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Neuroscience and behavioral genetics in US criminal law: an empirical analysis

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ABSTRACT

The goal of this study was to examine the growing use of neurological and behavioral genetic evidence by criminal defendants in US criminal law. Judicial opinions issued between 2005–12 that discussed the use of neuroscience or behavioral genetics by criminal defendants were identified, coded and analysed. Criminal defendants are increasingly introducing such evidence to challenge defendants' competency, the effectiveness of defense counsel at trial, and to mitigate punishment.

KEYWORDS: Neuroscience, neurobiology, criminal law, behavioral genetics, capital punishment, IAC

I. INTRODCUTION

Legal scholars, scientists, and commentators lament the onslaught of behavioral genetics and neuroscience in the criminal courtroom. Fueled largely by anecdotal evidence about the use of bioscience in criminal cases, or media reports of high-profile cases, there is a growing belief that neuroscience has become a mainstay of the US criminal justice system. And while scholars increasingly self-identify as part of the growing fields of 'law and neuroscience' or 'law and the biosciences', to date only small-scale studies have been conducted on the use of neuroscience and behavioral genetics in the US criminal justice system. One recent study involved an empirical analysis of just those cases in which neuroimaging had been reported in a judicial opinion, with 23 analysed

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cases.[1] Other studies have qualitatively, but not quantitatively, assessed the use and impact of neurobiological evidence in criminal law, again relying almost exclusively on discussion of that evidence in published judicial opinions.[2] Any examination of the impact of behavioral genetics and neuroscience on the US criminal justice system must begin with a more accurate understanding of how that evidence is currently being used. To better ground the interest and commentary on the use of neuroscience and behavioral genetics (hereinafter neurobiological[3] evidence) in criminal law, this article summarizes some findings from the widest scale empirical study on the use of neurobiological evidence in US criminal law to date.

Over the past decade, the outcomes of hundreds of criminal cases have been influenced by neurobiological data. Over 1585 judicial opinions issued between 2005 and 2012 discuss the use of neurobiological evidence by criminal defendants to bolster their criminal defense. In 2012 alone, over 250 judicial opinions—more than double the number in 2007—cited defendants arguing in some form or another that their 'brains made them do it'. Approximately 5 per cent of all murder trials and 25 per cent of death penalty trials feature criminal defendants making a bid for lower responsibility or lighter punishment using neurobiological data. While these claims often overstate the science, used responsibly neurobiological evidence has the potential to improve the accuracy and decrease errors in the criminal justice system.

Much of the scholarship on neurobiological evidence in criminal law has focused exclusively on either behavioral genetics[4] or neuroscience.[5] This study looks at these sciences together because the claims are inextricably intertwined. First, scientific developments increasingly link findings from behavioral genetics to neural correlates.

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1 Scott N. MacMillan & Michael S. Vaughn, *Weighing the Evidence: Neuroimagery Evidence of Brain Trauma or Disorder in Courts*, 46 Crim. L. Bull. 3 (2010).

2 Eg Diane E. Hoffman & Karen H. Rothenberg, *Judging Genes: Implications of the Second Generation of Genetic Tests in the Courtroom,* 66 Md. L. Rev. 858, 870 (2007); Erica Beecher-Monas, *Circumventing Daubert in the Gene Pool*, 43 Tulsa L. Rev. 241, 248–50 (2007).

3 I use neurobiological to mean evidence about the study of the brain and the nervous system. This includes claims about the 'normal' brain, abnormal brain, effects on neurotransmitters, brain structure, function, and genetic contributions to neurological functioning and structure.

4 See eg Deborah W. Denno, *Behavioral Genetics Evidence in Criminal Cases*, in The Impact Of Behavioral Sciences On Criminal Law 317, 321 (Nita A. Farahany ed., 2009) (behavioral genetics evidence has been introduced 'in a wide range of ways, but mostly as some sort of mitigating evidence in a death penalty case'); Hoffman & Rothenberg, supra note 2; Beecher-Monas, supra note 2.

5 Eg Henry T. Greely, *Neuroscience and Criminal Justice: Not Responsibility but Treatment*, 56 U. Kan. L. Rev. 1103, 1104 (2008); Teneille Brown & Emily Murphy, *Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant's Past Mental States*, 62 Stan. L. Rev. 1119 (2010); Scott N. MacMillan & Michael S. Vaughn, *Weighing the Evidence: Neuroimagery Evidence of Brain Trauma or Disorder in Courts*, 46 Crim. L. Bull. (2010); Amanda C. Pustilnik, *Violence on the Brain: a Critique of Neuroscience in Criminal Law*, 44 Wake Forest L. Rev. 183 (2009); Laura S. Khoshbin & Shahram Khoshbin, *Imaging the Mind, Minding the Image: An Historical Introduction to Brain Imaging and the Law*, 33 Am. J. L. & Med. 185 (2007); Peggy Sasso, *Implementing the Death Penalty: The Moral Implications of Recent Advances in Neuropsychology*, 29 Cardozo. L. Rev. 765, 806 (2007); Johanna C. Jennings, *Juvenile Justice, Sullivan, and Graham: How the Supreme Court's Decision Will Change the Neuroscience Debate*, 2010 Duke L. & Tech. Rev. 6 (2010); Stephen K. Erikson, *Blaming the Brain*, 11 Minn. J. L. Sci. & Tech. 27, 75–6 (2010); Leona D. Jochnowitz, *Missed or Foregone Mitigation: Analyzing Claimed Error in Missouri Capital Clemency Cases*, 46 Crim. L. Bull. (2010); Michael L. Perlin, *'And I See through Your Brain': access to Experts, Competency to Consent, and the Criminal Trial Process,* 2009 Stan. Tech. L. Rev. 4 (2009); J.W. Looney, *Neuroscience's New Techniques for Evaluating Future Dangerousness: Are We Returning to Lombroso's Biological Criminality?*, 32 U. Ark. Little Rock L. Rev. 301 (2010); Adam Kolber, *The Subjective Experience of Punishment*, 109 Colum. L. Rev. 182 (2009).

As a result, the emerging scientific inquiry into human behavior is trending toward a neurobiological approach over a purely genetic or neuroscientific one.[6] Moreover, the research in these fields foretells a more integrated future in human behavioral research, whereby genetics and neuroscience are linked rather than compartmentalized. As one telling example, the March 2010 issue of the seminal journal *Behavior Genetics* dedicated a special issue to pathways between gene, brain, and behavior. The 15 articles included in the volume represented the diversity of methodologies applied to the complexity of pathways linking genes, brain, and behavior. The introductory chapter concluded that the breadth of studies proves that tracing the pathways between biology and behavior requires expertise in genetics, neuroscience, psychology, and psychiatry.[7]

The integration is reflected in the use of behavioral genetics and neuroscience in the criminal justice system. Legal practitioners take a multifaceted approach to characterizing defendants' behaviors by introducing genetic, neurological, and environmental contributions. Monamine Oxidase A (MAOA), the first gene–environment interaction associated with temperament and antisocial behavior, is a well-studied example.[8] Although MAOA was first characterized as a genetic polymorphism, which together with environmental triggers is associated with behavioral variation in antisocial personality, more recent studies link the genetic and neurological correlates of MAOA. Joshua Buckholtz et al. published a study utilizing a combined genetic and imaging approach to the study of MAOA, which implicates a neural circuit for variation in human personality under genetic control.[9] Already, a multifaceted criminal defense using MAOA genotyping, and neuroimaging has been introduced into criminal cases.[10] Even assuming differences in scientific methodology and results between behavioral genetics and neuroscience, the substantive legal claims raised are nearly identical when either science is used in a criminal case. As a result in this study sample, anytime behavioral genetics was raised; a neuroscientific claim was also advanced. While neuroscience by far dominates the scientific evidence introduced, the results here include cases where both neuroscience and behavioral genetics are sometimes introduced.

With a few notable exceptions, scientists are on the sidelines of these developments in criminal law. Publicly engaged scientists often decry the use of neurobiological

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6 Lorraine Caron et al., *Nicotine Addiction Through A Neurogenomic Prism: Ethics, Public Health, And Smoking*, 7 Nicotine & Tobacco Res. 181, 197 (2005) (arguing that societal understandings of nicotine addiction will be shaped by an evolving neurogenomic prism rather than a purely geneticized approach to addiction); Brent Garland & Mark S. Frankel, *Considering Convergence: A Policy Dialogue About Behavioral Genetics, Neuroscience, and Law*, 69 Law & Contemp. Probs. 101 (2006) (considering the commonalities and differences between behavioral genetics and neuroscience as they relate to the criminal law, including topics addressed by both fields, similarities in likely misuse, as well as how each field might be applied in criminal proceedings).

7 William S. Kremen & Kristen C. Jacobson, *Introduction to the Special Issue, Pathways Between Genes, Brain, and Behavior*, 40 Behav. Genet. 111, 113 (2010).

8 Avshalom Caspi et al., *Role of Genotype in the Cycle of Violence in Maltreated Children*, 297 Science 851 (2002); William Bernet et al., *Bad Nature, Bad Nurture, and Testimony Regarding MAOA and SLC6A4 Genotyping at Murder Trials*, 52 J. Forensic Sci. 1362 (2007).

