NEUROSCIENCE IN THE LAW

It wasn't the first time neuroscience entered the courtroom, but it's had the most visible impact. Former players in the National Football League sued the NFL, claiming it failed to take reasonable steps to protect them from concussive brain injuries, while simultaneously concealing the long-term risks associated with concussions.[1] The preliminarily approved settlement covers thousands of former professional football players, to the tune of many hundreds of millions of dollars. And the reverberations of this legal clash are changing how head injuries are handled in football and other sports, across all ages, while drawing new attention to the growing role—for better or worse—of neuroscientific tools in law.

The relatively new ability to use noninvasive neuroscientific tools for investigating brain structure and function has been fueling a corresponding increase in courtroom proffers of brain-data evidence. Civil dockets see neuroscience not only in tort cases (as in the NFL case, or cases involving accidents, medical malpractice, and the like) but also in less obvious but crucial contexts, such as claims for disability benefits. And neuroscientific evidence is increasingly offered in criminal cases, particularly as part of the case for leniency at sentencing.

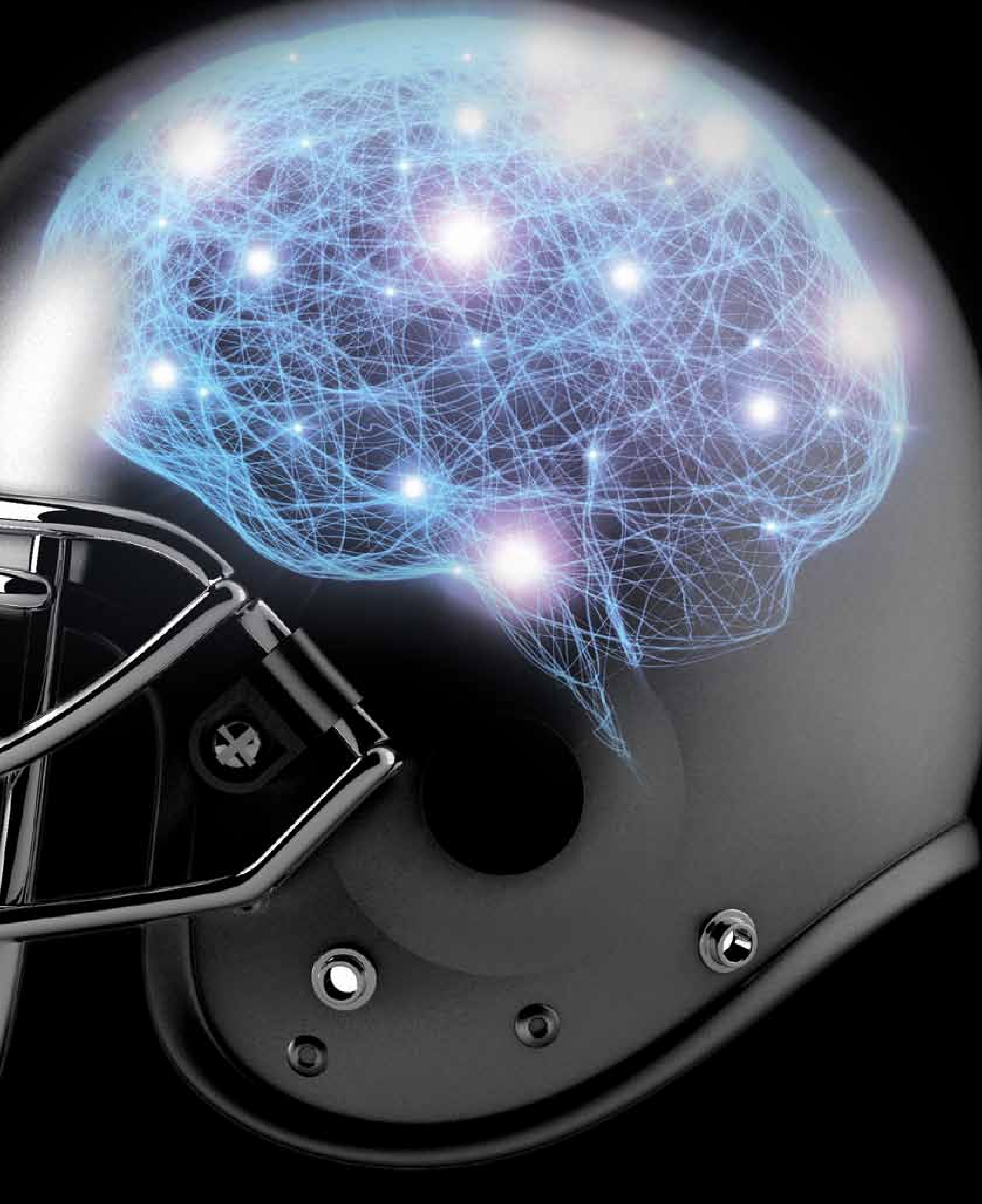
The growth of neuroscientific evidence, however, raises legitimate questions about its nature, boundaries, and roles. What is neuroscience? How is it being used in law? Where are we most likely to see it in the future?

