Law and Neuroscience

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CHAPTER 1

Overview of the Issues

"You," your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules. Who you are is nothing but a pack of neurons . . . although we appear to have free will, in fact, our choices have already been predetermined for us and we cannot change that.

—Francis Crick[†]

Neuroscience has the potential to make internal contributions to legal doctrine and practice if the relation is properly understood. For now, however, such contributions are modest at best and neuroscience poses no genuine, radical challenges to concepts of personhood, responsibility, and competence.

—Stephen Morse[††]

CHAPTER SUMMARY

This chapter:

- Introduces fundamental themes to be explored in the book, and illustrates the potentially wide-ranging applications of neuroscience to law.
- Foreshadows some of the important limits to using neuroscience in legal contexts.
- Raises practical and ethical questions about the implications of neuroscience research for the courtroom, legal practice, and public policy.

INTRODUCTION

Scientists have learned a tremendous amount about how the human brain works, how it malfunctions, and how it can be repaired and altered. This growing neuroscience knowledge base has already revolutionized medical practice. But when, why, and how can neuroscience aid *law*?

This is the central question you will encounter in this coursebook, and we will encourage you to consider a wide number of potential legal applications. We will also encourage you to maintain a critical eye. Careful scientific analysis and careful legal analysis are requisites to successfully navigating the field of neurolaw.

† Francis Crick, *The Astonishing Hypothesis* 3 (1994).

†† Stephen Morse, *Lost in Translation? An Essay on Law and Neuroscience*, in *Neuroscience: Current Legal Issues* 562 (Michael Freeman ed., 2011).

This introductory chapter presents a wide variety of possible neuroscience and law intersections. While criminal defenses of the ‘‘my brain made me do it’’ variety have drawn much attention, you should see from the material in this chapter that neuroscience is not limited to the criminal law domain. Indeed, lawyers on the civil side first coined the term neurolaw in 1995, and in personal injury litigation neurologists and lawyers have a long-standing relationship.[1]

In addition to recognizing the variety of potential uses, you should also see that current and future uses of neuroscience in law are not unlimited. Although evidence suggests that the number of cases involving neuroscientific evidence is rapidly rising, modern brain science is still new to the legal scene. This is perhaps obvious, but it is a point worth emphasizing because the youth of the field has implications for how you read the materials in this book. Unlike some courses, where the law is relatively fixed and has been for some time, neurolaw is comparatively new and changing. Consider that 86 percent of the publications and cases included in this book were published only since 2000, and that nearly 60 percent of these materials were published between 2008-2013.

As with other new technologies that law has confronted, the rise of modern neuroscience raises deep, recurring questions that you will ask yourself as you read this book: Is the neuroscience ready? Do we know enough to draw legally relevant conclusions? Does neuroscience tell us anything we don’t already know from common sense or previous behavioral research? Are there some areas of law to which neuroscience may never be relevant? How shall we assess when law should and should not defer to neuroscientific conclusions? Are the legal actors — judges, lawyers, and legislators — ready and able to integrate sound neuroscience evidence into their practice and deliberations? How can legal actors distinguish between neuroscientific wheat and chaff? Are the scientific researchers and medical professionals capable of communicating their ideas in ways accessible for a legal audience?

How these questions will be answered is of course unknown today. But what is known is that the future of neurolaw will likely be determined as much by legal decision-makers like yourself as it will be by scientists. Legislators, judges, lawyers, and legal scholars will decide first how to frame these policy questions and then how to answer them, based on the best information that science can provide.

This introductory chapter proceeds in five sections. In Section A you will read two cases, one in criminal law and one in contracts, in which attorneys offered neuroscience evidence. As you read these cases, consider the arguments of proponents and critics of using neuroscience in these ways — as those arguments will reoccur throughout the book. Section B discusses the rise of neurolaw as an area of legal practice, scientific research, and interdisciplinary dialogue. Having established some of the types of cases and research that have already begun to emerge, Section C then presents views on the possible future directions neurolaw may take. As you read Sections B and C, you should think critically and creatively

1. The earliest published uses of the term ‘‘neurolawyer’’ and ‘‘neurolaw’’ were in 1991 and 1995 by Attorney J. Sherrod Taylor. Sherrod J. Taylor, et. al, *Neuropsychologists and Neurolawyers*, 5 Neuropsychology 293 (1991); Sherrod J. Taylor, *Neurolaw: Towards a New Medical Jurisprudence*, 9 Brain Injury 745 (1995).

about what areas of law and policy will be most, and least, affected by advances in neuroscience.

A. INTRODUCING NEUROSCIENTIFIC EVIDENCE

Virginia Hughes

Science in Court: Head Case

464 Nature 340 (2010)

Brian Dugan, dressed in an orange jumpsuit and shackles, shuffled to the door of Northwestern Memorial Hospital in downtown Chicago, accompanied by four sheriff deputies. It was the first time that Dugan, 52, had been anywhere near a city in 20 years. Serving two life sentences for a pair of murders he committed in the 1980s, he was now facing the prospect of the death penalty for an earlier killing.

Dugan was here on a Saturday this past September to meet one of the few people who might help him to avoid that fate: Kent Kiehl, a neuroscientist at the University of New Mexico in Albuquerque. Dugan, Kiehl, and the rest of the entourage walked the length of the hospital, crossed a walkway to another building, and took the lift down to a basement-level facility where researchers would scan Dugan's brain using functional magnetic resonance imaging (fMRI).* Todd Parrish, the imaging center's director, offered plastic zip ties to replace the shackles — no metal is allowed in the same room as the scanner's powerful magnet — but the guards said they weren't necessary. Dugan entered the machine without restraints, and Parrish locked the door — as much to keep the guards and their weapons out as to keep Dugan in.

Dugan lay still inside the scanner for about 90 minutes, performing a series of cognitive control, attention, and moral decision-making tests. Afterwards, he ate a hamburger, sat through an extensive psychiatric interview, and rode back to DuPage county jail, about 50 kilometers west of Chicago.

Kiehl has been amassing data on men such as Dugan for 16 years. Their crimes are often impulsive, violent, committed in cold blood, and recalled without the slightest twinge of remorse. They are psychopaths, and they are estimated to make up as much as 1% of the adult male population and 25% of male prisoners. To date, Kiehl has used fMRI to scan more than 1,000 inmates, many from a mobile scanner set up in the courtyard of a New Mexico prison. He says that the brains of psychopaths tend to show distinct defects in the paralimbic system, a network of brain regions important for memory and regulating emotion.

Mitigating Circumstances

The purpose of the work, Kiehl says, is to eliminate the stigma against psychopaths and find them treatments so they can stop committing crimes. But Dugan's

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* [Chapters 8 and 9 describe the fMRI method, and the Appendix carefully explains how to critically evaluate publications using this method. — Eds.]

lawyers saw another purpose. During sentencing for capital crimes, the defense may present just about anything as a mitigating factor, from accounts of the defendant being abused as a child to evidence of extreme emotional disturbance. Kiehl's research could offer a persuasive argument that Dugan is a psychopath and could not control his killer impulses. After reading about Kiehl's work in the *New Yorker*, Dugan's lawyers asked Kiehl to testify and offered him the chance to scan the brain of a notorious criminal. Kiehl agreed. . . . Kiehl's decision has put him at odds with many in his profession and stirred debate among neuroscientists and lawyers.

''It is a dangerous distortion of science that sets dangerous precedents for the field,'' says Helen Mayberg, a neurologist at Emory University School of Medicine in Atlanta, Georgia. Mayberg, who uses brain imaging to study depression, has testified against the use of several kinds of brain scans in dozens of cases since 1992. Although other brain-imaging techniques have been used in court, it is especially hard to argue that fMRI should be, argue critics. The technique reveals changes in blood flow within the brain, thought to correlate with brain activity, and it has become popular in research. But most fMRI studies are small, unreplicated, and compare differences in the average brain activity of groups, rather than individuals, making it difficult to interpret for single cases. It is rarely used in diagnosis. Moreover, a recent scan, say some critics, wouldn't necessarily indicate Dugan's mental state when he committed his crimes.

In 1983, Dugan kidnapped 10-year-old Jeanine Nicarico, of Naperville, Illinois. He raped her in the back seat of his car and beat her to death. In 1984, he saw a 27-year-old nurse waiting at a stop light on a deserted road. He rammed into her car, raped her, and drowned her in a quarry. A year later, he plucked a 7-year-old girl from her bicycle, raped her, killed her, and left her body in a drainage ditch, weighed down with rocks.

Plea Bargaining

. . . Brain imaging has a long history in legal cases. Lawyers have often used scans as a way to tip the scale in the perpetual battle between opposing expert psychiatric witnesses. You can't control your brain waves, the theory goes, and scans are an objective measure of mental state. ''The psychiatric diagnosis is still soft data — it's behavior,'' notes Ruben Gur, director of the Brain Behavior Center at the University of Pennsylvania in Philadelphia. ''The brain scan doesn't lie. If there is tissue missing from your brain, there is no way you could have manufactured it for the purpose of the trial.''

Brain imaging played into the 1982 trial of John Hinckley Jr., who had attempted to assassinate U.S. President Ronald Reagan. Lawyers presented a computed tomography X-ray scan of his head, arguing that it showed slight brain shrinkage and abnormally large ventricles*, indicating a mental defect. The

* [Ventricles are cavities in the brain filled with fluid. This and all of the other brain structures you should know are explained in Chapter 7. You can look ahead if you wish, but you won't need to know details of brain structure or function in the first six chapters. — Eds.]

prosecution's expert witnesses said the scans looked normal. Whether imaging influenced the verdict is not known, but Hinckley was found not guilty by reason of insanity.

Over the next decade, lawyers gradually switched to positron emission tomography (PET), which can be used to give a measure of metabolic activity in the brain. Gur's research team has scanned dozens of patients with mental illness and hundreds of healthy volunteers using PET and structural MRI — a technique that looks at the static structure of the brain and is more established for diagnosis than fMRI. Through his research, he has developed algorithms that can predict whether a person has schizophrenia, for example, from structural MRI alone with about 80% accuracy. Gur has testified in roughly 30 criminal cases on behalf of defendants alleged to have schizophrenia or brain damage.