9 Joshua W. Buckholtz et al., *Genetic variation in MAOA modulates Ventromedial Prefrontal Circuitry Mediating Individual Differences in human personality*, 13 Molecular Psychiat. 313, 324 (2008).

10 William Bernet et al., *Bad Nature, Bad Nurture, and Testimony Regarding MAOA and SLC6A4 Genotyping at Murder Trials*, 52 J. Forensic Sci. 1362 (2007).

evidence criminal law, and call for an outright ban on its use. This is driven in part by concerns about significant methodological obstacles in the study of human behavior. Most basically are problems about consistently defining the scope and characteristics of particular behaviors. How, for instance, should one define violence? What does aggression mean? Does criminal behavior include petty crimes as well as violent ones? Even when scientists do establish a robust and consistent definition for a specific trait they face difficulties in finding reliable measures of those traits in a manner that satisfies acceptable standards of scientific validity, including reproducibility. Measuring complex behavioral traits has been difficult, and as a result difficult to replicate in other studies as well.[11] Research into the biological contributions to human behavior face an additional complication: behaviors, which are complex traits and involve multiple genes, regulated by widely varying cellular and neurological mechanisms, are subject to substantial environmental influence.

These scientific concerns underscore the study of complex behavioral traits of interest to the criminal law. No single behavior is appropriately characterized as 'criminal'. Any scientific claim about the biological contributions to criminal conduct begins with a narrower focus on the behaviors often implicated by criminal conduct including violence, aggression, and drug and alcohol abuse. Studies of those traits and related traits have likewise yielded only preliminary data that have yet to be well replicated or understood.[12]

But decrying the use of neurobiological evidence in criminal law seems both futile and counterproductive; neuroscience is already entrenched in the US legal system. And used appropriately, it holds promise of improving decision-making in law. An outright ban is neither warranted nor productive. But just as neuroscientists go too far in calling for an outright ban, defense attorneys are guilty of overstating the science. Criminal defendants regularly use neuroscience at every stage of the criminal process, from pretrial, to trial, and sentencing determinations. Prosecutors, too, have seized upon cognitive neuroscience to argue that defendants are incorrigible and should be given longer sentences. Neuroscientists can and should play a part in safeguarding these developments. Rather than standing in the way, neuroscientists should educate the public about the responsible use of neuroscience in the courtroom.

To empirically ground the dialog about the use of neuroscience in the US criminal justice system, this article is the first comprehensive empirical study of the use of neurobiological evidence in US criminal justice cases. Drawing from data analysed from 1585 coded criminal cases, in which judicial opinions were written and published in Westlaw during 2005–12, this study presents some surprising results and trends in emerging use of neurobiological evidence in criminal law.

II. BACKGROUND

The cases collected, coded, and analysed in this study demonstrate a rising use of neurobiological research in criminal law. That use continues to be haphazard, ad hoc, and

[11] Eg Kenneth S. Kendler & Lindon J. Eaves, Psychiatric Genetics 197, 198 (American Psychiatric Publishing, 2005) (concluding from aggregate studies in behavioral genetics that the results from behavioral genetics research are often inconsistent across studies).

[12] Eg Richard P. Bentall, *Psychiatry's Failed Paradigm*, Washington Post, Jan. 4, 2010 (finding that without exception later studies have failed to replicate findings of genetic links to schizophrenia, or 5-HTTLPR).

often ill conceived. While scientists caution that the neurobiological evidence at issue is weak, particularly for making claims about individuals rather than studying between-group differences, their cautionary advice has largely gone unheeded. Even the gravest decisions, including assessments bearing on deservingness for capital punishment, are beginning to turn on this research.[13] Defense attorneys have introduced behavioral genetics and neuroscience in attempts to exculpate criminal defendants, to bolster pre-existing legal defenses, and to mitigate defendants' culpability and punishment. Prosecutors have seized upon the double-edged potential of a claimed neurobiological evidence to denigrate defendants' characters and to demonstrate defendants' likely future dangerousness.

As the science continues to develop, its potential use in criminal investigations, interrogations, and predictions of dangerousness will undoubtedly rise. The discovery of more specific biological and neurological contributions to violence, aggressiveness, impulsivity, substance abuse, even though highly contestable and indeterminate as a scientific matter, has foreshadowed an inevitable reexamination of the US criminal justice system. Indeed, the United States Supreme Court has already become involved in evaluating the relevance of neurobiological evidence to criminal culpability: in September of 2006, it granted certiorari to address, in part, whether a defendant's genetic predisposition to violence should inform whether he should be sentenced to death for first-degree murder.[14] Liberty, justice, privacy, and the structure and purpose of the US criminal justice system are all at issue. A careful and systematic study of the use, perception, current and likely impact of neurobiological evidence on criminal law is essential before its application further expands.

III. METHODOLOGICAL APPROACH

Seventeen law students and three undergraduate students were trained over time on a coding book developed by the author that included 84 variables. The students included second and third-year law students, with varying scientific background. All undergraduate students were majoring in scientific disciplines. The 84 variables are detailed in the coding book with specificity to ensure uniform coding. These variables included, for example, purely identifying information about the case, the purpose for which the behavioral genetics or neuroscience evidence was introduced, the outcome of the case (successful or unsuccessful for the criminal defendant), the state where the case was heard, and the types of attorneys or representation present. Coders were first given the coding book, and asked to code a set of four test cases. After coding the four cases, they were trained in detail on the meaning of each variable through an intensive in-person training session with Farahany. They were then given a second set of test cases to code, and discrepancies were reviewed and discussed with Farahany. Coders were then were given cases in sets of 10 to code, which were spot-checked by Farahany. Subsequent

[13] Eg Roper v. Simmons, 543 U.S. 551 (2005) (citing Amicus discussion of adolescent brain development to support finding juveniles less culpable and categorically exempt from capital punishment); Graham v. Florida, 560 U.S. 48 (2010) (finding life imprisonment for juveniles violates the 8th Amendment, citing to neurological evidence about adolescent brains for support).

[14] Landrigan v. Schriro, 550 U.S. (2007) (resolving the case on alternate grounds. Opining, in dicta, that genetic predisposition evidence is at best equivocal with respect to criminal culpability).

cases were coded separately by two different coders to ensure accuracy. There was less than 5 per cent disagreement between coders, and typically pertaining only to the nature of the claim raised. Farahany reviewed all coding with spot-checking, and resolved any conflicts that arose between the coders.

Cases in the study were selected from searches of the Westlaw legal database using the keywords and variations on the words: neuroscience, frontal lobe, hereditary, head injury, pet scan, EEG, fMRI, CT Scan, Brain Disorder, Cognitive Impairment, MEG, NIRS, Brain Scan, Brain, Diffusion Tensor, Heritable, Hereditary, Genetic, Biological, Memory, Frontemporal, and qEEG. The Westlaw databases used included all US Supreme Court, all federal court and all state court.

The broad search terms used search yielded over 10,000 opinions per year, which were then scanned for relevance. After excluding cases that did not bear on the use of neurobiological evidence by a criminal defendant, 1585 cases were included in the study, and all opinions in those cases—majority, plurality, concurring, and dissenting opinions—for a total of 1800 judicial opinions, were coded. Cases in which the scientific evidence focused on the victim or forensic identification were excluded.

Limitations of Methodology

The legal opinions coded for this study were selected from the Westlaw legal database. Westlaw's inclusion criteria for judicial opinions are proprietary, unpublished, and may have changed during the study time period. These variations may account for some of the year-to-year differences in the number of opinions discovered. Moreover, the cases contained therein are primarily appellate opinions, since trial opinions at the state level are often jury verdicts without written judicial opinions. Consequently, the opinions coded may reflect defendants' failed attempts at using neuroscientific evidence at trial, failure to by defense counsel to investigate or introduce neurobiological evidence at trial, or newly discovered evidence on appeal. The sample may be skewed toward defendants who have already fared poorly in the criminal justice system with their claims.

Moreover, more than 90 per cent of criminal cases in the United States never go to trial. Most individuals who are charged with a crime forego their constitutional right to a trial and plead guilty in exchange for a plea agreement.[15] Of those cases that do go to trial, while many are appealed, many more are not. Of cases that are appealed, there are narrow legal grounds available for overturning a conviction or setting aside a sentence and procedurally the cases must be raised in that manner. Moreover, investigation into neurobiological contributions to criminal behavior can be costly. In cases where the defendant has adequate resources, or able to secure resources from the state, or as pro bono services, they are more likely to be able to introduce neurobiological evidence. This may skew the kind of criminal defendants who raise claims rooted in neurobiology. These skews may mean the sample of cases here underreports the actual use of neuroscience in the criminal courtroom. And that the cases are skewed toward unsuccessful use of neurobiological evidence. Hence, while the present empirical study significantly advances the ethical, legal and social discussions with respect to the use of neurobiological evidence in US criminal law, it is still a narrow view of the overall issue.

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[15] Timothy Lynch, The Case Against Plea Bargaining, Regulation (2003).

IV. RESULTS

A. Overview

Most studies on the use of neurobiological evidence in criminal cases claim it's used almost exclusively to mitigate capital punishment and with limited success.[16] The findings discussed herein suggest both a broader—and potentially more successful—use of neurobiological evidence in US criminal law.

