that includes freedom of thought, belief, expression, and certain intimate conduct" (*Lawrence* 2003, 562; Glenn 2006, 61).

Although political groups and social organizations have successfully invoked the protections of the First Amendment in order to hold closed meetings and keep from public disclosure their membership lists, a specific legal question for those with First Amendment expertise is whether individuals who may in the future be required, ordered or requested by a government actor to submit to fMRI to detect a particular condition, thought pattern, behavior, preference, or characteristic successfully could invoke the concept of "privacy of thought" as a ground for refusing to submit to the fMRI (Boire 1999–2000; Glenn 2005). Or, do the "privacy of thought" principles announced in these Supreme Court cases only apply to prohibit governmental interference with activities such as closed meetings, book reading and movie watching within the home, and homosexual activity? Does it matter that the government may only be imaging, but not interfering, with such thoughts? Would the answer change if the government attempted to intervene, change or penalize such thoughts? The literature frames these questions more broadly as "cognitive privacy," "cognitive liberty," and sometimes "cognitive freedom" questions (Boire 1999–2000; Glenn 2005; Wolpe et al., 2005).

FIFTH AMENDMENT

I will move past the Fourth Amendment, but just for a moment. The Fifth Amendment to the United States Constitution prohibits a person from being compelled in any criminal case to be a witness against herself. The Fifth Amendment's privilege—better known as the privilege against self-incrimination—has been broadly interpreted to protect criminal suspects and defendants from having to take the stand or testify in grand jury proceedings and criminal trials. The privilege also has been interpreted to protect suspects during informal proceedings, such as custodial interrogations. In its 1966 opinion in *Miranda v. Arizona*, the Supreme Court recognized the Fifth Amendment as "a substantive right, a 'right to private enclave where he may lead a private

life. That right is the hallmark of our democracy'" (460). The *Miranda* Court further explained that, "[T]o respect the inviolability of the human personality, our accusatory system of criminal justice demands that the government seeking to punish an individual produce the evidence against him by its own independent labors, rather than by the cruel, simple expedient of compelling it from his own mouth" (460). *Miranda* concluded that the privilege against self-incrimination is fulfilled "only when the person is guaranteed the right 'to remain silent unless he chooses to speak in the unfettered exercise of his own will'" (460).

A specific question for those with expertise in criminal procedure is whether the Fifth Amendment might prohibit government-imposed fMRI scans of criminal suspects and defendants if the scans are interpreted to reveal incriminating evidence (Glenn 2005, 61; Greely 2006c, 254; Stoller and Wolpe In press; Thompson In press). Stated another way, does the right to remain silent, or the right not to speak, also include the right not to reveal one's incriminating conditions, thoughts, and behaviors through fMRI? At first glance, *Miranda's* broad "all settings" language ("there can be no doubt that the Fifth Amendment . . . serves to protect persons in all settings . . . from being compelled to incriminate themselves" [467]), as well as similarly broad language in *West Virginia State Board of Education v. Barnette* ("The right of freedom of thought and of religion as guaranteed by the Constitution against State action includes both the right to speak freely and the right to refrain from speaking at all. . ." [645]) would seem to support an affirmative answer to this question (Glenn 2005, 61).

But a follow-up question is whether the results of some functional neuroimaging examinations will survive the *Schmerber v. California* "testimonial or communicative evidence" limitation on the Fifth Amendment (Stoller and Wolpe In press; Thompson In press). In *Schmerber*, a physician acting under police direction took a blood sample from defendant Schmerber, who had been arrested for driving while intoxicated (DWI), for purposes of measuring Schmerber's blood-alcohol content. The government attempted to introduce the blood test result into evidence during the DWI proceeding, but Schmerber argued that the involuntary blood test violated his Fifth Amendment right against self-incrimination. A five-Justice majority of the Supreme Court disagreed, reasoning that the Fifth Amendment only protects against the compulsion of "testimonial" or "communications," not against a "compulsion which makes a suspect or accused the source of 'real or physical evidence'" (764). The Supreme Court acknowledged that the line between testimonial and physical evidence might not always be easy to draw. For example, "Some tests seemingly directed to obtain 'physical evidence,' for example, lie detector tests measuring changes in body functions during interrogation, may actually be directed to eliciting responses which are actually testimonial" (764). The Supreme Court further stated that, "To compel a person to submit to testing in which an effort will be made to determine his guilt or innocence on the basis of physiological responses, whether willed or not,

is to evoke the spirit and history of the Fifth Amendment" (764). The majority clarified, however, that the defendant's blood test, which was taken to determine intoxication, did not yield "even a shadow of testimonial compulsion upon or enforced communication by the accused" (765).