''We determine whether the values are normal or abnormal,'' Gur says. ''It's a challenge to explain that to a jury, but when they understand, basically all I'm telling them is that this is not someone who's operating with a full deck. And so, they may not be eligible for the harshest punishment possible.'' Gur gets so many requests to testify that he has a team of psychology residents and interns to vet them. Still, he doesn't think that fMRI is reliable enough for legal settings. ''If somebody asked me to debunk an fMRI testimony, it wouldn't be too hard,'' Gur says.

That's mainly because fMRI studies deal in average differences between groups. For example, Kiehl's work has shown that, when processing abstract words, psychopathic prisoners have lower activity in some brain regions than non-psychopathic prisoners and non-prisoners. But there's bound to be overlap. He has not shown, for example, that any one person showing a specific brain signature is guaranteed, with some percent certainty, to be a psychopath or behave like one. . . .

Taking the Stand

On October 29, Kiehl participated in a ''Frye hearing'' for Dugan's case. Based on a 1923 ruling, the hearing determines whether scientific evidence is robust enough to be admitted.* Joseph Birkett, the lead prosecutor in the Dugan case, argued that allowing the scans — the bright colors and statistical parameters of which are chosen by the researchers — might bias the jury. Some studies, prosecutors argued, have shown that neuroscientific explanations can be particularly seductive to the layperson.

The judge ultimately ''cut the baby in half,'' says Birkett. He ruled that the jury would not be allowed to see Dugan's actual brain scans, but that Kiehl could describe them and how he interpreted them based on his research.

* [See Chapter 6 for a discussion of the evidentiary rules that govern the admissibility of expert evidence. Under *Frye* (discussed at length in Chapter 6) the court decides whether the proffered evidence has ''gained general acceptance in the particular field in which it belongs.'' *Frye* is no longer the standard in many states and in the federal courts, which apply a different rule called the *Daubert* standard (named after the *Daubert* case, also presented in Chapter 6). — Eds.]

On November 5, Kiehl took the stand for about six hours. He described the findings of two three-hour psychiatric interviews with Dugan. Dugan had scored 38 out of a possible 40 on the Hare Psychopathy Checklist, which evaluates 20 aspects of personality and behavior through a semi-structured interview. (It was developed by Kiehl's graduate-school mentor, Robert Hare.) That puts him in the 99.5th percentile of all inmates, Kiehl says.

Using PowerPoint slides of bar graphs and cartoon brains—but not the scans—Kiehl testified that Dugan's brain, like those of psychopaths in his other studies, showed decreased levels of activity in specific areas. Prosecutors, Kiehl says, went to great lengths to sow confusion about the data. . . .

The next day, the prosecution brought a rebuttal witness: Jonathan Brodie, a psychiatrist at New York University. He refuted the imaging evidence on several grounds.

First, there was timing: Kiehl scanned Dugan 26 years after he killed Nicarico. It was impossible to know what was going on in Dugan's brain while he was committing the act, and it was perhaps not surprising that his brain would look like a murderer's after committing murder. Second, Brodie said, there was the issue with average versus individual differences. If you look at professional basketball players, most of them are tall, he told the jury, but not everyone over six foot six is a basketball player.

From a technical perspective, Kiehl's work is expertly done, says Brodie. ''I have no issue with his science. I have an issue with what he did with it. I think it was just a terrible leap.''

Even if fMRI could reliably diagnose psychopathy, it wouldn't necessarily reduce a defendant's culpability in the eyes of a judge or jury. Ultimately, the law is based on an individual's rational, intentional action, not brain anatomy or blood flow, says Stephen Morse, professor of law and psychiatry at the University of Pennsylvania. ''Brains don't kill people. People kill people,'' says Morse, who also co-directs the MacArthur Foundation's Law and Neuroscience Project, which brings together scientists, lawyers, and judges to debate how brain technology should be used in legal settings.

Change of Heart

Dugan's sentencing proceedings ended four days after Brodie's testimony. The jury deliberated for less than an hour before coming back with a verdict: ten for the death penalty and two for life in prison—a death sentence requires a unanimous vote.

But while waiting for the Nicarico family to return to the courtroom, one of the jurors asked for more time and the judge agreed. The jury asked for copies of several transcripts of testimony, including Kiehl's, and went back into deliberation. The next day, all 12 jurors voted to send Dugan to his death.

Even with the unfavorable final verdict, Kiehl's testimony ''turned it from a slam dunk for the prosecution into a much tougher case,'' says Steve Greenberg, Dugan's lawyer. . . .

Navigating Neuroscience: Who Does What?

If a lawyer needs to consult someone with expert knowledge about the brain, who should she call? The answer to this question is somewhat complex because of the variety of specialized educational degrees, areas of expertise, and titles that surround medical and scientific work on the brain. Furthermore, the prefix ''neuro-'' fits so well in front of so many words (like neurolaw) that it may lead to confusion about who actually works directly with the brain.

To start, it's useful to know that we have not had a meaningful sense of what the brain actually does until very recently in human history. For example, Aristotle thought the brain distilled food vapors. When the modern scientific study of the brain began in the seventeenth century, it was called ''neurology''. Today neurology is understood to apply particularly to an area of medicine concerned with the diagnosis and treatment of disorders of the nervous system. Thus, a ''neurologist'' is an MD who has specialized training to deal with disorders, such as epilepsy or Parkinson's disease, as well as traumatic brain injury. A ''psychiatrist'' is also an MD but with specialization in diagnosing and treating disorders such as schizophrenia or depression. The boundary between neurology and psychiatry is becoming blurrier as we appreciate the brain basis of cognitive and emotional disorders. Thus, you will be able to find individuals who specialize in ''neuropsychiatry.'' Other MDs are known as ''radiologists''; they know how to use various technologies such as X-ray, ultrasound, computed tomography (CT), positron emission tomography (PET), and magnetic resonance imaging (MRI) to diagnose or treat diseases.

The MD degree entails the authority to deliver treatments such as prescribing drugs. The PhD degree does not entail this authority. The PhD degree is awarded for scientific research.

The term ''neuroscience'' was not used before the 1970s. Before that researchers who studied the brain and behavior earned PhD degrees in anatomy, physiology, or psychology. Today, many universities also grant a PhD degree in neuroscience. It is important to appreciate, though, that researchers working on the brain have a generally common educational background regardless of the discipline in which their PhD is granted. Broadly speaking, neuroscience research is conducted by individuals with a variety of labels such as neuroscientist, neurobiologist, and even psychologist.

You will also probably encounter a ''forensic psychologist'' or ''forensic psychiatrist.'' Such individuals work particularly at the intersection of law and psychology, and some subset of these professionals engage in neuroscience-related cases.

One category of PhD a lawyer may interact with in particular is referred to as a ''neuropsychologist.'' This is a rather vague term, but in the American medical domain it identifies individuals who perform various psychological tests to evaluate the effects or location of brain damage. Neuropsychologists, neurologists, and psychiatrists often work together on cases.

Van Middlesworth v. Century Bank & Trust Co.

No. 215512, 2000 WL 33421451 (Mich. Ct. App. May 5, 2000)

Per Curiam. Plaintiffs commenced this action seeking specific performance of a written agreement between them and the late Harold N. Piper to purchase approximately five hundred acres of farmland and a wheat crop from Piper, and seeking damages for breach of contract. After a bench trial, the trial court found that Piper was mentally incompetent to enter the agreement, and that the circumstances were such that reasonable persons in plaintiffs' position would have been put on notice that they should inquire further regarding Piper's mental competence before proceeding with the agreement. Plaintiffs now appeal as of right, challenging the trial court's order dismissing their complaint with prejudice. We affirm.

Plaintiffs first argue that the evidence of Piper's mental incompetence in March 1995 was insufficient to provide them with notice and require them to investigate his mental ability before proceeding with the transaction. We disagree. This Court reviews the trial court's findings of fact for clear error, and defers to the trial court's resolution of factual issues, especially where it involves the credibility of witnesses. A trial court's finding of fact is clearly erroneous when, although there is evidence to support it, this Court is left with the definite and firm conviction that a mistake has been made.

. . . ''The test of mental capacity to contract is whether the person in question possesses sufficient mind to understand in a reasonable manner the nature and effect of the act in which the person is engaged. To avoid a contract it must appear not only that the person was of unsound mind or insane when it was made, but that the un-soundness or insanity was of such a character that the person had no reasonable perception of the nature or terms of the contract.''

Timothy Piper testified that, in the fall of 1992, Rodney Van Middlesworth dried and sold some corn for Piper pursuant to the latter's request, and after Rodney gave Piper the figures involved in the transaction and settled with him, Piper later questioned the calculations and wondered whether he had been paid enough. Rodney then came back and went over the calculations with Piper a second time. Timothy also testified that, in 1993, Rodney agreed to haul and sell part of Piper's corn crop, and Piper believed that Rodney had hauled more bushels than Piper had requested to be hauled. As a result, Piper quit hauling or selling corn for a period of time, and Rodney told Timothy that, in the future, Timothy would have to verify what Piper wanted in order to avoid any more discrepancies. Also, on one occasion Piper asked Rodney to haul a couple of loads of corn for him, and Timothy did not confirm Piper's order because the corn was not ready to haul. In January 1995, Rodney hauled two almost identically sized loads of beans to the market for Piper, receiving a separate check for each load. Piper thought he had been paid twice for the same load of beans, and it took Rodney half a day ''to sort it out and make sure that he hadn't been.'' Rodney was also questioned about his deposition statement referring to an April 11, 1995, meeting with Piper, regarding which Rodney stated, ''He acted like he didn't know what I was talking about. He acted like he had no idea what he was talking about.''

Another indication that Rodney Van Middlesworth had notice that Piper was mentally incompetent occurred in relation to a police report that Piper apparently filed on April 28, 1995, accusing Rodney of assaulting him. From all that appears in the record, Piper's charge was false. When questioned about this incident at trial, Rodney denied having told the investigating police officer on May 1, 1995, that Piper's ''mind was starting to go,'' but he was impeached with an excerpt of his deposition testimony in which he acknowledged having made such a statement.