The data show an increasing trend in using neurobiological evidence in criminal cases. Significant differences by state also appear, including the extent to which the evidence has been introduced, and the ultimate success of that evidence. These differences can be explained in part by population differences, and varying legal regimes across states (eg the availability of capital punishment, the type of insanity defense available in the state, or the relevance of a diminished capacity defense). The implications of these statewide differences are important and require more research.

Importantly, neurobiological evidence is being used for purposes not yet discussed or analysed by scholars. For example, while many scholars have discussed the implications of using neurobiological evidence for mitigation of criminal punishment, virtually no author has discussed the implications of using it to assess the competency of a criminal defendant. And yet the empirical analysis herein illustrates that the second most common use of biological neurobiological evidence in criminal cases is to challenge competency. The implications of this use, and the relevance of behavioral genetics and neuroscience to competency determinations, are critical areas for further exploration.

Finally, while attempts to introduce neurobiological testimony have been relatively unsuccessful to date, the attempts may have been more successful than most scholars believe. Depending on the type of claim that a criminal defendant raises, testimony by an expert on the matter may serve as powerful evidence that impacts the outcome of the case for the defendant.

In short, the fundamental assumptions guiding the current ethical, legal and social inquiry into the use of neurobiological evidence in criminal law are limited and potentially flawed. The goal of this study is to broaden the dialog and bring empirical evidence to bear on the discussion.

B. General Findings

1. Use of Neurobiological Evidence is Increasing in Criminal Cases

The number of judicial opinions discussing the use of neurobiological evidence by criminal defendants is increasing year over year (see Graph 1). Contrary to popular belief, many of these cases are 'not' capital homicide cases (the prosecutor did not seek the

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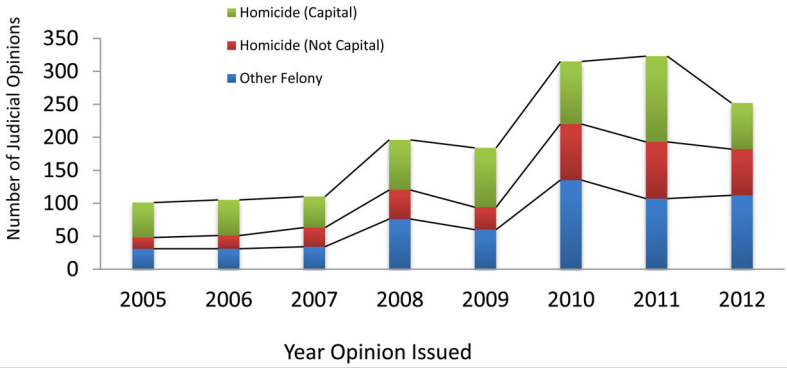
[16] See O. Carter Snead, *Neuroimaging and the 'Complexity' of Capital Punishment*, 82 N.Y.U. L. Rev. 1265, 1292–3 (2007) (asserting 'defendants have enjoyed the greatest success with neuroimaging evidence at the sentencing phase of capital trials in connection with mitigation claims'); Sasso, supra note 8 (concluding neuropsychological evidence is generally used during the sentencing phase); Greely, supra note 5 (predicting biological predisposition evidence will increasingly be used not to diminish responsibility, but to influence sentencing); Erikson, supra note 5 (neuroscience will primarily impact sentencing because defendants will be treated as lacking culpability); MacMillan & Vaughn, supra note 8; Pustilnik, supra note 8; Khoshbin & Khoshbin, supra note 8; E. Spencer Compton, *Not Guilty by Reason of Neuroimaging: The Need for Cautionary Jury Instructions*, 12 Vand. J. Ent. & Tech. L. 333 (2010).



Graph 1. Judicial opinions discussing neurobiological introduced by criminal defendants 2005–12. (Homicide (capital) are murder cases in which the prosecutor sought the death penalty. Homicide (not capital) are some degree of homicide (murder, manslaughter) cases in which the death penalty was not at issue. Other felony cases are those in which the defendant was not charged with homicide.)

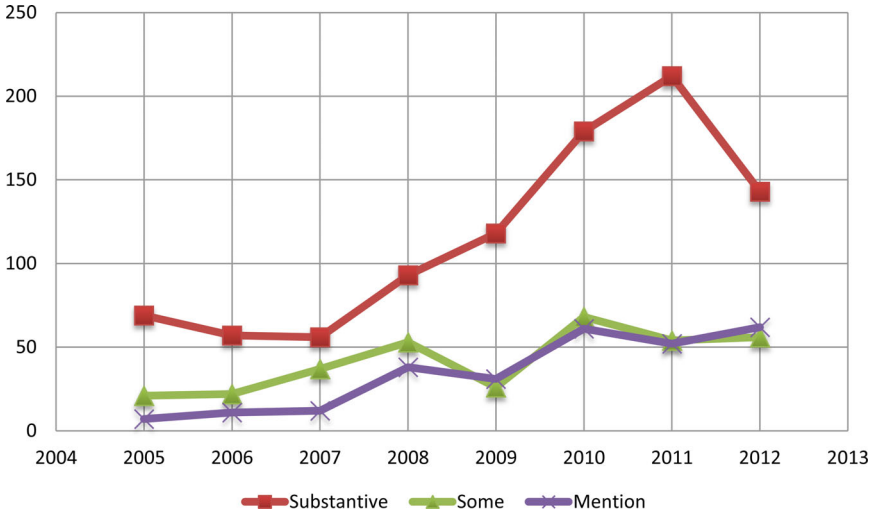
death penalty, or it was unavailable as a sentence in that jurisdiction). Defense attorneys are introducing neurobiological evidence across the board in serious felony cases, and not just in bifurcated capital sentencing hearings following a conviction of first-degree murder.

What started as about 100 judicial opinions per year discussing neurobiological evidence in criminal law in 2005 climbed to around 250–300 opinions in 2012. The quality and not just the quantity of opinions discussing neurobiological evidence has evolved. Opinions earlier in the study often discuss neurobiological evidence as part of a laundry list of other types of scientific evidence introduced. In later opinions, judges spilled substantial ink discussing the neurobiological evidence often in significant detail and with citations to scientific literature and the experts who testified in the case (see Graph 2). This suggests a shift in both the frequency and the nature of how such evidence is being evaluated by judges and juries in criminal cases.

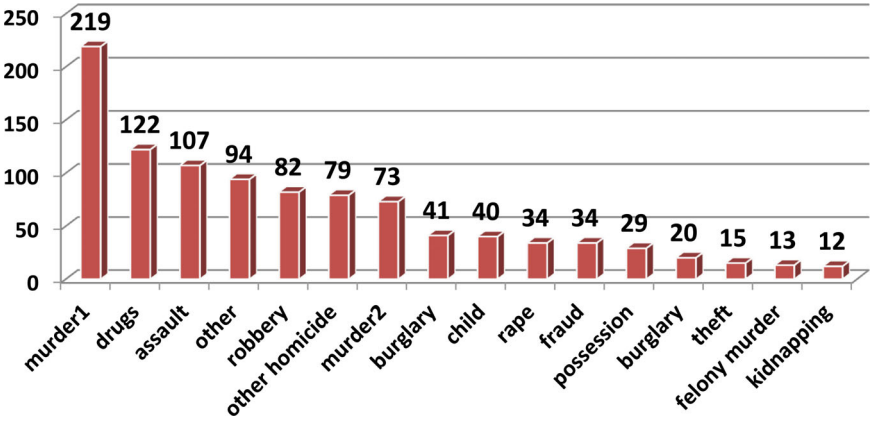
2. Nature of the Offense When Neuroscience Introduced

One surprising result is how broadly neurobiological evidence is being by criminal defendants at trial. The popular mantra in academic circles is that the use of neurobiological evidence is primarily a phenomenon limited to capital cases, as mitigating evidence for sentencing. In the sample of opinions studied here, only about 40 per cent of the cases were capital, and a staggering 60 per cent of cases were other serious felony cases. Drilling down further by looking at the most serious crime a defendant was charged with in the sample, it becomes clear that across felony cases neurobiological evidence is being used as part of criminal defenses (see Graph 3).

In the 60 per cent of non-capital cases where neurobiological evidence is introduced, neurobiological evidence is also introduced in drug possession and trafficking cases, violent assaults, robbery, fraud, and more. Although this sample likely underrepresents the prevalence of neurobiological evidence used in criminal cases due to the



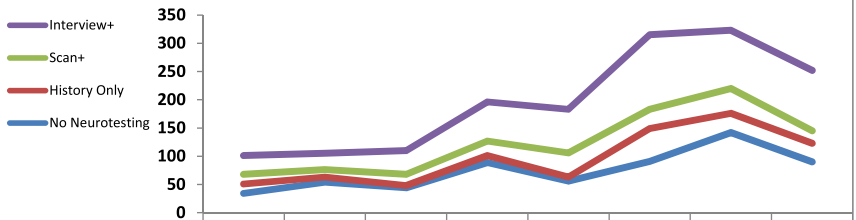
Graph 2. Degree to which neurobiological evidence is discussed in Judicial opinion. (Mention is in a list of information. Some is less than one paragraph of the opinion. Substantive is one paragraph or more of the opinion discussing the neurobiological evidence introduced by a criminal defendant.)