A four-Justice minority in *Schmerber* disagreed on the basis that blood involuntarily extracted is indeed "communicative" and obviously self-incriminatory (777). The minority reasoned that a person's private papers and diaries, which would be protected by the Fifth Amendment as testimony or communications, are no more revealing than a person's blood, and therefore that the privilege against self-incrimination should apply equally to a person's blood (777).

The majority opinion in *Schmerber* has been applied to find the privilege against self-incrimination inapplicable to urinalysis testing designed to determine intoxication, a mental examination of a defendant accused of murder, a stomach radiograph of a defendant accused of stealing (and swallowing) a ring, fingerprints, and a neutron activation test to determine the presence of gunpowder residue, as well as numerous other photographs, measurements, physical movements, handwriting analyses, and even examinations by ultraviolet light (Shipley 2005, 1407). With these holdings must be compared the *Schmerber* majority's clarification that lie detector tests, although measuring changes in body functions during interrogation, actually are designed to elicit testimonial responses.

To fine-tune the legal issue, the question is whether fMRI is more like testimonial and communicative evidence (and evidence elicited from lie-detector tests), or is a better analogy to blood tests, urinalysis testing, mental examinations, stomach radiographs, fingerprints, or neutron activation tests? Will the answer depend on the fMRI test and the information the test is designed to elicit? For example, if a government actor uses fMRI in an attempt to detect the deception of a criminal suspect, would the evidence be considered "testimonial or communicative" evidence in accordance with the *Schmerber* majority clarification relating to lie detector tests? Likewise, if a government actor uses fMRI in an attempt to detect a mental health condition or disorder such as Alzheimer's disease, schizophrenia or pedophilia (Fallon 2007), would the fMRI evidence be considered "real or physical" evidence not protected by the Fifth Amendment?

Or, is the testimonial versus communicative evidence approach to functional neuroimaging all wrong? (Thompson In press). Perhaps a better approach is to apply the Fifth Amendment's Due Process Clause's "shocks the conscience test," pursuant to which a government action is a violation of substantive due process if it shocks the conscience (Thompson In press). Stated another way, is a government-imposed fMRI that involuntarily extracts information from unwilling subjects contrary to the common law tradition and the fundamental concerns of Western polities, in part because it comes closer to mind reading than any other modern technology? (Thompson In press).

FOURTH AMENDMENT

The Fourth Amendment implications of functional neuroimaging have been introduced in the literature (Boire 2005, 62–63; Greely 2004; Greely 2006c, 254; Wolpe 2004, 1897). These issues can be phrased in terms of whether the Fourth Amendment protects an individual's interest in maintaining the privacy of her thoughts, or whether the government can "search and seize" those thoughts. Stated another way, when can an individual succeed in arguing that a government-ordered fMRI scan must be excluded from evidence as the product of an unlawful search and seizure?

An initial legal question is, of course, whether a functional brain scan constitutes a search of the person, thus implicating the Fourth Amendment. The initial literature seems to want to answer this question in the affirmative (Boire 2005, 62). Does the answer depend on the fMRI test or the information the test is designed to elicit? Or, would all government-ordered functional neuroimaging tests constitute searches?

A second question relates to how the Fourth Amendment would regulate the imposition of any functional brain scans that are determined to be searches. The Fourth Amendment's proper function "is to constrain, not against all intrusions as such, but against intrusions which are not justified in the circumstances, or which are made in an improper manner" (*Schmerber* 1966, 768). In criminal investigations, the Fourth Amendment has been interpreted to require police to obtain a search warrant to search areas in which the suspect has a reasonable expectation of privacy, including intrusions in the body (*Winston* 1986, 753). In other, "special needs," cases, the legality of a search may be reviewed according to a balancing test that weighs the government's interest in the search against the individual's privacy interests (*U.S. v. Martinez-Fuerte* 1976, 543; *Vernonia* 1995, 646).

In determining whether brain-scanning procedures followed by the government respect relevant Fourth Amendment standards of reasonableness, what factors would the courts consider? Does one factor relate to whether the test chosen is reasonable in terms of safety and efficacy? For example, the Supreme Court has found in the context of drunken driving that extraction of blood samples for testing is a highly effective means of determining the degree to which a person is under the influence of alcohol (*Breithaupt* 1957, 436n3). Is fMRI a highly effective means of identifying or diagnosing certain types of physical and mental conditions, behaviors, preferences and characteristics? Although some fMRI studies identify a rate of accuracy for detecting deception, what about the detection of other conditions and behaviors? Are their rates of accuracy known or unknown? Are they "highly effective," in the same way that blood tests are for determining alcohol influence? Or, are there other, more effective methods of identifying target conditions and behaviors?