Although these latter incidents occurred some weeks after Piper signed the sales agreement, we believe it reasonable to assume that Rodney's expressed belief on several dates so soon after the transaction that Piper's ''mind is starting to go'' can be extrapolated backward in time to Piper's condition on March 13, 1995, thus constituting further indication that plaintiffs were on notice regarding Piper's possible mental incompetence.

Additionally, the trial court placed reliance on the fact that three of the four expert witnesses testified to Piper's deteriorated mental state. The first witness, a clinical psychologist, concluded from his examination that Piper's reasoning would have been significantly impaired on and around March 13, 1995 to the extent that he would not have been able to understand the offer to purchase his real estate. The second witness, a neurologist, examined the results of Piper's magnetic resonance imaging (MRI), found evidence of brain shrinkage and hardening of the arteries, and opined that the MRI was consistent with dementia both at the time of the MRI and in March 1995. The third expert witness, a physician specializing in geriatric neurology, concluded that Piper suffered from a combination of Alzheimer's disease and multi-infarct dementia, and that Piper was mentally incompetent at the time of examination as well as in March 1995. Although plaintiffs presented a psychiatric expert witness of their own who came to a contrary conclusion, we give much weight to the opinion of the trial judge who was in the best position to consider and evaluate the testimony of these witnesses. . . .

Plaintiffs argue that defense counsel's closing argument reflects defense counsel's own belief that plaintiffs had no knowledge of Piper's incompetence at the time the sales agreement was executed. During his remarks, counsel stated that he did not believe that plaintiffs ''entered into those negotiations saying to themselves, 'Harold is incompetent and we are going to take advantage of him.''' Whatever counsel may have meant by these remarks, they do not negate the evidence of Piper's mental incompetence in March 1995, nor do they relieve plaintiffs of their obligation to inquire regarding Piper's competence before proceeding with the transaction. . . . Having examined counsel's statement in context, we conclude that it was not meant as a formal admission, but was rather merely part of counsel's rhetoric during argument, charitably suggesting that plaintiffs did not intend to take advantage of an incompetent old man.

Plaintiffs also contend that, even if Piper were mentally incompetent at the time of the agreement, the resulting contract is voidable, not void, and should be set aside only if its terms are unjust or unfair to Piper. However, the trial court determined that the fairness of the contract was affected due to a $75,000 discrepancy between the sale price and the price the property could have brought at auction, a below-market interest rate, and ''the fact that it's the family homestead and . . . we'd have to look into the competency of anybody deeding out the family homestead.'' . . .

Moreover, there is no inequity in the trial court's decision to declare the agreement void because the agreement involved only an acceptance of an offer to purchase Piper's farm, and plaintiffs neither paid Piper for the farm, nor received title from him. As this Court stated in *Star Realty, Inc v. Bower,* ''The integrity of written contracts must be preserved, but so must an incompetent be protected against his own folly. . . . The evidence presented does not preponderate for specific performance as equitable relief.'' There was no error. . . . Affirmed.

NOTES AND QUESTIONS

1. What did the commentator mean when he said that the judge in *Dugan* ''cut the baby in half'' with regards to the scientific evidence? What do you think led the judge to rule that way? And, on the information here, how would you likely have approached the admissibility question? Chapter 6 on Neuroscience in the Courtroom will introduce the rules of scientific evidence in more detail. But note in the meantime that in the federal system, and in many states, the rules for admissibility are different in the guilt and sentencing phases.
2. Admissibility concerns often involve juror reaction to the proffered evidence. But what about judges? In 2012, Lisa G. Aspinwall, Teneille R. Brown, and James Tabery published a study with 181 U.S. state trial judges as subjects in an online experiment. The results suggest that judges' sentencing decisions may be affected by the introduction of biomechanical evidence. The researchers found that ''. . . despite the significant variability among states when it came to sentencing, the addition of a biomechanism for psychopathy significantly reduced the sentence and significantly reduced the degree to which psychopathy was rated as aggravating.'' Lisa G. Aspinwall, et. al, *The Double-Edged Sword: Does Biomechanism Increase or Decrease Judges' Sentencing of Psychopaths?* 17 Science 846, 847 (2012). Are you surprised at this result? If the same effect were seen in actual cases, what, if anything, should the legal system do to respond?
3. In *Dugan,* neuroscientist Kent Kiehl suggested that we now know much about the psychopathic brain. Should that knowledge be relevant at sentencing? Neuroscientist David Eagleman argues that ''[t]he punishment has to fit the brain.'' *Talk of the Nation: David Eagleman Gets Inside Our Heads,* National Public Radio (Aug. 24, 2012). Do you agree, and what would this mean in practice? How would you define the threshold level of brain dysfunction necessary for a defendant to be considered as suffering from a brain dysfunction, and thus eligible for a reduced or alternative sentence? Should a defendant asserting such a claim be required to prove that he or she not only suffers from such a disorder but also acted *because of* the disorder at the time of the crime?
4. In 2012 an Italian pediatrician, Domenico Mattiello, was accused of pedophilia. Colleagues could not understand why he acted this way: ''He was a pediatrician for 30 something years and he saw tens of thousands of children and never had any problem. The question is why, at some point, did someone who has always behaved properly suddenly change so drastically?'' An MRI revealed a brain tumor, and at his defense Dr. Mattiello argued that this brain tumor made him act in the way he did. Kate Kelland, *Neuroscience in Court: My Brain Made Me Do It* (Aug. 29, 2012). This and other international developments raise questions about comparative neurolaw. To what extent do different legal regimes and different cultural attitudes affect the role of neuroscience in law?

5. What role do you think neuroscientific evidence played in *Van Middlesworth*? What factors do you think led the defense attorneys to pursue it and include it? What issues would have arisen if, holding all other facts equal, the brain scans had shown nothing unusual?
6. Neuroscientist Michael Gazzaniga cautions that ''exciting as the advances that neuroscience is making every day are, all of us should look with caution at how they may gradually come to be incorporated into our culture. The legal relevance of neuroscientific discoveries is only part of the picture. Might we someday want brain scans of our fiancées, business partners, or politicians, even if the results could not stand up in court?'' Michael S. Gazzaniga, *Neuroscience in the Courtroom*, 304 Scientific American 54, 59 (2011). How might and should the legal system respond to these possible implications of neuroscience in society?
7. Law professor Stephen Morse has written that ''Brains do not commit crimes; people commit crimes. This conclusion should be self-evident, but, infected and inflamed by stunning advances in our understanding of the brain, advocates all too often make moral and legal claims that the new neuroscience does not entail and cannot sustain.'' Stephen Morse, *Brain Overclaim Syndrome and Criminal Responsibility: A Diagnostic Note*, 3 Ohio St. J. Crim. L. 397, 397 (2006). What do you think are the likely limits of neuroscience-based defenses, whether to a criminal charge or contractual dispute? If people, not brains, commit crimes, and people, not brains, sign contracts, were the courts mistaken to admit brain science in their adjudication of the cases above?
8. In Chapter 11 you will read about brain injuries, including brain injuries experienced through participation in contact sports such as football. In some instances, former athletes who suffered a brain injury find themselves as criminal defendants and argue that their brain trauma is relevant to explaining, and perhaps excusing, their violent actions. One prosecutor, in a case in which a former football player killed his girlfriend, argued that ''There is no psychosis fairy who magically sprinkles a dose of psychosis on this defendant. . . . The time for blaming football, the time for blaming marijuana, the time for blaming the victim is over.'' Melinda Henneberger, *Blaming Football in Lauren Astley's Killing*, Wash. Post (Mar. 6, 2013). Is the prosecutor's characterization of this brain-based defense a useful one? Why or why not?
9. While law often looks backward to assess a mental state at a previous time, society and the criminal justice system also frequently look forward to make a prediction about an individual's likelihood of doing something bad. In 2013 a group of researchers published a study finding that anterior cingulate cortex activation, associated with a laboratory impulse control task, could aid in the prediction of future re-arrest. The researchers noted, however, that ''Should the neuroimaging effects be robust to replication, they remain silent on the question of suitability in making individual-level predictions. Whether neurobiological markers should ever be used to make predictions about individual offenders' risk is a thorny question that, at the least, depends on (i) whether these estimates can survive particular sensitivity and specificity thresholds with the use of large random samples, (ii) whether they can survive a required legal standard of proof, and (iii) whether their use would violate offender rights.'' Eyal Aharoni et al., *Neuroprediction of Future Rearrest*, 110 Proc. Nat'l Acad. Sci. 6223, 6224 (2013). How would you address these thorny issues?

B. THE BRAIN ON THE STAND

Jeffrey Rosen
The Brain on the Stand

N.Y. Times Magazine, Mar. 11, 2007

I. Mr. Weinstein's Cyst. When historians of the future try to identify the moment that neuroscience began to transform the American legal system, they may point to a little-noticed case from the early 1990s. The case involved Herbert Weinstein, a 65-year-old ad executive who was charged with strangling his wife, Barbara, to death and then, in an effort to make the murder look like a suicide, throwing her body out the window of their 12th-floor apartment on East 72nd Street in Manhattan. Before the trial began, Weinstein's lawyer suggested that his client should not be held responsible for his actions because of a mental defect—namely, an abnormal cyst nestled in his arachnoid membrane, which surrounds the brain like a spider web.

The implications of the claim were considerable. American law holds people criminally responsible unless they act under duress (with a gun pointed at the head, for example) or if they suffer from a serious defect in rationality—like not being able to tell right from wrong. But if you suffer from such a serious defect, the law generally doesn't care why—whether it's an unhappy childhood or an arachnoid cyst or both. To suggest that criminals could be excused because their brains made them do it seems to imply that anyone whose brain isn't functioning properly could be absolved of responsibility. But should judges and juries really be in the business of defining the normal or properly working brain? And since all behavior is caused by our brains, wouldn't this mean all behavior could potentially be excused?

The prosecution at first tried to argue that evidence of Weinstein's arachnoid cyst shouldn't be admitted in court. One of the government's witnesses, a forensic psychologist named Daniel Martell, testified that brain-scanning technologies were new and untested, and their implications weren't yet widely accepted by the scientific community. Ultimately, on Oct. 8, 1992, Judge Richard Carruthers issued a Solomonic ruling: Weinstein's lawyers could tell the jury that brain scans had identified an arachnoid cyst, but they couldn't tell jurors that arachnoid cysts were associated with violence. Even so, the prosecution team seemed to fear that simply exhibiting images of Weinstein's brain in court would sway the jury. Eleven days later, on the morning of jury selection, they agreed to let Weinstein plead guilty in exchange for a reduced charge of manslaughter.