Graph 3. Most serious offense charged with when neurobiological evidence raised in non-capital cases, 2005–12. An evaluation of the most serious criminal charge (per case) that the defendant was charged with to illustrate the range of felony cases impacted by neurobiological evidence.

methodological barriers discussed *supra*, a conservative estimate based on this sample alone is that neurobiological evidence is introduced in at least five to 6 per cent of murder trials in the USA, and 1–4 per cent of other felony offenses.[17]

[17] Based on analysis of Bureau of Justice Statistics and FBI arrestee data from 2005–12.



	2005	2006	2007	2008	2009	2010	2011	2012
Interview+	33	29	42	69	77	132	103	107
Scan+	17	13	20	26	43	34	44	22
History Only	17	9	4	12	7	58	34	33
No Neurotesting	34	54	44	89	56	91	142	90

Graph 4. Neurological testing discussed in criminal opinions 2005–12. (The number of opinions per year in which each time of neurobiological testing is discussed. Interview+ = neuropsychological testing/evaluation, as well as medical or other history of head/brain trauma; Scan+ = some form of brain scanning evidence, neuropsychological testing/evaluation, as well as medical or other history of head/brain trauma; History only = medical or other history of head/brain trauma but no other form of testing discussed in opinion; No neurotesting = no discussion of any form of neurological testing introduced in opinion.)

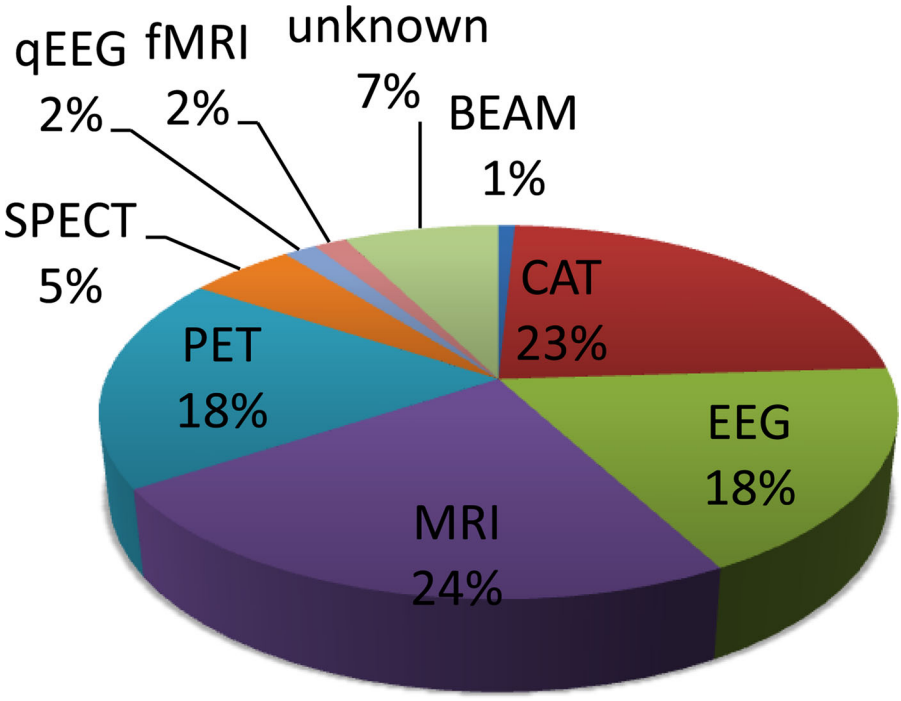
3. Type of Neurobiological Evidence

One explanation for differences in the findings of this study versus other empirical studies on the use of neurobiological evidence is a difference in what 'counts' in these studies as neurobiological evidence. In this study, the neurobiological evidence includes medical history (such the use of past medical records or medical history of head injuries or brain damage), neuropsychological testing (through interviews, battery of testing, and/or evaluation of the defendant), brain scanning of the defendant, or assertions that the defendant suffers from brain or head injury.

Notably, only about 15 per cent of the cases where neurobiological evidence was raised in the sample had any form of brain scanning discussed in the opinion (see Graph 4). A large proportion of the cases (nearly 40 per cent) have no discussion of neurological testing in the opinion, even though the defendant staked their defense in part on a claim that 'his brain made him do it'.[18] Of course, it's entirely possible that the judicial opinion did not discuss the specifics of testing that actually *was* introduced in the criminal case, so this is a conservative estimate of testing introduced.

In the 15 per cent of cases that included a discussion of brain scanning in the opinion, the type of scanning was most often MRI or CAT scans, rather than more sophisticated functional neuroimaging such as EEG, SPECT, or fMRI scanning (see Graph 5). Functional magnetic resonance imaging (fMRI) was discussed in about 2 per cent of the 15 per cent of scanning cases, but in each of the cases the fMRI evidence was not admitted

[18] A next step in this analysis would be to obtain all of the original records from trial, rather than relying on a discussion of the evidence introduced in the judicial opinion, as the cases may have included forms of evidence that supported the neurobiological claims not discussed in the opinion.



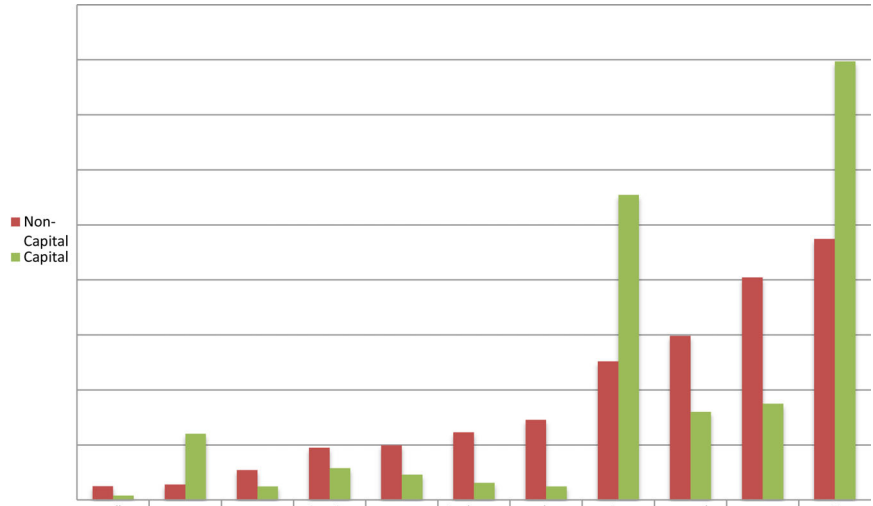
Graph 5. Distribution of neuroimaging discussed in Judicial opinion 2005–12. (In the opinions where neuroimaging was introduced, the type of neuroimaging. SPECT = single-photon emission computed tomography; qEEG = quantitative electroencephalography; fMRI = functional magnetic resonance imaging; Unknown = brain scanning discussed but type not mentioned; BEAM = sometimes known as qEEG, brain electrical activity mapping; CAT = computed tomography; EEG = electroencephalography; MRI = magnetic resonance imaging; PET = positron emission tomography.)

into the case for further consideration because of concerns about scientific reliability, credibility, or relevance.

C. Context for the Introduction of Neurobiological Evidence

1. Pretrial

One surprising finding is the extent to which neurobiological evidence is used in pretrial proceedings (see Graph 6). In pretrial proceedings, the subjective mental state and competency of the defendant can be contested. At this phase of trial, neurobiological evidence may offer a way to improve subjective competency evaluations. Judges typically engage in a colloquy with a defendant and rely upon their own perception of the defendant, together with mental health evaluations, to rule on the defendants' competency. Neuropsychological testing, neurological history, and neuroimaging may meaningfully and appropriately improve such judgments and perceptions.



	toll	ment. ret.	aggrav.	insanity	excuse	involuntary	other	iac	mental	compet.	mitig.
Non-Capital	1%	1%	3%	5%	5%	6%	7%	13%	15%	20%	24%
Capital	0.4%	6%	1%	3%	2%	2%	1%	28%	8%	9%	40%

Graph 6. Distribution of neurobiological evidence-based claims in capital and non-capital cases, 2005–2012. (The denominator is all claims raised in the study sample. The numerator is the specific type of claim. E.g. for mental retardation, 1% of the claims raised in the study sample were for a claim of mental retardation in a non-capital case.)

a. Competency. The United States Constitution forbids the trial of a defendant who lacks mental competency. The test for competency to stand trial is whether a criminal defendant has sufficient present ability to consult with his lawyer with a reasonable degree of rational understanding.[19]

At any point during a trial, the competency of a defendant can be challenged, but it often arises as a pretrial issue, to address whether the defendant has the present ability to proceed.[20]

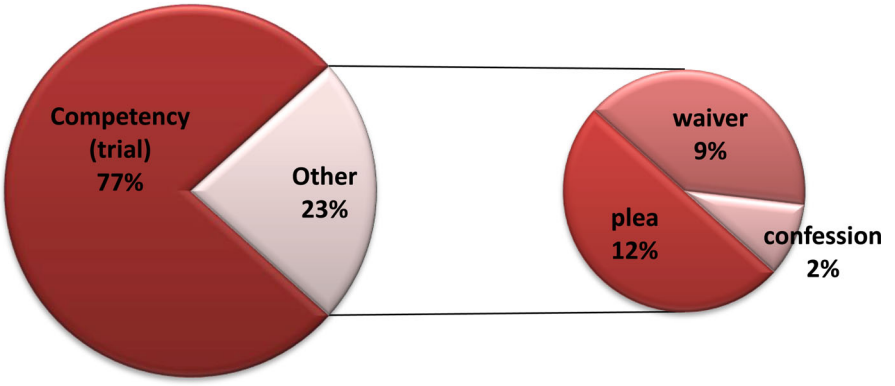
Finding a criminal defendant incompetent to stand trial does not necessarily mean that he is set free. Rather, he may be indefinitely detained in a psychiatric facility until he is rendered competent, or if he never is, remain there until he no longer serves as a present danger to himself or to others.[21]

The data here show a frequent use of neurobiological evidence to challenge defendants' competency during criminal proceedings. In 15 per cent of the neurobiological evidence-based claims raised in the study sample, the defendant argued that something unique about his brain rendered him incompetent to proceed during the criminal case. Of the 15 per cent of all of the claims in the study pertaining to competency, 77 per cent of those challenged the competency of the defendant to stand trial. A smaller but

[19] Dusky v. United States, 362 U.S. 402 (1960).