The Supreme Court also has found that blood tests are "commonplace in these days of periodic physical examination and experience with them teaches that the quantity of

blood extracted is minimal, and that for most people the procedure involves virtually no risk, trauma, or pain" (Schmerber 1966, 771). Other cases have found, however, that it is not reasonable to remove a bullet lodged one-inch deep in an individual's chest (Winston 1985, 753). Functional MRI currently is not as commonplace as blood tests. But, is it as uncommon or as unreasonable as removing a bullet that was taken in the chest? Is fMRI more or less uncomfortable than a needle prick? What about scans ordered for individuals who fear loud noises, or claustrophobic situations? Does the fact that fMRI usually is considered minimal risk in the context of biomedical research favor a government's interest in imposing an fMRI?

In determining the constitutionality of a brain scan under the Fourth Amendment, would the courts consider how the relevant government actor conducted the fMRI test? For example, the Supreme Court has found in the drunken driving context that a blood-alcohol test was conducted in a reasonable manner when the blood was drawn "by a physician in a hospital environment according to accepted medical practices" (Schmerber 1966, 771). The Supreme Court clarified that,

"We are thus not presented with the serious questions which would arise if a search involving use of a medical technique, even of the most rudimentary sort, were made by other than medical personnel or in other than a medical environment—for example, if it were administered by police in the privacy of the stationhouse. To tolerate searches under these conditions might be to invite an unjustified element of personal risk of infection and pain" (Schmerber 1966, 771).

The question becomes, what type of personnel would be permitted to conduct a government-ordered brain scan? Radiology technicians? Ivy League neuroscientists? In what type of facility may the testing occur? A police station? A cognitive neuroscience laboratory? What precautions and protocols must be followed?

In determining the constitutionality of a brain scan, how would the courts weigh the subjects' expectations of privacy? In the public school context, for example, the Supreme Court has held that grade K-12 students have a somewhat lowered expectation of privacy because school authorities act *in loco parentis* and need to control the student body in order for the educational mission to be implemented. School districts thus have been permitted to require all student athletes to submit to urinalysis drug testing as a condition of participation in interscholastic sports, provided that the testing was conducted in a relatively unobtrusive manner (Veronia 1995, 664–665). Of the individuals on whom it is speculated that the government might impose brain scans (executive branch leaders, employees, criminal suspects, etc.), which have lowered expectations of privacy? And would fMRI be considered "relatively unobtrusive"?

Finally, how would the courts weigh the government's interest in obtaining information through a functional neuroimaging test? For example, courts have given sufficient weight to a government's interest in fairly and accurately determining guilt or innocence (Winston 1985, 762). Would a court weigh more heavily a government's interest in deter-

mining whether a particular individual committed murder compared to whether a particular individual can get along with others in the workplace? Or, will fMRI never be capable of "fairly and accurately" determining guilt or innocence or social cooperation?

CRIMINAL LAW AND EVIDENCE

Criminal law and civil and criminal evidence are, perhaps, the two areas of the law that have received the most attention in scholarship examining the legal implications of advances in functional neuroimaging. Although the questions raised in these fields have by no means been answered, the quantity and depth of very recent scholarship in these two areas, as evidenced by the references at the end of this article, make it almost impossible to examine these issues in an essay of this length. Accordingly, I will identify just a few trends in the literature and refer those who are interested to the references listed below.

The law review literature is bursting at the seams with articles examining the criminal law implications of advances in neuroscience. Perhaps because of the Supreme Court's 2005 decision in *Roper v. Simmons* (Haider 2006), which held that the Eighth and Fourteenth Amendments forbid imposition of the death penalty on offenders who are younger than age 18 years when their crimes were committed, a good portion of this literature addresses the relationship between neuroscience, neuroimaging and juvenile justice. One recent article argues that advances in neuroscience favor a juvenile justice system that recognizes that juvenile offenders may be more amenable to rehabilitation than adults (Saunders 2005). A second article uses neuroscience to argue that the execution of adolescents should be considered cruel and unusual punishment (Ferguson 2004). A third argues that neuroimaging evidence should prompt reform pertaining to teen capacity and consent, especially in the area of sexual relations (Drobac 2006). A fourth examines more generally the role of neurobiology in juvenile justice (Gruber and Yurgelun-Todd 2006). The *Ohio State Journal of Criminal Law* even published a related symposium issue in Spring 2006: "The Mind of a Child: The Relationship between Brain Development, Cognitive Functioning, and Accountability under the Law" ([Collection of Authors] 2006)."

