# When a Picture Is Not Worth a Thousand Words

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ABSTRACT

*It is frequently put forth that the admission of neuroimaging evidence at criminal trials introduces the substantial risk of these sophisticated and visual presentations unduly influencing factfinders. As such, this Essay analyzes how brain image evidence might have this effect. Particularly, it focuses on the situation in which such evidence is proffered in support of mens rea and affirmative defense determinations, such as insanity. The Essay assesses the actual evidentiary value of neuroimaging evidence in these evaluations. It then presents relevant studies supporting and opposing the contention that this evidence unduly influences factfinders beyond its true explanatory power. Finally, given the current state of research into this issue, this Essay puts forth a prospective manner in which brain images might inordinately influence finders of fact and a path for further study.*

## INTRODUCTION

On January 7, 1991, Herbert Weinstein strangled his wife to death and threw her body out of the window of their twelfth-floor Manhattan apartment in an effort to make it look like a suicide. He disputed none of this.

Prior to trial, however, Weinstein put forth the defense "that [he] lacked criminal responsibility for killing his wife due to mental disease or defect."[1] In primary support of this contention, Weinstein sought to admit into evidence images of his brain procured through the use of a procedure called positron emission tomography ("PET").[2] This involves the injection of a radioactive substance into the bloodstream that the brain metabolizes.[3] Specialized machinery then produces images of the distribution of radioactivity across the brain.[4] Brighter areas show high metabolism while darker areas show low metabolism, and differences from normal metabolic

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1 People v. Weinstein, 591 N.Y.S.2d 715, 717 (N.Y. Sup. Ct. 1992).

2 *Id.* at 722–23.

3 RADIOLOGICAL SOC'Y OF N. AM., INC. (RSNA), *Positron Emission Tomography - Computed Tomography (PET/CT)*, RADIOLOGYINFO.ORG, http://www radiologyinfo.org/en/info.cfm?pg=pet (last updated June 11, 2015).

4 *Id.*

rates across brain regions can indicate abnormalities.[5]

Sure enough, Weinstein's PET scan revealed a cyst within his arachnoid membrane—a protective layer of tissue surrounding the brain—and metabolic imbalances in neighboring brain areas.[6] As a result, the judge allowed the images into evidence for the purpose of showing these physical irregularities, but expert testimony linking the PET results with violent thoughts or behavior was prohibited.[7] Despite this limitation, Weinstein's lawyer recounted being very optimistic: "I thought once a jury saw that PET scan with that big, black hole in the brain, they won't convict him."[8]

Apparently, the prosecution felt the same way. Before jury selection, they agreed to a plea deal whereby Weinstein pled guilty to manslaughter, as opposed to murder, and received a reduced sentence.[9]

But what exactly made the prosecution so scared? Given the proliferation in the use of neuroscience evidence in criminal trials, including neuroimaging,[10] the answer has serious implications for the integrity of the criminal justice system.

This Essay analyzes how the presentation of brain image evidence might inappropriately influence the conclusions reached by finders of fact, whether judges or jurors. Particularly, it focuses on the situation in which such evidence is proffered in support of mens rea and affirmative defense determinations, such as insanity. The Essay assesses the actual evidentiary value of neuroimaging evidence in these evaluations. It then presents relevant studies supporting and opposing the contention that this evidence unduly influences factfinders beyond its true explanatory power. Finally,

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5 *Id.*

6 *Weinstein*, 591 N.Y.S.2d at 722.

7 *Id.* at 724–25.

8 Kevin Davis, *Brain Trials: Neuroscience Is Taking a Stand in the Courtroom*, ABA J. (Nov. 1, 2012, 10:20 AM), http://www.abajournal.com/magazine/article/brain_trials_neuroscience_is_taking_a_stand_in_the_courtroom/.

9 *Id.* ("[The prosecutor] didn't want to take the risk of letting a jury decide after seeing those brain images. He agreed to a plea deal in which the charges would be reduced to manslaughter . . . .").

10 *See* ROBERT H. BLANK, INTERVENTION IN THE BRAIN: POLITICS, POLICY, AND ETHICS 148 (2013) ("With increasing frequency, criminal defense attorneys are integrating neuroimaging data into hearings related to determinations of guilt . . . ."); 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, 1132 (2010) ("Functional neuroimaging has already been admitted and relied upon as evidence of an individual's past mental state."); Nita A. Farahany, *Neuroscience and Behavioral Genetics in US Criminal Law: An Empirical Analysis*, 2 J.L. & BIOSCIS. 485, 491 (2015) ("The data show an increasing trend in using neurobiological evidence in criminal cases.").

given the current state of research into this issue, this Essay puts forth a prospective manner in which brain images might inordinately influence finders of fact and a path for further study.