[20] Stephen L. Golding & Ron Roesch, *Competency for Adjudication: An International Analysis,* in 4 Law and mental health: International perspectives 73, 109 (David N. Weisstub ed., Pergamon 1988).

[21] John Monahan & Henry J. Steadman (eds.), Mentally Disordered Defendants: Perspectives from Law and Social Science, 48, 49 (Spring Science+Business Media, LLC, 1983).



Graph 7. Nature of competency claims raised when neurobiological evidence introduced by criminal defendants.

increasing proportion of claims focused upon the defendant's lack of competency to waive his rights, to plead guilty, or to have confessed to the crime or crimes at issue (see Graph 7).

Consider for example the case of Miguel Angel Ruiz, who was found incompetent to stand trial based on neuropsychological testimony about his brain disorders. In February 2007, 17-year-old Miguel Angel Ruiz (Ruiz) was charged with murdering his mother. In January of 2008, a trial court suspended criminal proceedings against Ruiz to assess his competency to stand trial. After a hearing and a subsequent jury verdict finding Ruiz competent to stand trial, the trial judge set aside the verdict and concluded that there was no reasonable, credible evidence to support a finding that Ruiz was competent. He issued a judgment to that effect notwithstanding the jury's verdict. [22]

Ruiz presented testimony from two neuropsychologists who had performed a battery of tests on him. The prosecution introduced evidence from correctional officers who had interacted with Ruiz while he was awaiting trial.[23]

One of the defense experts diagnosed Ruiz with a severe language disorder that arose from an organic brain-processing deficit that interfered with his language skills. As a result, he had severe inability to converse, explain, or impart information, all critical elements of being able to assist in his own defense.[24] Another expert concluded similarly, that Ruiz had a developmental language disorder, specifically that 'the left part of his brain, which deals with language skills, did not develop as well as the right part of the brain, which deals with nonverbal skills'. The expert believed this was a congenital disorder 'because a brain injury after birth would have affected his motor skills, which were intact'. After administering standard tests to determine if Ruiz was faking his disorder, the expert testified that there was no evidence of malingering.[25]

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22 People v. Ruiz, 2010 WL 298561 (Cal. 5th. Dist. Ct. App. 2010).
23 *Id.* at *1.
24 *Id.* at *1,* 2.
25 *Id.* at *3,* 4.

The trial judge set aside the determination of the jury, stating 'I'm not inclined to set aside a jury's decision lightly or unadvisedly … but quite frankly when I received the verdict after hearing the evidence, I was surprised. I just couldn't believe the jury could return a finding of competency based on the evidence I heard… The testimony of both experts in the court's mind is very persuasive… And as a result, I'm setting aside the jury verdict in this matter'.[26] The California Court of Appeals for the Fifth District affirmed the trial court's decision to set aside the jury's verdict on finding the defendant competent to stand trial.

While highly unusual to set aside a jury's finding of fact, neurobiological evidence appears to have powerful factual and persuasive appeal to judges. The result is that in a substantial portion of cases where competency is raised, credible evidence of neurobiological impairment may enable more legitimately impaired defendants to obtain a favorable finding of incompetent to proceed.

(i) Competency to plead guilty

Similarly and relatedly, the right to Due process under the United States Constitution requires that a defendant's guilty plea be knowing, voluntary, and intelligent.[27] Traditionally, the bar to withdrawing a guilty plea has been quite difficult to surmount. Indeed, guilty pleas are rarely set aside.[28] Defendants are using neurobiological evidence to argue that based on their neurological functioning at the time of entering their guilty plea, they did not enter that plea in a knowing, voluntary and intelligent manner.

In 2007, for example, Richard Hodges pleaded guilty to possession of cocaine and residential burglary.[29] As the judge engaged in what is known as a plea colloquy, Hodges occasionally appeared lost, asked questions about matters not relevant to the plea process, and exhibited confusion.[30] The court ordered a competency determination including a neuropsychological examination and MRI testing.[31] The experts concluded that Hodges was faking it. They found no neurological reasons for Richard's problems and determined his learning abilities were within normal limits. After hearing all of the expert testimony, the judge concluded that Hodges was not suffering from an organic brain disorder.[32]

In some cases, the court has set aside a guilty plea and remanded the case for an evidentiary hearing on claims of competency to enter a guilty plea.[33] In other cases, the court has rejected the neurobiological evidence as contrary to his perceptions of competency based on the plea colloquy. To be sure, attempts to withdraw guilty pleas still largely fail. But it's interesting to note the extent to which claims about the involuntariness or lack of competency to have entered a guilty plea are grounded in neurobiology.

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26 *Id.* at *6.

27 Santobello v. New York, 404 U.S. 257, 261–2 (1971).

28 Wesley M. Oliver, *The Present and Future Regulation of Plea Bargaining: A Look at Missouri v. Frye and Lafler v. Cooper*, Cato Supreme Court Review, 257, 280 (2011–2012).

29 State v. Hodges, 156 Wash. App. 1015 (Wash. Ct. App. 2010).

30 *Id.* at *3.

31 *Id.* at *1.

32 *Id.*

33 See eg Arseneau v. State, 77 So. 3d 1280 (Fla. 2012).

This is an area to watch over time to see if framing these issues as 'brain disorders' will have an effect on case outcomes.

(ii) Competency to confess

In a much smaller portion of the defendants use neurobiological evidence to exclude evidence of past confessions. A particular difficulty for defendants raising these claims is the inability to go backward in time using present neuropsychiatric testing to understand the defendant's competency when questioned months or years prior to being evaluated.

Daniel Thomas,[34] for example, was stopped for a traffic violation when the police officer noticed the smell of marijuana and a large blanket draped over what seemed to be a big square object in the back seat. A search of the car found 110 kilograms of marijuana. Thomas was arrested, and waived his *Miranda* right to remain silent. He gave incriminating statements to the police, including a written statement. Later, he sought to suppress the evidence of his written confession, arguing that when he waived his right to remain silent he did not do so voluntarily, knowingly, or intelligently because he was suffering from severe migraine headaches and brain injury.

A neuropsychologist testified at Thomas's suppression hearing that a brain injury could cause a degree of cognitive impairment that under stress would manifest more symptoms. These symptoms could include problems with attention, concentration, and memory. In combination with stress and sleep-depravation, Thomas's brain injury might impair his attention and concentration, and that poor attention in turn could impair his ability to process information. Thomas would be more likely to lose focus and be more vulnerable to distraction. He would have a reduced ability to knowingly and intelligently waive his rights.

The judge acknowledged that the expert accurately described a person with traumatic brain injury but believed other evidence established that Thomas had adequate memory and intelligence to voluntarily, knowingly, and intelligently waive of his *Miranda* rights. The judge pointed to the time lapse before he wrote out his confession, and the counterexpert who said that given the defendant's educational and professional background such a deficit could not be considered a significant impairment. Based on the objective observations of the defendant's capacities, the court was unconvinced that defendant's brain injury impeded his ability to knowingly and intelligently waive his rights.

This appears to be a rather typical outcome in these cases. Because the present neurobiological evidence may have little bearing on the defendant's actual competency to have confessed at the time of the crime, courts may give neurobiology little weight particularly in comparison to other circumstantial evidence that bears on the defendant's likely capacities at the time.

b. Insanity. Although it captures popular imagination, the insanity defense is raised infrequently and notoriously difficult to prove.[35] Although the precise requirement of the insanity defense varies by jurisdiction, an approach common to many states is the

[34] U.S. v. Padilla and Thomas, 2010 WL 1719367 (D. Arizona 2010).

[35] Randy Borum & Solomon M. Fulero, *Empirical Research on the Insanity Defense and Attempted Reforms: Evidence Toward Informed Policy*, 23 L. & HUM. BEHAV. 375, 378 (1999).

requirement that the defendant have a complete lack of understanding of the difference between right and wrong. This legal standard can be exceedingly difficult to establish, since mental illness typically results in some degree rather than complete impairment of understanding. Jurors also tend to overcredit claims that a defendant is faking (malingering) their impairment. Although the first issue, the legal standard of insanity, is nearly impossible to overcome, to whether the defendant is malingering is an area that neurobiological evidence may inform.[36]

It is for this second purpose—bolstering claims of mental illness—that defendants used neurobiological evidence in about four per cent of the claims analysed in the study.