Technological Advances . . . and Limitations

Neuroscience is the study of the nervous system, of which the brain is the key part. Cognitive neuroscience, as a subfield, is the use of neuroscientific tools to study how the brain feels, thinks, and decides.

Those tools include *functional magnetic resonance imaging* (fMRI), which uses a combination of magnetic fields, radio frequency pulses, and sensitive detectors to measure changes in oxygen levels throughout the brain. The core idea is that oxygen consumption is a reasonably sound proxy for the activity of neurons (which consume oxygen as they work). This allows detailed looks at brain function, in addition to brain structure. A technique known as *positron emission tomography* (PET) enables similar investigations, by tracing the consumption of glucose in the brain.

As valuable as these techniques are, however, it is essential to keep their limitations in mind. For one thing, they are proxy measures, rather than direct measures, of brain activity. For another, there are many steps—steps that involve human judgment—between data acquisition and the creation of the eye-catching fMRI images that we have become accustomed to seeing. These steps can help to clarify the data, but they can also lead to distortions of the data if done imprecisely. In addition, one cannot assume that correlations between



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features and behavior, discovered through brain imaging, necessarily identify the *causal* pathways of behavior. Stronger inferences of causal relationships typically require many studies, using multiple methods, to demonstrate converging findings.

Effects in Law

Though precise measures are difficult, there are many indications that lawyers are increasingly proffering, and judges and juries are increasingly encountering, neuroscientific evidence.[2] (One source, for example, traced a doubling of reported cases involving neuroscience between 2006 and 2009.[3])

Within the civil context, lawyers have proffered neuroimaging evidence to show mental incompetence,[4] the existence of injury,[5] the extent of mental injury,[6] and the credibility of witnesses,[7] among other things. In one such instance the plaintiff, after being rear-ended by the defendant in a traffic accident, attempted to introduce *quantitative electroencephalography* (qEEG), *positron emission tomography* (PET), and *diffusion tensor imaging* (DTI) as evidence of *traumatic brain injury* (TBI). Although the plaintiff's expert witness was ultimately allowed to testify regarding only the DTI evidence, the case illustrates the increasing willingness of plaintiffs to turn to neuroscientific evidence to substantiate their claims. (Moreover, the jury awarded the plaintiff more than $2.25 million in damages.[8])

On the criminal side, courts have been more receptive to neuroscience evidence in the penalty phases of trials (especially capital trials), where less stringent evidentiary rules typically apply, compared to the liability phases.

In *State of Florida v. Grady Nelson*, for example, the jury had to decide, after convicting Mr. Nelson of murder, whether the state should execute him or keep him imprisoned for the rest of his life.[9] The court allowed the defense to present qEEG evidence to suggest that Nelson had brain abnormalities sufficient to mitigate his sentence. (The evidence purported to show unusual neural activity in the left frontal lobe, similar to that found in epilepsy, which may have been caused by one or more of three traumatic brain injuries that Nelson had suffered.) By a narrow vote, the jury spared Nelson's life. Two of the jurors in the majority explained afterward that the neuroscientific evidence had changed their minds, prompting them to vote for life imprisonment, rather than execution.[10]

Courts have been more reluctant, however, to allow the introduction of neuroscience at the guilt phase of criminal trials. In *United States v. Semrau*, for instance, the defense attempted to introduce fMRI lie detection evidence to prove that the defendant, accused of masterminding a scheme to defraud Medicare, was telling the truth when he asserted that the billing errors were merely earnest mistakes.[11] The trial judge—whose ruling was later upheld by the Sixth Circuit—did not admit the evidence, finding it to be unduly prejudicial and lacking in sufficient scientific validity.