## I. THE ACTUAL EVIDENTIARY VALUE OF BRAIN IMAGES

Neuroimaging generally comes in two forms.[11] First, there is structural imaging.[12] These procedures, such as computerized axial tomography ("CAT") scans and magnetic resonance imaging ("MRI"), involve capturing images of the static structure of the brain.[13] Second, there is functional imaging.[14] Rather than producing static pictures of brain structure, these procedures, including functional MRI ("fMRI") and the PET scan used in *People v. Weinstein*,[15] generate images and videos of brain *activity*.[16] They measure blood flow and metabolism in the brain to reveal how active regions and structures are when people carry out specific behaviors.[17]

Both structural and functional imaging have greatly enhanced the understanding of the brain and aided in the treatment of a myriad of cognitive disorders. Using them, a brain's physical condition and functioning can be seen, and these characteristics can be correlated with mental abilities or deficiencies.[18] However, correlation and causation are not the same thing, and the scientific value of neuroimaging therefore does not necessarily translate into evidentiary value at a criminal trial.[19]

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11 E. Albon et al., *Structural Neuroimaging in Psychosis: A Systematic Review and Economic Evaluation*, 12 HEALTH TECH. ASSESSMENT, no. 18, 2008, at iii, 8.

12 *Id.*

13 *See, e.g.*, *id.* at 8–11; S.A. Bunge & I. Kahn, *Cognition: An Overview of Neuroimaging Techniques*, 2 ENCYCLOPEDIA NEUROSCI. 1063, 1063 (2009).

14 Albon et al., *supra* note 11, at 8.

15 591 N.Y.S.2d 715 (N.Y. Sup. Ct. 1992).

16 *See, e.g.*, Bunge & Kahn, *supra* note 13, at 1063–65; Bruce Crosson et al., *Functional Imaging and Related Techniques: An Introduction for Rehabilitation Researchers*, 47 J. REHABILITATION RES. & DEV., no. 2, 2010, at vii–x.

17 Crosson et al., *supra* note 16, at viii.

18 *See generally* Brown & Murphy, *supra* note 10, at 1136–53.

19 *See* Theodore Y. Blumoff, *Foreword: The Brain Sciences and Criminal Law Norms*, 62 MERCER L. REV. 705, 751–52 (2011) ("All but a few of even its strongest proponents understand that imaging is not mind reading. Imaging can provide only post hoc explanations and thus is only one among many windows into the brain; all imaging requires interpretation. That this is so follows from the chain of inferences that must be drawn and the assumptions that must be made to move from an imaging artifact to satisfying the dictates of logical relevance at trial . . . . This is not to say that neuroimaging has no current relevance in our criminal justice system . . . . It is to say that its use in the guilt phase of criminal proceedings is quite limited." (footnote omitted)); *see also* Robert M. Sapolsky, *The Frontal Cortex and the Criminal Justice System*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y B: BIOLOGICAL SCI.

Although based on objective scientific measures of physical structures and functions, the process of producing a brain image using neuroimaging techniques introduces not inconsequential degrees of subjectivity into final visual depictions. Creators have a good deal of latitude in deciding what information will ultimately be represented in an image and how.[20] And as of yet, there are no universal standards for these portrayals that would allow an individual to easily and quickly understand what is being illustrated and to conduct comparisons.[21]

In addition, in the arena of a criminal trial, we are concerned with an individual's mental state, such as whether they intended to carry out the crime or were legally insane, when he committed the crime.[22] Using brain images to deduce this information requires two substantial, and highly problematic, inferential leaps.

First, firm causal links between physical brain abnormalities, whether structural or functional, and mental characteristics are thus far largely lacking. "While some irregularities, such as tumors or unusual metabolic activity in certain brain regions, correlate with deviant thoughts and behavior, there are also many people who possess these characteristics without engaging in either."[23]

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1787, 1788–89 (2004) (considering "some cultural differences between the legal world and that of science" that make findings from the latter difficult to interject into proceedings of the former).