Consider the case of Mr Chavez, who seemed to have a psychotic break while carrying a metal pole.[37] Perched at a busy intersection on the sidewalk and armed with a metal pipe, he menacingly approached cars as they stopped at a red light harassing them by asking 'Is this your car? Is this your car?'while hitting the windows of the car.[38] The victims later testified that Chavez looked 'kind of crazy' and 'evil looking'. When the police arrived, Chavez told the officer to 'shoot him as he was going to smash him'.[39] He was ultimately arrested. At trial, his defense counsel argued that Chavez was legally insane during the incident and introduced expert testimony that he was suffering from schizopaffective disorder of a bipolar type and a manic break at the time of the offense. A neuropsychologist testified that Chavez had a dysfunction in the frontal lobe region of his brain with an IQ of 79. A PET scan of defendant's brain revealed certain abnormalities in the left lateral frontal area.

The state's expert countered that Chavez's mental illness had no impact on his ability to understand the nature and quality of his acts, and to know that his acts were wrong when he committed them, focusing on the legal concept of insanity. With regard to the incident involving the deputy, the state's expert opined that the defendant intentionally attacked the deputy because he didn't like what he was being told, defendant's awareness of what he was doing and that it was wrong.

The jury found Chavez sane and convicted him for assault on the police officer. This example underscores that while neurobiological evidence may bolster a finding of mental illness or impairment, the legal standard for insanity may still remain an insurmountable hurdle for most defendants.

And yet, neurobiological evidence can and has assisted some criminal defendants with their claims of legal insanity. A particularly telling case is highlighted in the 2011 opinion in the case of *Thomas Curtis vs. the State of Indiana*. In December 2009, Curtis was charged with murdering his wife.[40] In 2010, Curtis filed a notice of intent to introduce the insanity defense and the trial court appointed a psychologist and a psychiatrist to evaluate him. Both experts testified that they believed Curtis was insane at the time he killed his wife. The trial court nevertheless found Curtis guilty but mentally ill ('GBMI').[41] Both the psychologist and psychiatrist who evaluated Curtis thought he

[36] See Nita A. Farahany & James E. Coleman, Jr., *Genetics and Responsibility: To Know the Criminal from the Crime*, 69 L. & CONTEMP. PROBS. 115, 126 (2007).

[37] People v. Chavez, 73 Cal. Rptr. 3d 189 (Ct. App. 2d CA 2008).

[38] *Id.* at 189, 192.

[39] *Id.* at 189, 193.

[40] Curtis v. State, 925 N.E.2d 887, *1 (Ind. Ct. App. 2011).

[41] States have attempted to reduce verdicts of not guilty by reason of insanity by allowing the alternative verdict of guilty but mentally ill (GBMI). This is meant to serve as an intermediary sentence between guilty and not

was unable to appreciate the wrongfulness of his conduct. Both believed he suffered from PTSD from his time in the military, and 'organic brain injury'.[42] Upon review of the trial judge's decision to enter a GBMI verdict the appellate court found that there was neither expert nor lay opinion that Curtis was sane at the time he killed his wife. Instead, the trial court had been swayed by the inadequacy of available treatment noting that in a state hospital Curtis would be 'kicked out as soon they can', and 'then there's no guarantees'. The trial court rejected 'the insanity defense after concluding that the defendant could continue to be a danger to society because of an inadequate State mental health system'.[43] Although sympathetic to the trial court's concern, the appellate court credited the uncontroverted evidence of legal insanity, reversed the judgment of GBMI, and remanded the case for an entry of not guilty by reason of insanity and the appropriate commitment proceedings.[44]

The trial court's concern is echoed throughout the study opinions. While neurobiological evidence may be compelling evidence to bolster a finding of incompetency or insanity, without adequate mental health treatment options available courts and juries are left to struggle with how to appropriately weigh the evidence while also safeguarding the community writ large from an admitted and potentially untreated or untreatable dangerous neurobiological predisposition.

2. Judging Guilt

Neurobiological evidence has been considerably less helpful in determining whether a defendant has committed a crime. Neurobiological evidence is often used to challenge the folk psychological beliefs underlying criminal law: that actions are voluntary and the product of conscious choice. The alternative—that actions arise from unconscious predispositions over which an individual has little control—has made little inroads in criminal law. Most basically, the concepts of voluntariness and intentionality in law don't map well onto how those concepts are understood by scientists. Nor does a theory that individuals are automatons and unable to control their actions align well with our subjective experiences of self-directed decision-making. Finally, the science—usually population-level science (such as a correlation between neurological or genetic variations and behavioral variations across a population)—doesn't tell us much about why any particular individual behaved as they did. As a result, attempts to use neurobiological evidence for determinations of guilt or innocence seems to make far less of an impact than attempts in pretrial and sentencing determinations.

a. Involuntariness. In about 4 per cent of the study-sample claims (~7 per cent of the judicial opinions) defendants argued that their neurobiology made them act involuntary. Typically, this involved a claim of involuntary conduct following the voluntary ingestion of drugs or alcohol. These claims appear to be non-starters.

Prosecutors start out ahead as a matter of law in proving that a defendant acted voluntarily. Criminal law grants a strong presumption that defendants act voluntarily. This

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guilty by reason of insanity, although in practice it may not result in a different sentence than a guilty verdict. See eg John D. Melville & David Naimark, *Punishing the Insane: The Verdict of Guilty but Mentally Ill*, 30 J. Am. Acad. Psychiat. Law 553, 555 (2002).

42 Curtis v. State, 925 N.E. 2d 887, *2 (Ind. Ct. App. 2011).

43 *Id.* at *5.

44 *Id.* at *4.

presumption means that the defense that a person acted involuntarily will only succeed in a narrow set of circumstances. The defense of 'involuntariness' is recognized if a defendant's actions were a reflex or convulsion, a bodily movement arising from unconsciousness, sleep, hypnosis, or by some factor other than actor's will.[45] These automatism cases are legal freaks, but a growing chorus of scientists argues that they should serve as a paradigm; decision-making is primarily 'unconscious', they say. Perhaps, unbeknownst to the chorus, those claims have been featured in criminal courtrooms.

Judges are certainly not allowing all of these claims into the courtroom as one opinion about a high-speed car chase makes plain.[46] In this case, a police officer saw a known former criminal offender with an outstanding warrant for his arrest at a gas station, and approached him when the defendant returned to his car. [47] The officer asked the defendant to step out of the car but the defendant instead instructed the driver to take off. [48] What ensued was a high-speed car chase culminating in the driver stopping in the middle of the street and backing his car into the police officer's car to injure him. The defendant was arrested and convicted with resisting arrest and assaulting the officer. On appeal he argued that the trial court judge made a legal error in excluding relevant expert testimony regarding his head injuries and subsequent blackouts.

Eight weeks prior to this incident a tree limb fell on his head. At the time he had a CAT scan and MRI performed on his head and neck. Because of his head injury, the defendant claimed that he was acting unconsciously in a blacked out state of shock during the police chase.

The trial judge excluded the neurobiological evidence because it was misleading and irrelevant. A mere failure to remember an event does not excuse its occurrence unless the failure to remember signifies involuntary or unconscious conduct. No expert supported the neurobiological claim. Instead, the experts agreed that while the defendant had been hit on the head the MRI and other evidence did not support neurological trauma, blackouts, or states of unconsciousness.

This case is an exemplar of the claims raised. Nearly 40 per cent of the opinions addressing automatism claims do not discuss any neurological testing of the criminal defendant. Instead, the claims appear to be rooted in past head injuries or other trauma the defendant alleges to have suffered.[49]

b. Mental States. It's all the more important that neuroscientists start talking about the responsible use of neurobiological evidence in law, because it has already influenced jury decision-making about defendants' mental states. In approximately 10 per cent of all the claims raised in the study, the defendant argued that neurobiological evidence showed he lacked the mental state necessary to commit the crime.

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[45] Model Penal Code § 2.01. Requirement of Voluntary Act; Omission as Basis of Liability; Possession as an Act.

[46] State v. Allsup, 2011 WL 332734, (Ohio App. 3 Dist. 2011).

[47] *Id.*

[48] *Id.*

[49] In the 109 judicial opinions discussing claims of involuntariness, 40 of the cases appear to have included no neurological testing and 36 of the 109 (33 per cent) did not mention any expert testimony whatsoever. See eg In the Matter of Brown v. Fischer, 948 N.Y.S.2d 779 (N.Y. App. 2012) (where defendant assaulted nursing staff taking his blood pressure, he claimed his conduct was involuntary arising from his brain cancer and seizures. While recognizing defendant does suffer seizures, no medical proof linked his seizures to involuntary conduct at the time he assaulted the nurse).