After the Weinstein case, Daniel Martell found himself in so much demand to testify as an expert witness that he started a consulting business called Forensic Neuroscience. Hired by defense teams and prosecutors alike, he has testified over the past 15 years in several hundred criminal and civil cases. In those cases, neuroscientific evidence has been admitted to show everything from head trauma to the tendency of violent video games to make children behave aggressively. But Martell told me that it's in death-penalty litigation that neuroscience evidence is having its most revolutionary effect. ''Some sort of organic brain defense has become de rigueur in any sort of capital defense,'' he said. Lawyers routinely order scans of convicted defendants' brains and argue that a neurological impairment prevented them from controlling themselves. The prosecution counters that the evidence shouldn't be admitted, but under the relaxed standards for mitigating evidence during capital sentencing, it usually is. Indeed, a Florida court has held that the failure to admit neuroscience evidence during capital sentencing is grounds for a reversal.* Martell remains skeptical about the worth of the brain scans, but he observes that they've ''revolutionized the law.''

The extent of that revolution is hotly debated, but the influence of what some call neurolaw is clearly growing. Neuroscientific evidence has persuaded jurors to sentence defendants to life imprisonment rather than to death; courts have also admitted brain-imaging evidence during criminal trials to support claims that defendants like John W. Hinckley Jr., who tried to assassinate President Reagan, are insane. Carter Snead, a law professor at Notre Dame, drafted a staff working paper on the impact of neuroscientific evidence in criminal law for President Bush's Council on Bioethics. The report concludes that neuroimaging evidence is of mixed reliability but ''the large number of cases in which such evidence is presented is striking.'' That number will no doubt increase substantially. Proponents of neurolaw say that neuroscientific evidence will have a large impact not only on questions of guilt and punishment, but also on the detection of lies and hidden bias and on the prediction of future criminal behavior. At the same time, skeptics fear that the use of brain-scanning technology as a kind of super mind-reading device will threaten our privacy and mental freedom, leading some to call for the legal system to respond with a new concept of ''cognitive liberty.'' . . .

Owen Jones, a professor of law and biology at Vanderbilt . . . has joined a group of prominent neuroscientists and law professors who have [received] . . . a large MacArthur Foundation grant; they hope to study a wide range of neurolaw questions, like: Do sexual offenders and violent teenagers show unusual patterns of brain activity? Is it possible to capture brain images of chronic neck pain when someone claims to have suffered whiplash? . . . Jones . . . with René Marois, a neuroscientist in the psychology department . . . has begun a study of how the human brain reacts when asked to impose various punishments. . . . Marois explained that he and Jones wanted to study the interactions among the emotion-generating regions of the brain, like the amygdala, and the prefrontal regions responsible for reason. ''It is also possible that the prefrontal cortex is critical for attributing punishment, making the essential decision about what kind of punishment to assign,'' he suggested. . . . [Other e]xperiments might help to develop a deeper understanding of the criminal brain, or of the typical brain predisposed to criminal activity. [For an introduction to these brain regions, see discussion in Chapter 7.]

III. The End of Responsibility? Indeed, as the use of functional M.R.I. results becomes increasingly common in courtrooms, judges and juries may be asked

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* [The case referred to is: *Hardwick v. Crosby*, 320 F.3d 1127, 1163 (11th Cir. 2003). The court, in analyzing mitigating evidence, stated that the statutory factor of the defendant's ability to ''conform his conduct to the requirements of the law'' was most significant. Evidence regarding the defendant's drunk, drugged, and sleepy condition was not presented to the judge and jury. Furthermore, the court held that the ''jury may not be prohibited from considering relevant non-statutory mitigating circumstances . . .'' and cites the example ''dysfunctional family life and the mental and physical abuse that he endured during his childhood and teen years.'' The court upheld the defendant's conviction but vacated the death sentence due to the lack of submitted evidence regarding the defendant's mental state and capabilities. — EDS.]

to draw new and sometimes troubling lines between ''normal'' and ''abnormal'' brains. Ruben Gur, a professor of psychology at the University of Pennsylvania School of Medicine, specializes in doing just that. Gur began his expert-witness career in the mid-1990s when a colleague asked him to help in the trial of a convicted serial killer in Florida named Bobby Joe Long. Known as the ''classified-ad rapist,'' because he would respond to classified ads placed by women offering to sell household items, then rape and kill them, Long was sentenced to death after he committed at least nine murders in Tampa. Gur was called as a national expert in positron-emission tomography, or PET scans, in which patients are injected with a solution containing radioactive markers that illuminate their brain activity.* After examining Long's PET scans, Gur testified that a motorcycle accident that had left Long in a coma had also severely damaged his amygdala. It was after emerging from the coma that Long committed his first rape.

''I didn't have the sense that my testimony had a profound impact,'' Gur told me recently . . . but he has testified at more than 20 capital cases since then. He wrote a widely circulated affidavit arguing that adolescents are not as capable of controlling their impulses as adults because the development of neurons in the prefrontal cortex isn't complete until the early 20s. Based on that affidavit, Gur was asked to contribute to the preparation of one of the briefs filed by neuroscientists and others in *Roper v. Simmons*, the landmark case in which a divided Supreme Court struck down the death penalty for offenders who committed crimes when they were under the age of 18.

The leading neurolaw brief in the case, filed by the American Medical Association and other groups, argued that because ''adolescent brains are not fully developed'' in the prefrontal regions, adolescents are less able than adults to control their impulses and should not be held fully accountable ''for the immaturity of their neural anatomy.'' In his majority decision, Justice Anthony Kennedy declared that, ''as any parent knows and as the scientific and sociological studies'' cited in the briefs ''tend to confirm, '[a] lack of maturity and an underdeveloped sense of responsibility are found in youth more often than in adults.''' Although Kennedy did not cite the neuroscience evidence specifically, his indirect reference to the scientific studies in the briefs led some supporters and critics to view the decision as the *Brown v. Board of Education* of neurolaw.

One important question raised by the *Roper* case was the question of where to draw the line in considering neuroscience evidence as a legal mitigation or excuse. Should courts be in the business of deciding when to mitigate someone's criminal responsibility because his brain functions improperly, whether because of age, inborn defects, or trauma? As we learn more about criminals' brains, will we have to redefine our most basic ideas of justice?

Two of the most ardent supporters of the claim that neuroscience requires the redefinition of guilt and punishment are Joshua D. Greene, an assistant professor of psychology at Harvard, and Jonathan D. Cohen, a professor of psychology who directs the neuroscience program at Princeton. Greene got Cohen interested in

* [Long subsequently entered into a plea agreement for eight of the murders and, after multiple appeals and remands, was spared the death penalty for the ninth murder in an acquittal due to evidentiary discrepancies. *Long v. State*, 689 So. 2d 1055 (Fla. 1997). — Eds.]

the legal implications of neuroscience, and together they conducted a series of experiments exploring how people's brains react to moral dilemmas involving life and death. In particular, they wanted to test people's responses in the fMRI scanner to variations of the famous trolley problem, which philosophers have been arguing about for decades.

The trolley problem goes something like this: Imagine a train heading toward five people who are going to die if you don't do anything. If you hit a switch, the train veers onto a side track and kills another person. Most people confronted with this scenario say it's O.K. to hit the switch. By contrast, imagine that you're standing on a footbridge that spans the train tracks, and the only way you can save the five people is to push an obese man standing next to you off the footbridge so that his body stops the train. Under these circumstances, most people say it's not O.K. to kill one person to save five.

''I wondered why people have such clear intuitions,'' Greene told me, ''and the core idea was to confront people with these two cases in the scanner and see if we got more of an emotional response in one case and reasoned response in the other.'' As it turns out, that's precisely what happened: Greene and Cohen found that the brain region associated with deliberate problem solving and self-control, the dorsolateral prefrontal cortex, was especially active when subjects confronted the first trolley hypothetical, in which most of them made a utilitarian judgment about how to save the greatest number of lives. By contrast, emotional centers in the brain were more active when subjects confronted the second trolley hypothetical, in which they tended to recoil at the idea of personally harming an individual, even under such wrenching circumstances. ''This suggests that moral judgment is not a single thing; it's intuitive emotional responses and then cognitive responses that are duking it out,'' Greene said.

''To a neuroscientist, you are your brain; nothing causes your behavior other than the operations of your brain,'' Greene says. ''If that's right, it radically changes the way we think about the law. The official line in the law is all that matters is whether you're rational, but you can have someone who is totally rational but whose strings are being pulled by something beyond his control.'' In other words, even someone who has the illusion of making a free and rational choice between soup and salad may be deluding himself, since the choice of salad over soup is ultimately predestined by forces hard-wired in his brain. Greene insists that this insight means that the criminal-justice system should abandon the idea of retribution — the idea that bad people should be punished because they have freely chosen to act immorally — which has been the focus of American criminal law since the 1970s, when rehabilitation went out of fashion. Instead, Greene says, the law should focus on deterring future harms. In some cases, he supposes, this might mean lighter punishments. ''If it's really true that we don't get any prevention bang from our punishment buck when we punish that person, then it's not worth punishing that person,'' he says. (On the other hand, Carter Snead, the Notre Dame scholar, maintains that capital defendants who are not considered fully blameworthy under current rules could be executed more readily under a system that focused on preventing future harms.)

Others agree with Greene and Cohen that the legal system should be radically refocused on deterrence rather than on retribution. Since the celebrated M'Naughten case in 1843, involving a paranoid British assassin, English and

American courts have recognized an insanity defense only for those who are unable to appreciate the difference between right and wrong. (This is consistent with the idea that only rational people can be held criminally responsible for their actions.) According to some neuroscientists, that rule makes no sense in light of recent brain-imaging studies. ''You can have a horrendously damaged brain where someone knows the difference between right and wrong but nonetheless can't control their behavior,'' says Robert Sapolsky, a neurobiologist at Stanford. ''At that point, you're dealing with a broken machine, and concepts like punishment and evil and sin become utterly irrelevant. Does that mean the person should be dumped back on the street? Absolutely not. You have a car with the brakes not working, and it shouldn't be allowed to be near anyone it can hurt.''