[20] Brown & Murphy, *supra* note 10, at 1144–55; *see also* Adina L. Roskies et al., *Neuroimages in Court: Less Biasing Than Feared*, 17 TRENDS COGNITIVE NEUROSCI. 99, 99 (2013) ("[B]rain imaging is not photography and is neither direct nor inferentially straightforward. The layperson is unaware of the many steps involved in producing a neuroimage and relating it to a particular cognitive process or capacity."). In addition, a recent study found that a substantial amount of research utilizing fMRI has been conducted using statistical methods that produce "a very high degree of false positives," far above that generally accepted for valid results. Anders Eklund et al., *Cluster Failure: Why fMRI Inferences for Spatial Extent Have Inflated False-Positive Rates*, 113 PROC. NAT'L ACAD. SCI. 7900, 7900 (2016).

[21] Brown & Murphy, *supra* note 10, at 1146.

[22] *See id.* at 1131 ("Determining the mens rea of an accused person is to attempt mind reading (and, indeed, time travel).").

[23] Andreas Kuersten, Opinion, *Brain Scans in the Courtroom*, THE SCIENTIST (Nov. 23, 2015), http://www.the-scientist.com/?articles.view/articleNo/44604/title/ Opinion--Brain-Scans-in-the-Courtroom/; *see also* Matteo Carandini, *From Circuits to Behavior: A Bridge Too Far?*, *in* THE FUTURE OF THE BRAIN: ESSAYS BY THE WORLD'S LEADING NEUROSCIENTISTS 177, 177 (Gary Marcus & Jeremy Freeman eds., 2015) ("A fundamental mandate of neuroscience is to reveal how neural circuits lead to perception, thought, and ultimately behavior. The general public might think this goal is already achieved: when a news report says that a behavior is associated with some part of the brain, people tend to take that statement as an explanation. But neuroscientists know that most aspects of behavior result from neural

As a result, brain images, whether structural or functional, are not windows into an individual's mind. One cannot look at these visual representations and know what a person was thinking or capable of thinking.[24] Rather, they merely reveal physical characteristics of the brain in question.[25] Evidence of an accused's behavior, including speech acts, is still what is necessary to reveal mental capacities and states. Neuroimaging simply allows for assessments of whether the physical characteristics of a person's brain, as revealed by such techniques, and an individual's cognitive faculties, as revealed by their behavior, align with correlations previously deduced through clinical research.[26] And "[u]ntil we know vastly more than we do now, in most cases [neuroimaging evidence] will not be in a position to add much to assessing responsibility behaviorally."[27]

Second, neuroimaging produces visual representations of the physical structure and functioning of the brain at the moment it is conducted. If employed after an alleged offense, let alone a significant period of time after, it cannot conclusively reveal anything about the given individual's brain when the alleged offense occurred.[28] Instead, one is left to speculate as to whether the physical characteristics of the brain in question were the same at the time of the alleged crime as they were when imaged.

The troublesome nature of the inferential leaps noted above—(1) from a brain's physical traits to individual mental abilities and states, and (2) from a brain's physical state when imaged to its physical condition at the time of a charged offense—is illustrated by the example of the insanity defense. A

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circuits that are yet to [be] established."); Brown & Murphy, *supra* note 10, at 1160 ("With respect to complex mental states and cognitive functions, there is virtually no one-to-one mapping of a particular function to a particular brain region."); Stephen J. Morse, *Brain Overclaim Syndrome and Criminal Responsibility: A Diagnostic Note*, 3 OHIO ST. J. CRIM. L. 397, 400 (2006) ("[A]t present, neuroscience is insufficiently advanced to offer precise data that will be genuinely legally relevant.").

24 Kuersten, *supra* note 23.

25 *Id.*

26 *Id.*

27 Morse, *supra* note 23, at 404.

28 *Id.* at 400 ("In specific cases, we will virtually never have direct neuroscientific evidence contemporaneous with the time of the crime. At most, we will have *ex ante* or *ex post* evidence that can produce inferences of varying validity about brain structure and function at the time of the crime."). *But see* Richard E. Redding, *The Brain-Disordered Defendant: Neuroscience and Legal Insanity in the Twenty-First Century*, 56 AM. U. L. REV. 51, 110 (2006) ("To be sure, neuropsychological or neuroimaging evidence cannot establish a defendant's lack of criminal responsibility, which is a legal determination, not a medical one. Taken together, however, behavioral, neuropsychological, and/or neuroimaging evidence can paint a rich portrait of a defendant's frontal lobe dysfunction and its causal role in the criminal behavior in question.").

recent study found that the majority formulation of the insanity defense across American criminal codes is as follows: "An actor is not responsible for criminal conduct if at the time of such conduct as a result of mental disease or defect he did not know his conduct was wrong."[29] At present, brain images have little to contribute to the core factors necessary to determine whether this defense applies.[30] There are no clear physical, structural, or functional markers in the brain that sufficiently show whether a person can tell right from wrong, and neuroimaging cannot peer into the past "at the time of such conduct." Traditional evidence of an accused's behavior is far more objectively valuable to factfinders in resolving this issue.