The typical defendant uses neurobiological information to argue that he acted impulsively rather than with the premeditation or purpose contemplated by the crime definition. So claimed John Gunther who was charged with first-degree murder of his mother in 2008.[50] Gunther used a metal pipe to bludgeon his mother to death and she died of blunt force trauma to her head. He did so apparently to steal her money, television, VCR, and jewelry to purchase drugs. He admitted to killing his mother and threatening to do so many time but 'denied planning or intending to kill her'.[51] In support of his claim, two experts testified on his behalf. The first, a clinical psychologist and neuropsychologist, reviewed Gunther's medical records and evidence of head trauma in 2007 and again in 2008. This medical history together with a series of neuropsychological tests the expert administered supported his conclusion that Gunther had damage to his frontal lobe 'possibly reducing his ability to premeditate or deliberate, and instead causing him to act impulsively on the night he killed his mother'.[52] A second expert concurred echoing that Gunther's brain injuries could explain killing his mother as impulsive and 'affect[ing] his ability to form mental states such as specific intent to kill his mother, premeditation or deliberation'.[53] The jury nevertheless found Gunther guilty of first-degree murder, which requires deliberation and premeditation. In reviewing the jury's determination on appeal the court found the jury reached a reasonable conclusion: 'Here, the jury reasonably could conclude that Gunther planned to murder his mother. He repeatedly told several people, over an extended period of time, that he hated her.… He asked [another] to help him kill her.… Gunther's conversations were sufficiently frequent and detailed as to signal his intent to murder his mother, which he eventually did'.[54]

This opinion is consistent with how other courts approach neurobiological evidence when used to challenge mental state. Presented with circumstantial evidence consistent with planning and premeditation and with conflicting neurobiological evidence, judges and juries tend to credit the circumstantial evidence over the neurobiological. This may be in part because of the near impossibility of understanding the defendant's mental state at the time the crime was committed. Neurobiological evaluations cannot take us backward in time to understand what the defendant was thinking, feeling, or why the defendant acted as he did. It may possibly tell us something about the defendant's general behavioral predispositions. But the missing link between predisposition evidence and the causes and intentions of any specific actions cannot presently be overcome.[55]

Moreover, concepts like mental states are narrower in criminal law than the lay perspective may assume. Mental state in criminal law is about the intentionality with respect to the specific act in question. Did the defendant mean to swing the pipe (purpose of the act), understanding the person he was swinging the pipe at was another human being (the circumstances), and that the impact of swinging a pipe at another person would be to cause grave bodily suffering or injury (consequences)? With this narrow understanding of the mental state necessary to convict a criminal defendant, it becomes

[50] People v. Gunther, 2012 WL 924846 (Ct. App. 4th. Div.Cl. 2012).
[51] *Id.* at *3.
[52] *Id.*
[53] *Id.* at *4.
[54] *Id.*
[55] See generally David L. Faigman, John Monahan & Christopher Slobogin, *Group to Individual (G2i) Inference in Scientific Expert Testimony*, 81 U. Chi. L. Rev. 417 (2014).

apparent that at least as the law is presently understood neurobiological evidence may provide little support. In only the rare case will neurobiological evidence address the purpose of the act, an understanding of the circumstances or anticipation of the consequences.[56]

More direct dialog between neuroscientists and attorneys could better inform both groups about how concepts like voluntariness and mental state differ in both law and science, which could lead to more responsible testimony by neuroscientists in criminal cases about the (ir) relevance of neurobiological evidence to determining the voluntariness or mental state of the defendant. Greater engagement by leading neuroscientists in the legal process would substantially improve both judges' and jurors' understanding of the limitations of science in answering the questions that law poses in addressing voluntariness and mental state.

c. Sentencing. Fundamentally, neurobiological evidence is fueling a societal debate about why we punish people who commit crimes. Do we do so because defendants deserve punishment for their acts of wrongdoing? Do we punish to protect society against dangerous criminals? And if so, would this goal be better served by rehabilitating and reintegrating into society those who commit crimes? Although neurobiological evidence cannot answer these philosophical questions for us, it can provide empirical evidence about human behavior that bear on these discussions.

And yet, neurobiological data may tell us little about any particular defendant and whether they are deserving of punishment. It's this concern—that studies do not tell us why a particular person behaved as they did—that seems to motivate many scientists to oppose the use of neurobiological evidence in sentencing. But regardless of whether scientists agree or not about the appropriate role of neurobiological evidence in criminal law, neurobiological evidence seems clearly entrenched in sentencing decisions. Developmental neuroscience has served as the empirical basis for recent constitutional prohibitions against the execution of or life imprisonment of juveniles.[57] And there may be a coming tsunami of neurobiological evidence-backed sentencing claims at trial. Trial attorneys have already been found ineffective at trial because they failed to investigate a defendant's probable neurological abnormality (even though defendants rarely prevail otherwise on such claims).

Approximately 44 per cent of the neurobiological claims raised were attempts to mitigate sentencing.[58] Nearly half of those claims were the defendant arguing he received ineffective assistance of counsel by failing to introduce neurobiological evidence at sentencing.[59] More than half of the sentencing claims were for capital cases, while the remaining 42 per cent were non-capital cases.

To establish a defendant received ineffective assistance of counsel he must show that his attorney acted 'below an objective standard of reasonableness', and there was a reasonable probability that but for counsel's unprofessional errors the outcome of the case likely would have been different.[60] Defendants can rarely establish both prongs of this

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[56] See Nita A. Farahany et al., *Supra* note 36, at 115, 123–5.

[57] Eg Roper v. Simmons, 543 U.S. 551 (2005); Graham v. Florida, *130 S.Ct.* 2011 (2010); Miller v. Alabama, *132 S.Ct.* 2455 (2012).

[58] 820 of the 1861 claims were claims of mitigation.

[59] 369 of the 820 claims for mitigation were raised as ineffective assistance of counsel claims.

[60] Strickland v. Washington, 366 U.S. 668 (1984).

claim. In fact, even when defense counsel has slept through substantial portions of a trial, judges have ruled that defendants did not receive ineffective assistance of counsel.[61] It's particularly notable then that judges have already found that failing to investigate a reasonable probability of a brain abnormality constitutes ineffective assistance of counsel.

Even in cases with horrific facts, judges have found neurobiological evidence an essential component of counsel investigation. In one case,[62] a defendant and his coworker went to a bar in Arizona where they consumed almost two-dozen beers. When they left the bar, they picked up a female victim walking along the side of the road. Eventually, things turned badly between these three and one of the defendants turned a knife on the woman. He sexually assaulted her, slit her throat, stabbed her over 30 times and then left her mutilated body in the desert. He was convicted by a jury of first-degree murder and sentenced to death. He presented volumes of new evidence on appeal about his brain damage and neuropsychological deficits. The court found a reasonable probability that the sentencing judge would have imposed a sentence less than death had the defendant's counsel obtained and presented an expert evaluation of his neuropsychological functioning. The court believed this was 'powerful' evidence of mitigation and therefore found that the defendant's trial counsel had rendered ineffective assistance of counsel by failing to investigate it.[63]

Such rulings put neurobiological evidence in a rarified position of must-investigate evidence. Defense counsel are ineffective if they fail to mount a defense at all, sleep through an entire (but not just parts of) a trial, or if they fail to investigate a probable neurological abnormality in a defendant. One of these things is not like the others, and its oddity makes clear that neurobiological evidence is an embedded part of the criminal process.

To further underscore this point, consider that it may be entirely reasonable to choose not to introduce neurological evidence because of it's double-edged potential. When the defendant Connie was convicted[64] of burglary, battery, kidnapping, sexual battery with great force, and first-degree murder of 77-year-old woman in her own home, his neurobiological evidence-based defense didn't just fail, it did so miserably.

In the closing statement of the trial, the prosecutor summed up the neurobiological evidence he introduced saying:

> So, what are we left with? … a doctor [] comes in and tells you … he couldn't help it, he was born that way. This man was born evil, born bad, he's going to be that way for now on and there's nothing I can do except identify it for you. … he's got diffuse brain damage and he goes around raping women and beating them up... Well, Ladies and Gentlemen, you decide how much mitigation that deserves. How much weight do you give to he just does it because he does it? [65]

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61 Eg Muniz v. Smith, 647 F.3d 619 (6th Cir. 2011).
62 Dietrich v. Ryan, 619 F.3d 1038 (9th Cir. 2010).
63 *Id.*
64 Israel v. State, 985 So. 2d 510 (Florida 2008).
65 *Id.*

The jury voted 11-1 in favor of the death penalty, and the judge followed their recommendation. It's entirely unsurprising that even upon discovering neurobiological evidence defense attorneys may often choose to forego using it as part of mitigation.

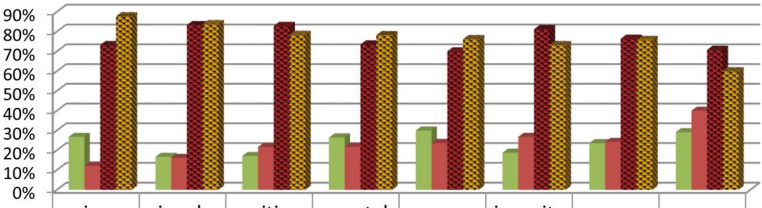
This is particularly true where civil commitment may later be at issue. Once a criminal defendant has been released from prison he can be involuntarily civilly committed if he continues to serve as a danger to himself or the community. This is most prevalent in cases of 'sexually violent predators', which requires proving that a person has a past conviction of a sexual offense, is likely to reoffend, and has a diagnosed mental disorder that makes the person a danger to the health and safety of others. Some of the brain abnormality evidence introduced by a criminal defendant at trial can cut against him at a civil commitment hearing.