The remainder of the literature at the intersection of criminal law and neuroscience examines both expected and unique issues, such as whether neuroimaging findings can be used to vitiate *mens rea* (Bitz and Bitz 1999), how neuroscience can be used to examine the disturbing phenomenon of prosecutorial tunnel vision (Bandes 2006), how neuroimaging findings can be used to challenge opposition to the use of control tests in insanity determinations (Redding 2006), and how functional neuroimaging can be used in restorative justice to heal the violence of crime (Mills 2006). The titles of these articles show just as clearly the trend of blending biology, psychology, neuroscience and jurisprudence: "Law and Behavioral Biology (Jones and Goldsmith 2005), "Mental Capacity and the Death Penalty" (Ryan and Berson 2006), "Neuroanatomical Background to Understanding the Brain of the Young Psychopath (Fallon

2006), "Clinical Neuropsychologists: Training, Credentials, and Courtroom Credibility" ([no author] 2003), "A Judge's Introduction to Neuropsychological Assessments" (McKinze 2001), and "The Criminal Brain: Frontal Lobe Dysfunction Evidence in Capital Proceedings" (Seiden 2004).

The question of whether neuroscientific evidence, including functional neuroimages and their related interpretations, are admissible as evidence in civil and criminal proceedings has been debated for almost 10 years (Alexander 2006; Kulynych 1997; Morse 2004; Morse 2006a; Pettit In press). The titles of some of the most recent articles show how scholars are applying evidentiary principles to neuroimaging. "Functional Magnetic Resonance Imaging Lie Detection: Is a 'Brainstorm' Heading for the 'Gatekeeper'?" (Alexander 2006), "Cross-Examining the Brain: A Legal Analysis of Neural Imaging for Credibility Impeachment" (Keckler 2006), and "fMRI and BF Meet FRE: Brain Imaging and the Federal Rules of Evidence" (Pettit In press) are three recent articles that come to mind. The majority of the lawyers in the audience at a mock trial examining the admissibility of fMRI in civil proceedings ("Using Your Brain in the Courtroom," jointly presented by the Neuroethics and Law Affinity Groups at the 2006 American Society for Bioethics and Humanities conference, Denver, CO; October 26–29, 2006) seemed to think that fMRI should not yet be admissible in civil proceedings. What do you think? ■