Even as these debates continue, some skeptics contend that both the hopes and fears attached to neurolaw are overblown. ''There's nothing new about the neuroscience ideas of responsibility; it's just another material, causal explanation of human behavior,'' says Stephen J. Morse, professor of law and psychiatry at the University of Pennsylvania. ''How is this different than the Chicago school of sociology,'' which tried to explain human behavior in terms of environment and social structures? ''How is it different from genetic explanations or psychological explanations? The only thing different about neuroscience is that we have prettier pictures and it appears more scientific.''

Morse insists that ''brains do not commit crimes; people commit crimes''—a conclusion he suggests has been ignored by advocates who, ''infected and inflamed by stunning advances in our understanding of the brain . . . all too often make moral and legal claims that the new neuroscience . . . cannot sustain.'' He calls this ''brain overclaim syndrome'' and cites as an example the neuroscience briefs filed in the Supreme Court case *Roper v. Simmons* to question the juvenile death penalty. ''What did the neuroscience add?'' he asks. If adolescent brains caused all adolescent behavior, ''we would expect the rates of homicide to be the same for 16- and 17-year-olds everywhere in the world—their brains are alike—but, in fact, the homicide rates of Danish and Finnish youths are very different than American youths.'' Morse agrees that our brains bring about our behavior—''I'm a thoroughgoing materialist, who believes that all mental and behavioral activity is the causal product of physical events in the brain''—but he disagrees that the law should excuse certain kinds of criminal conduct as a result. ''It's a total non sequitur,'' he says. ''So what if there's biological causation? Causation can't be an excuse for someone who believes that responsibility is possible. Since all behavior is caused, this would mean all behavior has to be excused.'' Morse cites the case of Charles Whitman, a man who, in 1966, killed his wife and his mother, then climbed up a tower at the University of Texas and shot and killed 13 more people before being shot by police officers. Whitman was discovered after an autopsy to have a tumor that was putting pressure on his amygdala. ''Even if his amygdala made him more angry and volatile, since when are anger and volatility excusing conditions?'' Morse asks. ''Some people are angry because they had bad mommies and daddies and others because their amygdalas are mucked up. The question is: When should anger be an excusing condition?''

Still, Morse concedes that there are circumstances under which new discoveries from neuroscience could challenge the legal system at its core. ''Suppose neuroscience could reveal that reason actually plays no role in determining human behavior,'' he suggests tantalizingly. ''Suppose I could show you that your intentions and your reasons for your actions are post hoc rationalizations that somehow your brain generates to explain to you what your brain has already done'' without your conscious participation. If neuroscience could reveal us to be automatons in this respect, Morse is prepared to agree with Greene and Cohen that criminal law would have to abandon its current ideas about responsibility and seek other ways of protecting society.

Some scientists are already pushing in this direction. In a series of famous experiments in the 1970s and '80s, Benjamin Libet measured people's brain activity while telling them to move their fingers whenever they felt like it. Libet detected brain activity suggesting a readiness to move the finger half a second before the actual movement and about 400 milliseconds before people became aware of their conscious intention to move their finger. Libet argued that this leaves 100 milliseconds for the conscious self to veto the brain's unconscious decision, or to give way to it—suggesting, in the words of the neuroscientist Vilayanur S. Ramachandran, that we have not free will but ''free won't.''

Morse is not convinced that the Libet experiments reveal us to be helpless automatons. But he does think that the study of our decision-making powers could bear some fruit for the law. ''I'm interested,'' he says, ''in people who suffer from drug addictions, psychopaths and people who have intermittent explosive disorder—that's people who have no general rationality problem other than they just go off.'' In other words, Morse wants to identify the neural triggers that make people go postal. ''Suppose we could show that the higher deliberative centers in the brain seem to be disabled in these cases,'' he says. ''If these are people who cannot control episodes of gross irrationality, we've learned something that might be relevant to the legal ascription of responsibility.'' That doesn't mean they would be let off the hook, he emphasizes: ''You could give people a prison sentence and an opportunity to get fixed.''

IV. Putting the Unconscious on Trial. If debates over criminal responsibility long predate the fMRI, so do debates over the use of lie-detection technology. What's new is the prospect that lie detectors in the courtroom will become much more accurate, and correspondingly more intrusive. There are, at the moment, two lie-detection technologies that rely on neuroimaging, although the value and accuracy of both are sharply contested. The first, developed by Lawrence Farwell in the 1980s, is known as ''brain fingerprinting.'' Subjects put on an electrode-filled helmet that measures a brain wave called p300, which, according to Farwell, changes its frequency when people recognize images, pictures, sights, and smells. After showing a suspect pictures of familiar places and measuring his p300 activation patterns, government officials could, at least in theory, show a suspect pictures of places he may or may not have seen before—a Qaeda training camp, for example, or a crime scene—and compare the activation patterns. (By detecting not only lies but also honest cases of forgetfulness, the technology could expand our very idea of lie detection.)

The second lie-detection technology uses fMRI machines to compare the brain activity of liars and truth tellers. It is based on a test called Guilty Knowledge, developed by Daniel Langleben at the University of Pennsylvania in 2001. Langleben gave subjects a playing card before they entered the magnet and told them to answer no to a series of questions, including whether they had the card in question.

Langleben and his colleagues found that certain areas of the brain lit up when people lied.

Two companies, No Lie MRI and Cephos, are now competing to refine fMRI lie-detection technology so that it can be admitted in court and commercially marketed. I talked to Steven Laken, the president of Cephos, which plans to begin selling its products this year. ''We have two to three people who call every single week,'' he told me. ''They're in legal proceedings throughout the world, and they're looking to bolster their credibility.'' Laken said the technology could have ''tremendous applications'' in civil and criminal cases. On the government side, he said, the technology could replace highly inaccurate polygraphs in screening for security clearances, as well as in trying to identify suspected terrorists' native languages and close associates. ''In lab studies, we've been in the 80- to 90-percent-accuracy range,'' Laken says. This is similar to the accuracy rate for polygraphs, which are not considered sufficiently reliable to be allowed in most legal cases. Laken says he hopes to reach the 90-percent- to 95-percent-accuracy range — which should be high enough to satisfy the Supreme Court's standards for the admission of scientific evidence. Judy Illes, director of Neuroethics at the Stanford Center for Biomedical Ethics, says, ''I would predict that within five years, we will have technology that is sufficiently reliable at getting at the binary question of whether someone is lying that it may be utilized in certain legal settings.''

If and when lie-detection fMRI's are admitted in court, they will raise vexing questions of self-incrimination and privacy. Hank Greely, a law professor and head of the Stanford Center for Law and the Biosciences, notes that prosecution and defense witnesses might have their credibility questioned if they refused to take a lie-detection fMRI, as might parties and witnesses in civil cases. Unless courts found the tests to be shocking invasions of privacy, like stomach pumps, witnesses could even be compelled to have their brains scanned. And equally vexing legal questions might arise as neuroimaging technologies move beyond telling whether or not someone is lying and begin to identify the actual content of memories. Michael Gazzaniga, a professor of psychology at the University of California, Santa Barbara, and author of ''The Ethical Brain,'' notes that within 10 years, neuroscientists may be able to show that there are neurological differences when people testify about their own previous acts and when they testify to something they saw. ''If you kill someone, you have a procedural memory of that, whereas if I'm standing and watch you kill somebody, that's an episodic memory that uses a different part of the brain,'' he told me. Even if witnesses don't have their brains scanned, neuroscience may lead judges and jurors to conclude that certain kinds of memories are more reliable than others because of the area of the brain in which they are processed. Further into the future, and closer to science fiction, lies the possibility of memory downloading. ''One could even, just barely, imagine a technology that might be able to 'read out' the witness's memories, intercepted as neuronal firings, and translate it directly into voice, text, or the equivalent of a movie,'' Hank Greely writes.

Greely acknowledges that lie-detection and memory-retrieval technologies like this could pose a serious challenge to our freedom of thought, which is now defended largely by the First Amendment protections for freedom of expression. ''Freedom of thought has always been buttressed by the reality that you could only tell what someone thought based on their behavior,'' he told me. ''This technology holds out the possibility of looking through the skull and seeing what's really happening, seeing the thoughts themselves.'' According to Greely, this may challenge the principle that we should be held accountable for what we do, not what we think. ''It opens up for the first time the possibility of punishing people for their thoughts rather than their actions,'' he says. ''One reason thought has been free in the harshest dictatorships is that dictators haven't been able to detect it.'' He adds, ''Now they may be able to, putting greater pressure on legal constraints against government interference with freedom of thought.''

In the future, neuroscience could also revolutionize the way jurors are selected. Steven Laken, the president of Cephos, says that jury consultants might seek to put prospective jurors in fMRI's. ''You could give videotapes of the lawyers and witnesses to people when they're in the magnet and see what parts of their brains light up,'' he says. A situation like this would raise vexing questions about jurors' prejudices — and what makes for a fair trial. Recent experiments have suggested that people who believe themselves to be free of bias may harbor plenty of it all the same.

The experiments, conducted by Elizabeth Phelps, who teaches psychology at New York University, combine brain scans with a behavioral test known as the Implicit Association Test, or I.A.T., as well as physiological tests of the startle reflex. The I.A.T. flashes pictures of black and white faces at you and asks you to associate various adjectives with the faces. Repeated tests have shown that white subjects take longer to respond when they're asked to associate black faces with positive adjectives and white faces with negative adjectives than vice versa, and this is said to be an implicit measure of unconscious racism. Phelps and her colleagues added neurological evidence to this insight by scanning the brains and testing the startle reflexes of white undergraduates at Yale before they took the I.A.T. She found that the subjects who showed the most unconscious bias on the I.A.T. also had the highest activation in their amygdalas — a center of threat perception — when unfamiliar black faces were flashed at them in the scanner. By contrast, when subjects were shown pictures of familiar black and white figures — like Denzel Washington, Martin Luther King Jr., and Conan O'Brien — there was no jump in amygdala activity.