The Future of Neurolaw

Many of the perennial questions with which the law grapples are fundamentally questions about what is or was happening inside a person's brain: What was an individual's intention at the time? What does she remember, and how accurately? Should she be held accountable for her actions? Although neuroscience will never provide all of the answers, the tools of neuroscience are increasingly illuminating potentially important pieces of answers. When those are weighed alongside other important forms of evidence, they may increase confidence in the law's conclusions, or in some cases challenge our confidence in them. It therefore seems inevitable that neuroscience and law will continue to intersect, as the science improves and as lawyers become more familiar with its possibilities.

Consider two examples—juvenile justice and parole decisions—that illustrate the range between buttressing things we more or less know already, at one end, and adding an entirely new metric to our decision-making, at the other.

We already know that, somewhere along the path between infancy and adulthood, adolescents gradually accrue the cognitive and social skills that warrant both full participation in society and full responsibility for actions. Less clear is the process by which those skills come online. To the extent that neuroscience can help to forge greater understanding of the connections between brain maturation and decision-making abilities, it may concomitantly inform our policy deliberations over such things as when to hold adolescents (whether as a class, or as individuals) legally accountable for their actions.

The science obviously can't set the policy, but, by increasing knowledge of the processes and effects of brain maturation, it may aid the evaluative assessments by which such policies are made and improved over time. For example, studies suggest that the areas of the brain associated with reward and sensation-seeking develop earlier than the areas associated with executive and impulse control,[12] which may help to explain, in terms of developmental physiology, why teenagers seemingly competent in some domains exhibit frustratingly poor impulse control in

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others.[13] This perspective may also suggest that juvenile offenders—because their brains are more actively developing than are those of corresponding adult offenders—may be more responsive to rehabilitation, or may even "grow out of it," as their brain reaches full maturity and their capacity for impulse control and executive functioning increases.

A more speculative domain of law/neuroscience intersection involves parole decisions. Parole boards already rely heavily on actuarial tables to help identify which individuals are safe to release back into society.[14] These vary from relatively simple four-risk-factor models—using gender, age, age of first arrest, and the number of prior arrests—to more comprehensive tools such as California's Correctional Offender Management and Profiling Alternative Sanctions (COMPAS), which uses both actuarial data and clinical interviews. And neuroscience has the potential—at least in theory—to enhance the accuracy of predictive tools.

For example, a 2013 study reported a significant correlation between activity in a particular part of prisoners' brains—the anterior cingulate, or ACC—while performing an impulse control task and the likelihood that an individual would be rearrested within four years after release for recidivism.[15] (The ACC is an area associated with error processing and avoidance learning.) Offenders with low ACC activity while performing the task were twice as likely to be rearrested as their counterparts with high ACC activity.[16] To their credit, the authors were quick to point out that this has no immediate forensic implications. Yet while the legal system's decision on the probability of recidivism neither will nor should be reducible to a single measure of activity in a single brain region, even a modest increase in predictive accuracy, when the information is combined with other measures, could eventually provide a welcome improvement to the accuracy of predictive tools already in use.

It bears emphasis, however, that uses of neuroscience in law must be both intelligent and cautious. There are many discrete links in the chain of causal inference that must be separately identified and examined. There are more incorrect conclusions to draw than there are valid, supportable ones; and there are more ways to misrepresent the science to judges and jurors than there are ways to represent it accurately.

COURTS HAVE BEEN RELUCTANT TO ALLOW THE INTRODUCTION OF NEUROSCIENCE AT THE GUILT PHASE OF CRIMINAL TRIALS.

For example, courtroom invocations may gloss over important subtleties and limitations of the research (such as the distinction between causation and correlation) or may extrapolate to conclusions not warranted by the data (such as the belief that a brain abnormality has, by virtue of its very existence, reduced a person's capacity for self-control). Moreover, at the receiving end, even well-presented evidence may be misunderstood—either overinterpreted or underinterpreted by jurors and judges.[17]

One particularly thorny problem is the extent to which neuroscientific research on the group-averaged brain of multiple subjects has relevant bearing on the case of a single person before the court.[18] It is one thing to say that people suffering from a particular psychological and behavioral condition tend, on average, to exhibit one or another feature of brain structure or function. It is quite another to say that a person before the court, who has such a feature, must therefore also have the condition.