REFERENCES

- 29 C.F.R. 1630.3(d)(1).
- 29 C.F.R. 1630.3(d)(2).
- 29 C.F.R. 1630.3(e).
- Aboud v. Detroit Board of Education*, 431 U.S. 209 (1977).
- Alexander, A. 2006. Functional magnetic resonance imaging lie detection: Is a "brainstorm" heading for the "gatekeeper"? *Houston Journal of Health Law and Policy* 7: 1–56.
- Allen, A. 2002. Origins and growth of U.S. privacy law. *Practising Law Institute* 701: 83–102.
- American Medical Association. 2006a. Code of medical ethics: Current opinions with annotations. Ethical opinion E-2.135, Insurance companies and genetic information. Chicago: AMA Press.
- American Medical Association. 2006b. Code of medical ethics: Current opinions with annotations. Ethical opinion E-2.136, Genetic information and the criminal justice system. Chicago: AMA Press.
- American with Disabilities Act, 42 U.S.C. §§ 12101–12117, 2007.
- Appendix to 29 C.F.R. Part 1630.
- Bandes, S. 2006. Loyalty to one's convictions: The prosecutor and tunnel vision. *Howard Law Journal* 49(2): 475–494.
- Bentham, J. 1802 [1914]. Of property. In *The theory of legislation, vol. 1. Principles of civil code, part 1*, ed. E. Dumont, 145–147. Oxford, UK: Oxford University Press.
- Bitz, D. M., and J. S. Bitz. 1999. Incompetence in the brain injured individual. *St. Thomas Law Review* 12: 205–276.
- Board of Education v. Pico*, 457 U.S. 853 (1982).
- Boire, R. G. 1999–2000. On cognitive liberty (part I). *Journal of Cognitive Liberties* 1(1): 7–13.
- Boire, R. G. 2005. Searching the brain: The fourth amendment implications of brain-based deception devices. *American Journal of Bioethics* 5(2): 62–63.
- Breithaupt v. Abram*, 352 U.S. 432, 436n3 (1957).
- Brown, G. G., and L. T. Eyler. 2006. Methodological and conceptual issues in functional magnetic resonance imaging: Applications to schizophrenia research. *Annual Review of Clinical Psychology* 2: 51–81.
- Caplan, A. 2002. No-brainer: Can we cope with the ethical ramifications of new knowledge of the human brain? In *Neuroethics: Mapping the field*, ed. S. J. Marcus, 95–131. New York, NY: Dana Press.
- Cephus Corporation. 2006. *CEPHOS' CEO Speaks on Commercial Testing*. Available at http://www.cephoscorp.com/cephos.comm.testing_20061215%20v2.pdf (accessed July 2, 2007).
- Clifford, R. D. 2005. Random numbers, chaos theory and cogitation: A search for the minimal creativity standard in copyright law. *Denver University Law Review* 82(2): 259–299.
- Coghill, R. C., J. G. McHaffie, and Y-F Yen. 2003. Neural correlates of interindividual differences in the subjective experience of pain. *Proceedings of the National Academy of Sciences USA* 100(14): 8538–8542.
- Coghill, R. C., C. N. Sang, J. M. Maisog, and M.J. Iadarola. 1999. Pain intensity processing within the human brain: A bilateral, distributed mechanisms. *Journal of Neurophysiology* 82(4): 1934–1943.
- [Collection of authors]. 2006. The mind of a child: The relationship between brain development, cognitive functioning, and accountability under the law. *Ohio State Journal of Criminal Law* 3(2): 317–541.
- Committee on Science and Law. 2005. Are your thoughts your own?: "Neuroprivacy" and the legal implications of brain imaging. *CBA Record* 60: 407–436.
- Diagnostic and Statistical Manual of Mental Disorders, 4th ed., Text Revised. 2000. Arlington, VA: American Psychiatric Publishing.
- Donaldson, D. I. 2004. Parsing brain activity with fMRI and mixed designs: What kind of a state is neuroimaging in? *Trends in Neurosciences* 27(8): 442.
- Drobac, J. A. 2006. "Developing capacity": Adolescent "consent" at work, at law, and in the sciences of the mind. *Journal of Juvenile Law and Policy* 10:1–68.
- Eisenberger, N.I. 2006. Identifying the neural correlates underlying social pain: Implications for developmental processes. *Human Development* 49(5): 273–293.
- Eisenberger, N. I. and M. D. Lieberman. 2004. Why rejection hurts: A common neural alarm system for physical and social pain. *Trends in Cognitive Sciences* 8(7): 294–300.
- Eisenberger, N. I., M. D. Lieberman, and K. D. Williams. 2003. Does rejection hurt? An fMRI study of social exclusion. *Science* 302(5643): 290–292.
- Elhauge, E. R. 2006. Can health law become a coherent field of law? *Wake Forest Law Review* 41(2): 365–390.