The legal implications of the new experiments involving bias and neuroscience are hotly disputed. Mahzarin R. Banaji, a psychology professor at Harvard who helped to pioneer the I.A.T., has argued that there may be a big gap between the concept of intentional bias embedded in law and the reality of unconscious racism revealed by science. When the gap is ''substantial,'' she and the U.C.L.A. law professor Jerry Kang have argued, ''the law should be changed to comport with science'' — relaxing, for example, the current focus on intentional discrimination and trying to root out unconscious bias in the workplace with ''structural interventions,'' which critics say may be tantamount to racial quotas. One legal scholar has cited Phelps's work to argue for the elimination of peremptory challenges to prospective jurors — if most whites are unconsciously racist, the argument goes, then any decision to strike a black juror must be infected with racism. Much to her displeasure, Phelps's work has been cited by a journalist to suggest that a white cop who accidentally shot a black teenager on a Brooklyn rooftop in 2004 must have been responding to a hard-wired fear of unfamiliar black faces — a version of the amygdala made me do it.

Phelps herself says it's ''crazy'' to link her work to cops who shoot on the job and insists that it is too early to use her research in the courtroom. ''Part of my discomfort is that we haven't linked what we see in the amygdala or any other region of the brain with an activity outside the magnet that we would call racism,'' she told me. ''We have no evidence whatsoever that activity in the brain is more predictive of things we care about in the courtroom than the behaviors themselves that we correlate with brain function.'' In other words, just because you have a biased reaction to a photograph doesn't mean you'll act on those biases in the workplace. Phelps is also concerned that jurors might be unduly influenced by attention-grabbing pictures of brain scans. ''Frank Keil, a psychologist at Yale, has done research suggesting that, when you have a picture of a mechanism, you have a tendency to overestimate how much you understand the mechanism,'' she told me. Defense lawyers confirm this phenomenon. ''Here was this nice color image we could enlarge, that the medical expert could point to,'' Christopher Plourd, a San Diego criminal-defense lawyer, told the *Los Angeles Times* in the early 1990s. ''It documented that this guy had a rotten spot in his brain. The jury glommed onto that.''

Other scholars are even sharper critics of efforts to use scientific experiments about unconscious bias to transform the law. ''I regard that as an extraordinary claim that you could screen potential jurors or judges for bias; it's mind-boggling,'' I was told by Philip Tetlock, professor at the Haas School of Business at the University of California at Berkeley. Tetlock has argued that split-second associations between images of African Americans and negative adjectives may reflect ''simple awareness of the social reality'' that ''some groups are more disadvantaged than others.'' He has also written that, according to psychologists, ''there is virtually no published research showing a systematic link between racist attitudes, overt or subconscious, and real-world discrimination.'' (A few studies show, Tetlock acknowledges, that openly biased white people sometimes sit closer to whites than blacks in experiments that simulate job hiring and promotion.) ''A light bulb going off in your brain means nothing unless it's correlated with a particular output, and the brain-scan stuff, heaven help us, we have barely linked that with anything,'' agrees Tetlock's co-author, Amy Wax of the University of Pennsylvania Law School. ''The claim that homeless people light up your amygdala more and your frontal cortex less and we can infer that you will systematically dehumanize homeless people — that's piffle.''

V. Are You Responsible for What You Might Do? The attempt to link unconscious bias to actual acts of discrimination may be dubious. But are there other ways to look inside the brain and make predictions about an individual's future behavior? And if so, should those discoveries be employed to make us safer? Efforts to use science to predict criminal behavior have a disreputable history. In the nineteenth century, the Italian criminologist Cesare Lombroso championed a theory of ''biological criminality,'' which held that criminals could be identified by physical characteristics, like large jaws or bushy eyebrows. Nevertheless, neuroscientists are trying to find the factors in the brain associated with violence. PET scans of convicted murderers were first studied in the late 1980s by Adrian Raine, a professor of psychology at the University of Southern California; he found that their prefrontal cortexes, areas associated with inhibition, had reduced glucose metabolism and suggested that this might be responsible for their violent behavior. In a later study, Raine found that subjects who received a diagnosis of antisocial personality disorder, which correlates with violent behavior, had 11 percent less gray matter in their prefrontal cortexes than control groups of healthy subjects and substance abusers. His current research uses fMRI's to study moral decision-making in psychopaths.

Neuroscience, it seems, points two ways: it can absolve individuals of responsibility for acts they've committed, but it can also place individuals in jeopardy for acts they haven't committed — but might someday. ''This opens up a Pandora's box in civilized society that I'm willing to fight against,'' says Helen S. Mayberg, a professor of psychiatry, behavioral sciences, and neurology at Emory University School of Medicine, who has testified against the admission of neuroscience evidence in criminal trials. ''If you believe at the time of trial that the picture informs us about what they were like at the time of the crime, then the picture moves forward. You need to be prepared for: 'This spot is a sign of future dangerousness,' when someone is up for parole. They have a scan, the spot is there, so they don't get out. It's carved in your brain.''

Other scholars see little wrong with using brain scans to predict violent tendencies and sexual predilections — as long as the scans are used within limits. ''It's not necessarily the case that, if predictions work, you would say take that guy off the street and throw away the key,'' says Hank Greely, the Stanford law professor. ''You could require counseling, surveillance, G.P.S. transmitters, or warning the neighbors. None of these are necessarily benign, but they beat the heck out of preventative detention.'' Greely has little doubt that predictive technologies will be enlisted in the war on terror — perhaps in radical ways. ''Even with today's knowledge, I think we can tell whether someone has a strong emotional reaction to seeing things, and I can certainly imagine a friend-versus-foe scanner. If you put everyone who reacts badly to an American flag in a concentration camp or Guantánamo, that would be bad, but, in an occupation situation, to mark someone down for further surveillance, that might be appropriate.''

Paul Root Wolpe, who teaches social psychiatry and psychiatric ethics at the University of Pennsylvania School of Medicine, says he anticipates that neuroscience predictions will move beyond the courtroom and will be used to make predictions about citizens in all walks of life. ''Will we use brain imaging to track kids in school because we've discovered that certain brain function or morphology suggests aptitude?'' he asks. ''I work for NASA, and imagine how helpful it might be for NASA if it could scan your brain to discover whether you have a good enough spatial sense to be a pilot.'' Wolpe says that brain imaging might eventually be used to decide if someone is a worthy foster or adoptive parent — a history of major depression and cocaine abuse can leave telltale signs on the brain, for example, and future studies might find parts of the brain that correspond to nurturing and caring.

The idea of holding people accountable for their predispositions rather than their actions poses a challenge to one of the central principles of Anglo-American jurisprudence: namely, that people are responsible for their behavior, not their proclivities — for what they do, not what they think. ''We're going to have to make a decision about the skull as a privacy domain,'' Wolpe says. Indeed, Wolpe serves on the board of an organization called the Center for Cognitive Liberty and Ethics, a group of neuroscientists, legal scholars, and privacy advocates ''dedicated to protecting and advancing freedom of thought in the modern world of accelerating neurotechnologies.''

There may be similar ''cognitive liberty'' battles over efforts to repair or enhance broken brains. A remarkable technique called transcranial magnetic stimulation, for example, has been used to stimulate or inhibit specific regions of the brain. It can temporarily alter how we think and feel. Using T.M.S., Ernst Fehr and Daria Knoch of the University of Zurich temporarily disrupted each side of the dorsolateral prefrontal cortex in test subjects. They asked their subjects to participate in an experiment that economists call the ultimatum game. One person is given $20 and told to divide it with a partner. If the partner rejects the proposed amount as too low, neither person gets any money. Subjects whose prefrontal cortexes were functioning properly tended to reject offers of $4 or less: they would rather get no money than accept an offer that struck them as insulting and unfair. But subjects whose right prefrontal cortexes were suppressed by T.M.S. tended to accept the $4 offer. Although the offer still struck them as insulting, they were able to suppress their indignation and to pursue the selfishly rational conclusion that a low offer is better than nothing.

Some neuroscientists believe that T.M.S. may be used in the future to enforce a vision of therapeutic justice, based on the idea that defective brains can be cured. ''Maybe somewhere down the line, a badly damaged brain would be viewed as something that can heal, like a broken leg that needs to be repaired,'' the neurobiologist Robert Sapolsky says, although he acknowledges that defining what counts as a normal brain is politically and scientifically fraught. Indeed, efforts to identify normal and abnormal brains have been responsible for some of the darkest movements in the history of science and technology, from phrenology to eugenics. ''How far are we willing to go to use neurotechnology to change people's brains we consider disordered?'' Wolpe asks. ''We might find a part of the brain that seems to be malfunctioning, like a discrete part of the brain operative in violent or sexually predatory behavior, and then turn off or inhibit that behavior using transcranial magnetic stimulation.'' Even behaviors in the normal range might be fine-tuned by T.M.S.: jurors, for example, could be made more emotional or more deliberative with magnetic interventions. Mark George, an adviser to the Cephos company and director of the Medical University of South Carolina Center for Advanced Imaging Research, has submitted a patent application for a T.M.S. procedure that supposedly suppresses the area of the brain involved in lying and makes a person less capable of not telling the truth.

As the new technologies proliferate, even the neurolaw experts themselves have only begun to think about the questions that lie ahead. Can the police get a search warrant for someone's brain? Should the Fourth Amendment protect our minds in the same way that it protects our houses? Can courts order tests of suspects' memories to determine whether they are gang members or police informers, or would this violate the Fifth Amendment's ban on compulsory self-incrimination? Would punishing people for their thoughts rather than for their actions violate the Eighth Amendment's ban on cruel and unusual punishment? However astonishing our machines may become, they cannot tell us how to answer these perplexing questions. We must instead look to our own powers of reasoning and intuition, relatively primitive as they may be. As Stephen Morse puts it, neuroscience itself can never identify the mysterious point at which people should be excused from responsibility for their actions because they are not able, in some sense, to control themselves. That question, he suggests, is ''moral and ultimately legal,'' and it must be answered not in laboratories but in courtrooms and legislatures. In other words, we must answer it ourselves.