For example, when a defendant committed a series of sexually violent attacks and was convicted and sentenced to 15 years in state prison, he was sent to a state hospital as a mentally disordered sex offender instead.[66] While there, he failed the treatment programs because of his repeated sexual advances to female staff members.[67] In a later civil commitment proceeding, the court weighed heavily that the defendant had suffered a serious head injury when struck in the head by the butt of a shotgun.[68] A year and a half after the injury, his behavior became more aggressive, and the experts concluded that the brain injury was likely a factor in his crimes.[69] Based on this evidence, the court concluded that the defendant's capacity to control his violent sexual tendencies would be seriously impaired if released into the community and committed him to confined institutionalization.[70]

d. Sentencing for Juveniles. Mitigation by adolescent offenders using neurobiology has been met with more consistent receptiveness. Ninety-one of the cases in the study pertained to juveniles (about 6 per cent). Eighty-four of those cases used a 'developing brain' theory rather than the more individualized neurobiological claims raised by adult offenders. The developing brain theory is about the juvenile brain generally, rather than specifically about the particular offender. These defendants argue that the juvenile brain is still developing—that the frontal lobe region is still underdeveloped and that the brain is not fully myelinated—and that as a result juveniles should be treated less harshly than adults. The fact that the brain is still developing means a juvenile has less capacity for self-restraint, but also means that their criminal conduct is not representative of how they will behave as an adult with a fully developed brain.

In a triology of cases, the United States Supreme Court has cited to evidence about the developing juvenile brain to find it unconstitutional under the Eighth Amendment of the United States Constitution to executive juveniles,[71] to impose life without the possibility of parole for non-homicidal offenders,[72] or to have a mandatory scheme of life imprisonment without the possibility of parole.[73] Since the latest of these cases, *Miller v. Alabama*, there is considerable confusion and debate by lower courts about

[66] People v. Calderon, 2009 WL 428911 (Cal. App. 2009).
[67] *Id.*
[68] *Id.*
[69] *Id.*
[70] *Id.*
[71] Roper v. Simmons, 543 U.S. 551 (2005).
[72] Graham v. Florida, 560 U.S. 48 (2010).
[73] Miller v. Alabama, 567 U.S. (2012).



	iac	invol.	mitig.	mental	excuse	insanity	comp.	men. ret.
Capital (+)	27%	17%	17%	26%	30%	19%	24%	29%
Non-Capital (+)	12%	16%	22%	22%	24%	27%	24%	40%
Capital (-)	73%	83%	83%	74%	70%	81%	76%	71%
Non-Capital (-)	88%	84%	78%	78%	76%	73%	76%	60%

Graph 8. Case outcome in adult trials when neurobiological evidence is introduced by defendant. + means the defendant achieved a positive outcome on appeal, whether as a reversal, remand, or modification of a component of the trial courts' decision. – means the defendant did not achieve any positive outcome on appeal.

the meaning of that ruling and the extent to which a judge must consider neuroscience when sentencing a juvenile offender.

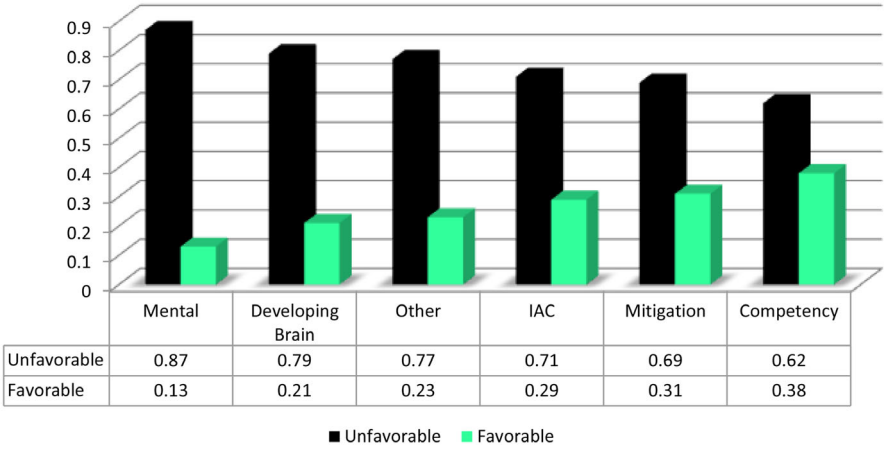
3. Case Outcomes When Neurobiological Evidence Introduced

So how does this neurobiological data fare in criminal cases? Generally, between 20 and 30 per cent of defendants enjoy some success on appeal, in part because of neurobiological evidence, in capital case and non-capital case alike. Although a one-to-one comparison of matched cases where neurobiological evidence was *not* introduced cannot be done to accurately understand how neuroscience impacts case outcomes, the success rate on appeal in these cases appears to be higher than in criminal appeals in general. Comparing the reversal rates in these cases versus all criminal appellate cases, the reversal rate in cases with neurobiological evidence is higher. In a 2010 study of the estimate 69,348 criminal appeals in the US, in only about 12 per cent of the cases did the appellate court reverse, remand, or modify a component of the trial courts' decision.[74] Whereas the success rate in death penalty study cases was 23 per cent (merits and non-merits cases together), compared to the 18.6 per cent success rate in death-penalty merits appeals overall. The success rate in non-capital cases also appears to be higher in the study cases—the general reversal rate in non-capital cases was 7.7 per cent (merits cases) and 2.3 per cent (without a review of the merits), while the overall reversal rate was 20 per cent in the non-capital cases in the study.[75] The reversal rates by specific claim raised are illustrated in Graph 8.

We have not been able to locate any comparable data against which the relative success rate in juvenile cases with and without neurobiological cases can be compared. The data from the Bureau of Justice Statistics excludes cases pertaining to juveniles. The study cases show that, in general, the juvenile defendants fared *better* than adult

[74] Nicole L. Waters et al., *Criminal Appeals in State Courts*, Bureau of Justice Statistics, Sep. 2015, NCJ 248874, http://www.bjs.gov/content/pub/pdf/casc.pdf (accessed Nov. 1, 2015).

[75] *Id.* see Table 1.



	Mental	Developing Brain	Other	IAC	Mitigation	Competency
Unfavorable	0.87	0.79	0.77	0.71	0.69	0.62
Favorable	0.13	0.21	0.23	0.29	0.31	0.38

Graph 9. Case outcome in juvenile trials when neurobiological evidence is introduced by defendant. Favorable means the defendant achieved a positive outcome on appeal, whether as a reversal, remand, or modification of a component of the trial courts' decision. Unfavorable means the defendant did not achieve any positive outcome on appeal.

defendants, in some categories achieving as high as a 38 per cent favorable outcome on appeal (see Graph 9).

CONCLUSION

The use of neurobiological evidence in criminal cases may draw serious criticism and justifiable concern by scientists. But neurobiological evidence also has improved the criminal justice system through better competency determinations and reconsiderations about the role of punishment in society. And neurobiological evidence at times replaces what was even shoddier evidence that we relied about to make inferences about the individual capacities and behavior of a criminal defendant. Given the recent rulings about the neurobiological evidence and ineffective assistance of counsel, it's safe to assume that neurobiological evidence is now a mainstay of our criminal justice system.

As a result, it's time for a more nuanced dialog between neuroscientists, legal decision-makers, and the public about the role of neurobiological evidence in the criminal courtroom. It's no longer productive to call for outright bans; neuroscientists should help to improve public understanding about what neurobiological evidence can and cannot tell us about human behavior.

At the same time, the dialog about how neurobiological evidence is being used in criminal cases by legal scholars, commentators, and the media should account for the differences between popular perception and the results of this study. The use of neurobiological evidence is clearly more widespread and nuanced than previously believed.

Some successful efforts are already underway to improve public understanding of law and cognitive neuroscience. To name a few, the Dana Foundation and the American Association for the Advancement of Science have launched a Neuroscience in Society Series that has hosted a number of pertinent events to inform judges and the public about advances in cognitive neuroscience. The John D. and Catherine T. MacArthur Foundation funded a multiyear project on Law and Neuroscience, which includes an

educational component. The Royal Society in London has issued a four-part series of accessible reports on the developments in neuroscience and their implications for society, public policy, and law. The Presidential Commission for the Study of Bioethical Issues has issued a two-part report entitled "Grey Matters," that includes a detailed chapter and recommendations on law and neuroscience. Dozens of worldwide academic conferences have been held on the topic. And a recent PBS special entitled 'Brains on Trial' engaged neuroscientists, philosophers, and lawyers to educate the public about these developing trends. But more can and should be done to engage the public on these issues—after all it is the public who constitutes the criminal jury.

Neuroscientists should be at the forefront of this conversation—as experts in criminal courtrooms, in public presentations, through accessible writing for public audiences, or by filing amicus briefs in legal cases where neurobiological evidence is at issue. Neurobiological evidence has profound implications for some of the most significant decisions we make in law and policy. It's time we better understand how it's being used and start to address how it may be better used in our criminal justice system.

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