- Employee Polygraph Protection Act, 29 U.S.C. §§ 2001–2009. 2007.
- Equal Employment Opportunity Commission [EEOC]. 1995. Employment guidance: Preemployment disability-related questions and medical examinations, Notice No. 915.002.
- Equal Employment Opportunity Commission [EEOC]. 2000. EEOC enforcement guidance on disability-related inquiries and medical examinations of employees under the Americans with Disabilities Act (ADA), Notice No. 915.002.
- Fallon, J. H. 2006. Neuroanatomical background to understanding the brain of the young psychopath. *Ohio State Journal of Criminal Law* 3(2): 341–367.
- Fallon, J. H. 2007. *Through a glass darkly: Transdisciplinary brain imaging studies to predict and explain abnormal behavior*. Presented at the Sandra Day O'Connor College of Law conference: The law and ethics of brain scanning: Coming soon to a courtroom near you? Arizona State University, Phoenix, AZ, April 13, 2007. PowerPoint and MP3 audio file available at <http://www.law.asu.edu/brainscanning> (accessed July 2, 2007).
- Farah, M. 2006. Neuroethics: The practical and philosophical. *Trends in Cognitive Sciences* 9(1): 34–40.
- Farah, M. J., and P. R. Wolpe. 2004. Monitoring and manipulating brain function: New neuroscience technologies and their ethical implications. *Hastings Center Report* 34(3): 36.
- Federal Trade Commission Act, 15 U.S.C. § 41–58 (2006).
- Ferguson, L. C. 2004. The implications of developmental cognitive research on “evolving standards of decency” and the imposition of the death penalty on juveniles. *American University Law Review* 54(Dec.): 441–484.
- Foster, K. R., P. R. Wolpe and A. Caplan. 2003. Bioethics and the brain. *IEEE Spectrum* June: 34–39.
- Fugelsang, J. A., and K. N. Dunbar. 2006. A cognitive neuroscience framework for understanding causal reasoning and the law. In *Law & the brain*, ed. S. Zeki and O. Goodenough, 157–166. Oxford, UK: Oxford University Press.
- Ganske-Frist Amendment, 35 U.S.C. § 287(c) (2006).
- Garland, B. 2004. *Neuroscience and the law: Brain, mind, and the scales of justice*. New York, NY: Dana Press.
- Glen, L. M. 2005. Keeping an open mind: What legal safeguards are needed? *American Journal of Bioethics* 5(2): 60–61.
- Goodenough, O. R. 2006. Responsibility and punishment: Whose mind? A response. In *Law & the brain*, ed. S. Zeki and O. Goodenough, 259–266. Oxford, UK: Oxford University Press.
- Goodenough, O. R., and K. Prehn. 2006. A neuroscientific approach to normative judgment in law and justice. In *Law & the brain*, ed. S. Zeki and O. Goodenough, 77–109. Oxford, UK: Oxford University Press.
- Greely, H. T. 2004. Prediction, litigation, privacy, and property: Some possible legal and social implications of advances in neuroscience. In *Neuroscience and the law: Brain, mind, and the scales of justice*, ed. B. Garland, 114–156. New York, NY: Dana Press.
- Greely, H. T. 2005. Premarket approval regulation for lie detection: An idea whose time may be coming. *American Journal of Bioethics* 5(2): 50–52.
- Greely, H. T. 2006c. The social effects of advances in neuroscience: Legal problems, legal perspectives. In *Neuroethics: Defining the issues in theory, practice, and policy*, ed. J. Illes, 245–263. Oxford, UK: Oxford University Press.
- Greely, H. T. 2006d. Some thoughts on academic health law. *Wake Forest Law Review* 41(2): 391–409.
- Greely, H. T., and J. Illes. In press. Neuroscience-based lie detection: The urgent need for regulation. *American Journal of Law and Medicine* 33.
- Green, R. M. 2005. Spy versus spy. *American Journal of Bioethics* 5(2): 53–54.
- Grey, B., commentator. 2007. *The law and ethics of brain scanning: The next big thing coming soon to a courtroom near you*. Presented at the Sandra Day O'Connor College of Law Conference: The law and ethics of brain scanning: Coming soon to a courtroom near you? Arizona State University, Phoenix, AZ, April 13, 2007. MP3 audio file available at <http://www.law.asu.edu/brainscanning> (accessed July 2, 2007).
- Gruber, S. A., and D. A. Yurgelun-Todd. 2006. Neurobiology and the law: A role in juvenile justice? *Ohio State Journal of Criminal Law* 3(2): 321–333.
- Haider, A. 2006. Roper v. Simmons: The role of the science brief. *Ohio State Journal of Criminal Law* 3(2): 369–377.
- Hall, M. A. 2006. The history and future of health care law: An essentialist view. *Wake Forest Law Review* 41(2): 347–364.
- Hall, M. A., C. E. Schneider, and L. Shepherd. 2006. Rethinking health law. *Wake Forest Law Review* 41(2): 341–345.
- Illes, J. 2003. Neuroethics in a new era of neuroimaging. *American Journal of Radiology* 24(9): 1739–1740.
- Illes, J., and E. Racine. 2005. Imaging or imagining? A neuroethics challenge informed by genetics. *American Journal of Bioethics* 5(2): 5–18.
- In re Air Crash at Little Rock*, 291 F.3d 503 (8th Cir. 2002).
- Jaffee, S. 2004. Fake method for research impartiality. *Scientist* 18(14): 64.
- Jones, O. D., and T. H. Goldsmith. 2005. Law and behavioral biology. *Columbia Law Review* 105(2): 405–500.
- Jones v. Opelika*, 316 U.S. 584 (1942).
- Keckler, C. N. 2006. Cross-examining the brain: A legal analysis of neural imaging for credibility impeachment. *Hastings Law Journal* 57(3): 509–556.
- Kolber, A. J. 2007. Pain detection and the privacy of subjective experience. *American Journal of Law & Medicine* 33(1)–(2). Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=976831.
- Kulynych, J. 1997. Psychiatric neuroimaging evidence: A high-tech crystal ball? *Stanford Law Review* 49: 1249–1270.
- Kulynych, J. 2002. Legal and ethical issues in neuroimaging research: Human subjects protection, medical privacy, and the public communication of research results. *Brain and Cognition* 50(3): 345–357.