NOTES AND QUESTIONS

1. React to this Letter to the Editor, which was sent in response to the article above (April 1, 2007). The author states that *The Brain on the Stand* reminds us ''that a form of phrenology is alive and well in the 21st century. . . . Let's get away from looking for easy answers and bumps on (or inside) the head to explain why we act as we do. The world, and we, are much more complex than that.''
2. Many of the experts interviewed for the Rosen article suggest, either explicitly or implicitly, that we are nothing more than our brains. But many see things differently. Consider philosopher Tyler Burge's argument: ''Individuals see, know, and want to make love. Brains don't. Those things are psychological—not, in any evident way, neural.'' Tyler Burge, *A Real Science of Mind,* N.Y. Times (Dec. 19, 2010). In what ways do you agree or disagree?
3. Supreme Court Justice Anthony Kennedy is one of the many judges who have criticized sentencing practices in the United States for being too severe. For instance, sentences in the U.S. are eight times longer on average than those in Europe, contributing to a much higher rate of incarceration. Editorial, *Justice Kennedy on Prisons*, N.Y. Times (Feb. 16, 2010). Based on what you've read in this article, what do you see as the potential implications of neuroscience for sentencing and incarceration practices, and why?
4. In 2009, Dr. Martha Farah, a cognitive neuroscientist at the University of Pennsylvania, observed that ''neuroscience is giving us increasingly powerful methods for understanding, predicting, and manipulating behavior. Every sphere of life in which the human mind plays a central role will be touched by these advances.'' Univ. Pennsylvania Press Release (Aug. 14, 2009). Neuroscientist Joshua Greene and psychologist Jonathan Cohen have similarly argued that ''cognitive neuroscience, by identifying the specific mechanisms responsible for behavior, will vividly illustrate what until now could only be appreciated through esoteric theorizing: that there is something fishy about our ordinary conceptions of human action and responsibility, and that, as a result, the legal principles we have devised to reflect these conceptions may be flawed.'' Joshua Greene & Jonathan Cohen, *For the Law, Neuroscience Changes Nothing and Everything,* 359 Phil. Trans. R. Soc. Lond. B. 1775 (2004). What pronouncements, if any, would you make about the implications if neuroscience?
5. United States District Court Judge Jed Rakoff has observed that ''as neuroscience enters the courtroom . . . [there is a] growing perception among judges that [it] has the potential to be of great service, and challenge, to a great many aspects of the law.'' In what ways do you think might neuroscience be of service? And when and how might it pose significant challenges to judges? Judge Rakoff has also observed that the law ''has struggled both to define relevant states of mind and to devise ways of perceiving them.'' Can neuroscience help law in defining and perceiving mental states? Why or why not? The SAGE Center for the Study of the Mind, *A Judge's Guide to Neuroscience: A Concise Introduction* 1, 1 (2010).

6. In addition to neuroscience researchers and treating clinicians, criminologists are also making use of neuroscience and behavioral genetics. The field of ''biosocial criminology,'' which like neurolaw is only now emerging, seeks to integrate knowledge from the biological sciences (including genetics, evolutionary psychology, and the neurosciences) into criminology. The goal is a greater understanding of criminal behavior. See *Biosocial Criminology: New Directions in Theory and Research*, (Anthony Walsh & Kevin M. Beaver eds., 2009). How might findings from biosocial criminology be relevant to the criminal justice system?
7. In his 2013 book *The Anatomy of Violence*, neurocriminologist Adrian Raine suggests that neuroscience may one day allow society to preemptively intervene into the lives (and brains) of would-be criminals. Raine asks his readers to imagine that in 2034 the government launches the LOMBROSO program, ''Legal Offensive on Murder: Brain Research Operation for the Screening of Offenders.'' Under this program, every adult male must have a brain scan and submit a DNA sample to the government. Using this data and algorithms that are improved over time, some of these males are labeled as ''Lombroso Positive'' (LP). The LPs are held in a detention center (though they do have an opportunity to legally challenge the findings). LPs are retested each year, and can become eligible for release back into the community. Raine further imagines, in 2040, the creation of a National Child Screening Program (NCSP), which would apply to all children ten years and above. The picture Raine paints is, of course, purely speculative at this point. But Raine argues that this is a realistic, and indeed likely a desirable, future. Do you agree?
8. Lie detection, the subject of a later chapter in this book, has been a focus of much neurolaw research. A 2001 editorial in *Nature Neuroscience* suggested that questions about the efficacy of neuroscience-based lie detection can ''only be resolved by extensive field-testing. This seems desirable; although EEG testing may raise the specter of 'Big Brother' in the public imagination, it is in reality just another tool for determining the facts, no different in principle from handwriting, fiber, or DNA evidence. Moreover, its use by prosecutors, at least in the U.S., would be governed by the constitutional protection against self-incrimination, and its main application in the courts would probably be to argue for innocence rather than guilt.'' *Forensic Neuroscience on Trial*, 4 Nature Neuroscience 1, 1 (2001). Do you agree that neuroscientific evidence is no different than handwriting, fiber, or DNA evidence? Or is neuroscience categorically different?

C. FUTURE POSSIBILITIES FOR LAW AND NEUROSCIENCE

Stacey Tovino

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

7 Am. J. of Bioethics 44 (2007)

. . . 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 suggests several interesting applications.

One traditional view of property is its dependency on the law for its existence. Jeremy Bentham in 1802 stated: ''[T]here 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.'' 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.

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. A second property concept involves possession, which is said to require both physical control and intent to assert control. 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.

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? Or is the ability to recognize and adhere to specific conventions part of our behavioral repertoire? Do we have a natural feeling that we can transfer things to other people? What about a natural instinct of how to transfer or dispose of property? 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?

Moving beyond traditional property law, scholars have identified several intellectual-property implications of advances in functional neuroimaging. 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? 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? Or is there no ''composition of matter''— no structure or molecule in BOLD activity— that can be patented? . . .

Moving from patent to copyright issues, recent studies suggest 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). 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. If not, should we adopt a new test for determining whether there is sufficient evidence of creativity in a work to grant a copyright?

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, 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. 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.

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. 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. If so, will functional neuroimaging provide increasingly objective methods of assessing the severity of an individual's pain? 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 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. 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. 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?). 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.

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. 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? If neuroscientific evidence is accepted as tangible proof of a plaintiff's otherwise intangible distress, will that end the courts' distrust of the tort? 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. Early speculation that fMRI could be used as a commercial lie detector 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, 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.

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. 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. . . .

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.'' 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? Or is it good enough that BOLD signal has been found to be a ''close approximation,'' or a ''faithful signal,'' of neuronal activity? 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 2006b). 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 state that fMRI has ''potential applications to a wide variety of concerns held by individual citizens [including] risk reduction in dating[, t]rust 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? 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?

HEALTH LAW: CONFIDENTIALITY AND PRIVACY

. . . The confidentiality and privacy issues raised by advances in functional neuroimaging were recognized early and are discussed often. 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 ''neuroprivacy.''

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. 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. The literature suggests that there are gaps in confidentiality protections for functional-neuroimaging information and privacy protections for individuals whose brains are scanned. . . .

The million-dollar question identified in this literature is whether functional neuroimaging information requires special, or heightened, confidentiality and privacy protections. 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[-]exceptionalism''—should be implemented. Some have suggested that the answer is ''yes.''

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; the existence of state genetic-discrimination legislation in health insurance, employment, and life insurance; the existence of ethical provisions addressing the disclosure of genetic information to insurers and law-enforcement agencies; the possible predictive value of some functional-neuroimaging information; the sensitive and potentially stigmatizing nature of some functional-neuroimaging information; the fact that functional-neuroimaging information may not now (although it could in the future) carry a stigma like genetic information; the fact that the public may not now (although it could in the future) regard functional-neuroimaging information as unique; 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. 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. Along these lines, a law professor and a scientist have already 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.

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. Given that one company currently is marketing its brain-scanning services directly to employers, 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.

One potential source of privacy rights for employees and job applicants is Title I of the federal Americans with Disabilities Act (ADA). 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. 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. . . . 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?

. . . The question becomes how the ADA's rules regarding medical examinations (which differ at the preemployment, preplacement, 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). The EPPA prohibits some, but not all, employers from requiring employees to submit to lie-detector tests, defined to include polygraphs, deceptographs, 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,'' 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. The Pentagon's Defense Advanced Research Projects Agency (DARPA) (Arlington, VA) reportedly has funded research at Lockheed Martin (Bethesda, MD) 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. 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. 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.'' 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). . . .

. . . [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. 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.

FIFTH AMENDMENT

. . . 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. . . .

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. 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. . . .

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, 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? 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. 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?

FOURTH AMENDMENT

The Fourth Amendment implications of functional neuroimaging have been introduced in the literature. 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. 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. . . .

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? . . .

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. 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, 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. 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. Would a court weigh more heavily a government's interest in determining 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?

Nita Farahany

The Government Is Trying to Wrap Its Mind Around Yours

Wash. Post, Apr. 13, 2008

Imagine a world of streets lined with video cameras that alert authorities to any suspicious activity. A world where police officers can read the minds of potential criminals and arrest them before they commit any crimes. A world in which a suspect who lies under questioning gets nabbed immediately because his brain has given him away.

Though that may sound a lot like the plot of the 2002 movie ''Minority Report,'' starring Tom Cruise and based on a Philip K. Dick novel, I'm not talking about science fiction here; it turns out we're not so far away from that world. But does it sound like a very safe place, or a very scary one?

It's a question I think we should be asking as the federal government invests millions of dollars in emerging technology aimed at detecting and decoding brain activity. And though government funding focuses on military uses for these new gizmos, they can and do end up in the hands of civilian law enforcement and in commercial applications. As spending continues and neurotechnology advances, that imagined world is no longer the stuff of science fiction or futuristic movies, and we postpone at our peril confronting the ethical and legal dilemmas it poses for a society that values not just personal safety but civil liberty as well.

Consider Cernium Corp.'s ''Perceptrak'' video surveillance and monitoring system, recently installed by Johns Hopkins University, among others. This technology grew out of a project funded by the Defense Advanced Research Projects Agency — the central research-and-development organization for the Department of Defense — to develop intelligent video-analytics systems. Unlike simple video cameras monitored by security guards, Perceptrak integrates video cameras with an intelligent computer video. It uses algorithms to analyze streaming video and detect suspicious activities, such as people loitering in a secure area, a group converging, or someone leaving a package unattended. Since installing Perceptrak, Johns Hopkins has reported a 25 percent reduction in crime.