Resources

The best antidote to misuse, whether intentional or inadvertent, is information. For those interested in, or confronted with, neuroscientific evidence, there are several key avenues for learning more. The *MacArthur Foundation Research Network on Law and Neuroscience*[19] maintains a comprehensive, sortable, searchable, online bibliography of neurolaw publications,[20] and also distributes a regular newsletter—*Neurolaw News*[21]—that describes new developments in the field. In addition to funding extensive scientific research at the law/neuroscience intersection, the research network has also supported a collection of online video lectures,[22] *A Primer on Criminal Law and Neuroscience,*[23] and the new book *Law and Neuroscience*.[24] ◆

Endnotes

1. Turner v. NFL (In re NFL Players' Concussion Injury Litig.), 2014 U.S. Dist. LEXIS 91534 (E.D. Pa. July 7, 2014).

2. *See generally* Owen D. Jones, Jeffrey D. Schall & Francis X. Shen, Law and Neuroscience (2014); Owen D. Jones & Francis X. Shen, *Law and Neuroscience in the United*

States, *in* International Neurolaw: A Comparative Analysis 349 (T.M. Spranger ed., 2012).

3. N.A. Farahany, An Empirical Study of Brains and Genes in U.S. Criminal Law, Vanderbilt University Law School (2011).

4. The defendant in a contract dispute involving the sale of land introduced testimony based on an MRI scan revealing "brain shrinkage and hardening of the arteries . . . consistent with dementia" in an attempt to prove that she was mentally incompetent to enter the agreement. The court found for the defendant. Van Middlesworth v. Century Bank & Trust Co., 2000 WL 33421451 (Mich. App. 2000).

5. The plaintiff, attempting to prove his eligibility for the NFL's Football Degenerative Disability benefits, offered a physician's diagnosis, based on single photon emission computed tomography (SPECT), a form of neuroimaging, that the plaintiff had reduced brain activity consistent with head trauma. The Retirement Board denied the plaintiff's claim, finding that his disability did not arise from league football activities. The Board's decision was affirmed on appeal. Boyd v. Bell (Pete Rozelle NFL Players Retirement Plan), 410 F.3d 1173 (9th Cir. 2005).

6. The plaintiff proffered SPECT-based testimony as evidence of her closed-head injury. The jury found for the plaintiff and the court awarded $2,615,000 in damages. Fini v. Gen. Motors Corp., 2003 WL 1861025 (Mich. App. 2003).

7. In a suit claiming employer retaliation after an employee reported inappropriate activity, the plaintiff attempted to introduce an fMRI-based lie detection test as evidence that her witness was being truthful. The defendant successfully challenged the admissibility of the evidence and the jury ultimately found for the defendant. Wilson vs. Corestaff Servs., 900 N.Y.S.2d 639, 1 (Sup. Ct. 2010).

8. LaMasa v. Bachman, 8 Misc. 3d 1001(A) (N.Y. Sup. Ct. 2005).

9. State v. Grady Nelson, No. F05-00846 (11th Fla. Cir. Ct. 2010).

10. Owen D. Jones et al., *Neuroscientists in Court*, 14 Nature Reviews Neuroscience 730, 734 (2013).

11. United States v. Semrau, 693 F.3d 510 (6th Cir. 2012).

12. B.J. Casey & Kristina Caudle, *The Teenage Brain: Self Control*, 22 Current Directions in Psychological Science 82, 83–84 (2013).

13. *Id.*

14. Sheldon X. Zhang, *An Analysis of Prisoner Reentry and Parole Risk Using COMPAS and Traditional Criminal History Measures*, 60 Crime and Delinquency 167 (2014).

15. Aharoni, Eyal et al., *Neuroprediction of Future Rearrest*, 110 Proceedings of the National Academy of Sciences 6223 (2013).

16. *Id.*

17. Michael J. Saks et al., *The Impact of Neuroimages in the Sentencing Phase of Capital Trials*, 11 J. of Empirical Legal Stud. 105 (2014).

18. David L. Faigman, John Monahan & Christopher Slobogin, *Group to Individual (G2I) Inference in Scientific Expert Testimony*, 81 U. Chi. L. Rev. 417 (2014).

19. The MacArthur Foundation Research Network on Law & Neuroscience, http://www.lawneuro.org.

20. *Law & Neuroscience Bibliography*, The MacArthur Foundation Research Network on Law & Neuroscience, http://www.lawneuro.org/bibliography.php.

21. *Neurolaw Newsletter*, The MacArthur Foundation Research Network on Law & Neuroscience, http://www.lawneuro.org/listserv.php.

22. The MacArthur Foundation Research Network on Law & Neuroscience, YouTube Channel, https://www.youtube.com/user/LawNeuroOrg/videos.

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

24. Owen D. Jones, Jeffrey D. Schall & Francis X. Shen, Law and Neuroscience (2014), http://www.vanderbilt.edu/lawbrain.