- Kulynych, J. In press. The regulation of MRI neuroimaging research: Disentangling the Gordian knot. *American Journal of Law and Medicine* 331.
- Lawrence v. Texas*, 539 U.S. 558 (2003).
- Le Bihan, D., P. Jefferard, J. Haxby, N. Sadato, L. Rueckert, and V. Mattay. 1995. Functional magnetic resonance imaging of the brain. *Annals of Internal Medicine* 122(4): 296–303.
- Mandavilli, A. 2006. Actions speak louder than images. *Nature* 444(7120): 664–665.
- McCaffrey, E. J., D. J. Kahneman, and M. L. Spitzer. 1995. Framing the jury: Cognitive perspectives on pain and suffering awards. *Virginia Law Review* 81: 1341.
- McKinney, R. K. 2001. A judge's introduction to neuropsychological assessments. *Court Review* 37: 24–30.
- Mills, L. G. 2006. The justice of recovery: How the state can heal the violence of crime. *Hastings Law Journal* 57(3): 457–508.
- Minnesota False Statement in Advertising Act, Minn. Stat. § 325F.67 (2006).
- Minnesota Prevention of Consumer Fraud Act, Minn. Stat. § 325F.69, subd. 1 (2006).
- Minnesota Unlawful Trade Practices Act, Minn. Stat. § 325D.09–.16 (2006).
- Miranda v. Arizona*, 384 U.S. 436 (1966).
- Moreno, J. D. 2003. Neuroethics: An agenda for neuroscience and society. *Nature Reviews Neuroscience* 4(2): 152.
- Moreno, J. D. 2005. Dual use and the 'moral taint' problem. *American Journal of Bioethics* 5(2): 52.
- Morse, S. J. 2004. Reasons, results, and criminal responsibility. *University of Illinois Law Review* 2004(2): 363–444.
- Morse, S. J. 2006a. Brain overclaim syndrome and criminal responsibility: A diagnostic note. *Ohio State Journal of Criminal Law* 3(2): 397–412.
- Moulton, E. A., M. L. Keaser, R. P. Gullapalli, and J. D. Greenspan. 2005. Regional intensive and temporal patterns of functional MRI activation distinguishing noxious and innocuous contact heat. *Journal of Neurophysiology* 93: 2183–2193.
- National Institute of Mental Health, National Institutes of Health [NIH]. 2001. fMRI signal found "faithful" to neuronal activity. Available at <http://www.nimh.nih.gov/press/fmrtsignal.cfm> (accessed July 2, 2007).
- [No author]. 2003. Clinical neuropsychologists: Training, credentials and courtroom credibility. *Journal of the Missouri Bar* 59:184–187.
- No Lie MRI. 2006a. <http://www.noliemri.com/>.
- No Lie MRI. 2006b. <http://www.noliemri.com/customers/Group-OrCorporate.htm>.
- No Lie MRI. 2006c. <http://www.noliemri.com/customers/Individuals.htm>.
- No Lie MRI. 2006d. <http://www.noliemri.com/products/Overview.htm>.
- No Lie MRI. 2006e. <http://www.noliemri.com/pressNPubs/Publications.htm>.
- No Lie MRI. 2006f. <http://www.noliemri.com/customers/Government.htm>.
- Ochsner, K. N., D. H. Ludlow, K. Knierim, J. Hanelin, T. Ramachandran, G. C. Glover, and S. C. Mackey. 2006. Neural correlates of individual differences in pain-related fear and anxiety. *Pain* 120: 69–77.
- Olson, S. 2005. Brain scans raise privacy concerns. *Science* 307(5715): 1548–1550.
- Palko v. Connecticut*, 302 U.S. 319 (1937).
- Pettit, M. In press. fMRI and BF meet FRE: Brain imaging and the federal rules of evidence. *American Journal of Law and Medicine* 33.
- Peyron, R., B. Laurent, and L. Garcia-Larrea. 2000. Functional imaging of brain responses to pain: A review and meta-analysis. *Journal of Clinical Neurophysiology* 30(5): 263–288.
- Porro, C.A. 2003. Functional imaging and pain: Behavior, perception, and modulation. *Neuroscientist* 9(5): 354–369.
- Porro, C.A., V. Cettolo, M. P. Francescato, and P. Baraldi. 1998. Temporal and intensity coding of pain in human cortex. *Journal of Neurophysiology* 80(6): 3312–3320.
- Rainville, P., G. H. Duncan, D. D. Price, B. Carrier, and M. C. Bushnell. 1997. Pain affect encoded in human anterior cingulate but not somatosensory cortex. *Science* 277(5328): 968–971.
- Redding, R. E. 2006. The brain-disordered defendant: Neuroscience and legal insanity in the twenty-first century. *American University Law Review* 56(1): 51–127.
- Ryan, E. P., and S. B. Berson. 2006. Mental illness and the death penalty. *St. Louis University Public Law Review* 25: 351–381.
- Saunders, K. W. 2005. A disconnect between law and neuroscience: Modern brain science, media influences, and juvenile justice. *Utah Law Review* 2005: 695–741.
- Schacter, D. L., J. Kagan, and M. D. Leichtman. 1995. True and false memories in children and adults: A cognitive neuroscience perspective. *Psychology, Public Policy, and the Law* 1: 411–24.
- Schick, A. 2005. Neuro exceptionalism? *American Journal of Bioethics* 5(2): 36–38.
- Schmerber v. California*, 384 U.S. 757 (1966).
- Seiden, J. A. 2004. The criminal brain: Frontal lobe dysfunction evidence in capital proceedings. *Capital Defense Journal* 16: 395–420.
- Shipley, W. E. 2005. Requiring submission to physical examination or test as violation of constitutional rights. *American Law Reports 2nd ed.* 25: 1407.
- Spence, S. A., M. D. Hunter, T. F. D. Farrow, R. D. Green, D. H. Leung, C. J. Hughes, and V. Ganesan. 2006. A cognitive neurobiological account of deception: Evidence from functional neuroimaging. In *Law & the brain*, ed. S. Zeki and O. Goodenough, 169–182. Oxford, UK: Oxford University Press.
- Stake, J. E. 2006. The property 'instinct.' In *Law & the Brain*, ed. S. Zeki and O. Goodenough, 185–204. Oxford, UK: Oxford University Press.
- Stanley v. Georgia*, 394 U.S. 557 (1969).
- Stoller, S., and P. R. Wolpe. In press. Emerging neurotechnologies for lie detection and the fifth amendment. *American Journal of Law and Medicine* 33.