But that's only the beginning. Police may soon be able to monitor suspicious brain activity from a distance as well. New neurotechnology soon may be able to detect a person who is particularly nervous, in possession of guilty knowledge, or, in the more distant future, to detect a person thinking, ''Only one hour until the bomb explodes.'' Today, the science of detecting and decoding brain activity is in its infancy. But various government agencies are funding the development of technology to detect brain activity remotely and are hoping to eventually decode what someone is thinking. Scientists, however, wildly disagree about the accuracy of brain imaging technology, what brain activity may mean and especially whether brain activity can be detected from afar.

Yet as the experts argue about the scientific limitations of remote brain detection, this chilling science fiction may already be a reality. In 2002, the Electronic Privacy Information Center reported that NASA was developing brain-monitoring devices for airports and was seeking to use noninvasive sensors in passenger gates to collect the electronic signals emitted by passengers' brains. Scientists scoffed at the reports, arguing that to do what NASA was proposing required that an electroencephalogram (EEG) be physically attached to the scalp.

But that same year, scientists at the University of Sussex in England adapted the same technology they had been using to detect heart rates at distances of up to one meter, or a little more than three feet, to remotely detect changes in the brain. And while scientific limitations to remote EEG detection still exist, clearly the question is when, not if, these issues will be resolved.

Meanwhile, another remote brain-activity detector, which uses light beamed through the skull to measure changes in oxygen levels in the brain, may be on the way. Together with the EEG, it would enhance the power of brain scanning. Today the technology consists of a headband sensor worn by the subject, a control box to capture the data, and a computer to analyze it. With the help of government funding, however, that is all becoming increasingly compact and portable, paving the way for more specific remote detection of brain activity. But don't panic: The government can't read our minds—yet. So far, these tools simply measure changes in the brain; they don't detect thoughts and intentions.

Scientists, though, are hard at work trying to decode how those signals relate to mental states such as perception and intention. Different EEG frequencies, for example, have been associated with fear, anger, joy, and sorrow and different cognitive states such as a person's level of alertness. So when you're stopped for speeding and terrified because you're carrying illegal drugs in the trunk of your car, EEG technology might enable the police to detect your fear or increased alertness. This is not so far-fetched: Some scientists already are able to tell from brain images in the lab whether a test subject was envisioning a tool such as a hammer or a screwdriver or a dwelling, and to predict whether the subject intended to add or subtract numbers. . . .

Although brain-based lie-detection technology has been quite controversial and has only been tested on a limited basis, early researchers have claimed high accuracy at detecting deception. But there's a problem: Most brain-based lie-detection tests assume that lying should result in more brain activity than truth-telling because lying involves more cognition. So these lie-detection methods may fail in sociopaths or in individuals who believe in the falsehood they're telling.

Whether such technology will be effective outside the laboratory remains to be seen, but the very fact that the government is banking on its future potential raises myriad questions. Imagine, for example, a police officer approaching a suspect based on Perceptrak's ''unusual activity'' detection. Equipped with remote neural-detection technology, the officer asks her a few questions, and the detection device deems her responses to be deceptive. Will this be enough evidence for an arrest? Can it be used to convict a person of intent to commit a crime? Significant scientific hurdles remain before neurotechnology can be used that way, but, given how fast it's developing, I think we must pause now to ask how it may affect the fundamental precepts of our criminal-justice system.

Americans have been willing to tolerate significant new security measures and greater encroachments on civil liberties after the terrorist attacks of Sept. 11, 2001. Could reports of significant crime reduction such as that seen by Johns Hopkins, or incidents such as the student shootings last year at Virginia Tech or more recently at Northern Illinois University, be enough to justify the use of precrime technology? Could remote neural monitoring together with intelligent video analytics have prevented those tragedies? And if they could, should they be allowed to?

These are just some of the questions we must ask as we balance scientific advances and the promise of enhanced safety against a loss of liberty. And we must do it now, while our voices still matter. In a world where private thoughts are no longer private, what will our protections be?

NOTES AND QUESTIONS

1. To ask whether ''neuroscience'' will affect ''law'' is of course actually to ask whether *specific types* of neuroscientific findings will affect *specific types* of law in *specific kinds* of legal contexts. Professor Tovino identifies a number of possible intersections for law and neuroscience. Before delving deeper into the neuroscience later in this coursebook, take a moment to assess your first impressions. What specific areas of law are most likely to be affected by neuroscience? How and why did you identify those areas?
2. As brain science matures, claims about brain health are increasing as well. For instance, one brand of milk includes the following on their milk cartons: ''Kids' brains grow incredibly fast. In fact the brain nearly quadruples in the first five years of life. Up to 20 percent of the human brain is made of DHA, yet most kids don't get their recommended DHA from common dietary sources like fish. By making Horizon Organic Milk Plus DHA your family choice, you're bringing home all the goodness of organic plus an extra nutritional boost for growing minds and bodies.'' How would you evaluate such a claim? In *Barrera v. Dean Foods* (No. 11-CV2249L, filed Sept. 27, 2011), a plaintiff is suing Dean Foods for false, misleading, and deceitful representations. The plaintiff in the case argues that clinical cause and effect studies have found no causative link between DHA algal oil supplementation and brain health.

3. The selections from Tovino and Farahany suggest that the government may use brain imaging to "read minds." What does it mean to read someone's mind? And if brain-based mind reading were possible, would you see such uses as more akin to the government administering a blood test, forcing a confession, or something else?
4. Headlines such as "Brain Scanning May Be Used in Security Checks" have not been uncommon in recent years, and a 2012 review found that "the US national security establishment has come to see neuroscience as a promising and integral component of its 21st century needs." Michael N. Tennison & Jonathan D. Moreno, *Neuroscience, Ethics, and National Security: The State of the Art*, 10 PLoS Biology e1001289 (2012). In what ways might neuroscience contribute to governments' national security efforts?
5. Brain science might also play a role in understanding, administering, and critiquing interrogation techniques. The release of Department of Justice memos in 2009 detailing coercive interrogation techniques used on terrorist suspects has raised questions about the underlying science of such techniques. The premise is simple: continuously inflicting shock, stress, anxiety, disorientation, and lack of control will induce suspects to reveal reliable information from long-term memory. But, as you will read in the chapter on memory, this is not necessarily the case. While studies have shown that extreme stress impairs the ability to recall previously learned information and prior events, mildly stressful events in fact enhance recall. One neuroscientist suggests that "[t]he experience of capture, transport and subsequent challenging questioning would seem to be more than enough to make suspects reveal information." Shane O'Mara, *Torturing the Brain: On the Folk Psychology and Folk Neurobiology Motivating "Enhanced and Coercive Interrogation Techniques,"* 13 Trends in Cognitive Sci. 497, 498 (2009). Can neuroscience help to draw the line between permissible and non-permissible interrogation techniques? See Jonathan H. Marks, *Interrogational Neuroimaging in Counterterrorism: A "No-Brainer" or a Human Rights Hazard?*, 33 Am J.L. Med. 483 (2007).
6. The readings in this chapter have discussed many new technologies, and many legal issues they do or might raise. Which issues strike you as the most important for society and its legal system to grapple with, and why? As an attorney, which would you find most useful to you, or most threatening to encounter from the other side, and why?
7. How soon, if ever, will the imagined future of neurolaw arrive? Consider that in 2002 *The Economist* wrote that, "Genetics may yet threaten privacy, kill autonomy, make society homogeneous and gut the concept of human nature. But neuroscience could do all of these things first." *The Ethics of Brain Science: Open Your Mind*, The Economist, May 23, 2002. To what extent do you agree? For a contrasting view, see Stephen J. Morse, *Avoiding Irrational Neurolaw Exuberance: A Plea for Neuromodesty,* 62 Mercer L. Rev. 837 (2011).
8. Neurotheorist David Marr once wrote that "trying to understand perception by studying only neurons is like trying to understand bird flight by studying only feathers: it just cannot be done. In order to understand bird flight, we have to understand aerodynamics; only then do the structure of feathers and the different shapes of birds' wings make sense." David Marr, *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* 27

(1982). What else might one need to study, other than the brain, in order to understand human cognition?

9. The importance and promise of neuroscience research was prominently highlighted when President Obama in April, 2013, announced the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) initiative. For more on that initiative, see http://www.whitehouse.gov/share/brain-initiative.

FURTHER READING

Law and Neuroscience: Current Legal Issues (Michael Freeman ed., 2010).

International Neurolaw: A Comparative Analysis (Tade M. Spranger ed., 2012).

A Primer on Criminal Law and Neuroscience (Stephen J. Morse & Adina L. Roskies eds., 2013).

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Handbook on Psychopathy and Law (Kent Kiehl & Walter Sinnott-Armstrong eds., 2013).

Michael S. Pardo & Dennis Patterson, *Minds, Brains, and Law: The Conceptual Foundations of Law and Neuroscience* (2013).

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Neuroimaging in Forensic Psychiatry: From the Clinic to the Courtroom (Joseph R. Simpson ed., 2012).

New Perspectives on Human Activities (A.Battro, S. Dehaene & W. Singer eds.), Scripta Varia 121, Pontifical Academy of Sciences, Vatican City (2013).

Peter A. Alces, *The Moral Intersection of Law & Neuroscience* (forthcoming).

Law & The Brain (Semir Zeki & Oliver Goodenough eds., 2006).

Owen D. Jones, René Marois, Martha J. Farah & Henry T. Greely, *Law and Neuroscience*, 33 Journal of Neuroscience 17624 (2013).

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David Eagleman, *The Brain on Trial*, The Atlantic (June 7, 2011).

Neuroscience and the Law: Brain, Mind, and the Scales of Justice (Brent Garland ed., 2004).

William R. Uttal, *Neuroscience in the Courtroom: What Every Lawyer Should Know About the Mind and the Brain* (2008).

William R. Uttal, *The New Phrenology: The Limits of Localizing Cognitive Processes in the Brain* (2001).