- Thompson, S. K. In press. A brave new world of interrogation jurisprudence. *American Journal of Law and Medicine* 33.
- Thompson, S. K. 2005. The legality of the use of psychiatric neuroimaging in intelligence interrogation. *Cornell Law Review* 90(6): 1601–1637.
- Tovino, S. A. 2005. The confidentiality and privacy implications of functional magnetic resonance imaging. *Journal of Law, Medicine and Ethics* 33(4): 844–848.
- Tovino, S. A. 2006. *The visible brain: Confidentiality and privacy implications of functional magnetic resonance imaging*. Ph.D. Dissertation, University of Texas Medical Branch.
- Tovino, S. A. 2007. Imaging body structure and mapping brain function: A historical approach. *American Journal of Law and Medicine* 33.
- Tovino, S. A. In press. Functional neuroimaging information: A case for neuro exceptionalism? *Florida State University Law Review* 34.
- U.S. Const. amend. I.
- U.S. Const. amend IV.
- U.S. Const. amend. V.
- U.S. v. Martinez-Fuerte, 428 U.S. 543 (1976).
- U.S. v. Reidel, 402 U.S. 351 (1971).
- Vernonia School District v. Acton, 515 U.S. 646 (1995).
- West Virginia State Board of Education v. Barnette, 319 U.S. 624 (1943).
- Wild, J. 2005. Brain imaging ready to detect terrorists, say neuroscientists. *Nature* 437(7058): 457.
- Willing, R. 2006. MRI tests offer glimpse at brains behind the lies. *USA Today*, June 26: n.p.
- Winston v. Lee, 470 U.S. 753 (1985).
- Wolpe, P. R. 2004. Neuroethics. In *Encyclopedia of bioethics 3rd ed.*, ed. S. G. Post, 1894–1898. New York, NY: Macmillan Reference.
- Wolpe, P. R., K. R. Foster, and D. D. Langleben. 2005. Emerging technologies for lie-detection: Promises and perils. *American Journal of Bioethics* 5(2): 39–49.
- Zeki, S., and O. Goodenough. 2006. *Law & the Brain*. Oxford, UK: Oxford University Press.