But the actual evidentiary value of something does not always determine the value that individuals ascribe to it.

## II. THE "CHRISTMAS TREE EFFECT"

Research on the impact of neuroimaging on people's assessments of information provides insight into why the prosecution in the *Weinstein* case got skittish.

To begin with, individuals have certain predispositions in evaluating information. That is, they broadly find visual depictions, hard science data, and simple explanations incredibly persuasive.[31] And neuroimaging combines all of these.[32] These techniques produce eye-catching displays of information.[33] Their scientific grounding, coupled with the average person's stark lack of understanding of neuroimaging methods,[34] can also lead to

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29 Paul H. Robinson et al., *The American Criminal Code: General Defenses*, 7 J. LEGAL ANALYSIS 37, 77 (2015).

30 *But see* Redding, *supra* note 28, at 110.

31 D.A. Baker et al., *Making Sense of Research on the Neuroimage Bias*, 2015 PUB. UNDERSTANDING SCI. 1, 3–4.

32 *See* Brown & Murphy, *supra* note 10, at 1188–1202 (expounding on the possible unfairly prejudicial effects of introducing brain image evidence at trial).

33 *See* John VanMeter, *Neuroimaging*, *in* SCIENTIFIC AND PHILOSOPHICAL PERSPECTIVES IN NEUROETHICS 230, 241 (James J. Giodano & Bert Gordijn eds., 2010) ("The beautiful and eye-catching pictures that can be generated from [neuroimaging] experiments are powerfully persuasive and handily help to convince readers of the results being presented in papers. This tendency is greatly amplified when data are presented in various media where images and movies of the brain can grab the attention of consumers, which is naturally to the advantage of the journalist and media outlet. This, combined with the limited science background of most journalists and in some instances with overselling by researchers, can lead to serious misperceptions of the certainty and generalizability of the results.").

34 *Id. See generally* Suzana Herculano-Houzel, *Do You Know Your Brain? A Survey on Public Neuroscience Literacy at the Closing of the Decade of the Brain*, 8 THE

overly reductionist thinking by factfinders in what has been termed "neuro-essentialism": brain images being thought of as fully capturing and explaining a person and his mental characteristics.[35] Finally, the increasingly widespread, and often simplistic, representation of neuroimaging in the media and popular discourse[36] may cause what is known as the "tech effect," by which media extolments of a new technology and its ubiquitous presence in public discussion result in its societal permeation and expansive acceptance as material to and highly influential in criminal proceedings.[37]

All of the aforementioned factors have led to the popular belief that brain images can have a "Christmas tree effect," whereby, impressed "by the visual display of a colorful brain scan,"[38] which is somewhat analogous to the vibrant lights that typically adorn Christmas trees,[39] "laypersons tend to give undue credence to assertions purportedly supported by neuroimaging

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NEUROSCIENTIST 98, 98 (2002).

35 Eric Racine et al., *fMRI in the Public Eye*, 6 NATURE REVS. NEUROSCI. 159, 160–61 (2005).

36 *See* Martha J. Farah, *A Picture Is Worth a Thousand Dollars*, 21 J. COGNITIVE NEUROSCI. 623, 623 (2008) ("Brain images are the scientific icons of our age."); Jay Van Bavel & Dominic Packer, *The Seductive Allure of Neuroscience and the Science of Persuasion*, SCI. AM. (Sept. 16, 2013), http://blogs.scientificamerican.com/mind-guest-blog/the-seductive-allure-of-neuroscience-and-the-science-of-persuasion/ ("On the heels of the decade of the brain and the development of neuroimaging, it is nearly impossible to open a science magazine or walk through a bookstore without encountering images of the human brain.").

37 Hon. Donald E. Shelton et al., *A Study of Juror Expectations and Demands Concerning Scientific Evidence: Does the "*CSI *Effect" Exist?*, 9 VAND. J. ENT. & TECH. L. 331, 368 (2006); *see also* Hon. Donald E. Shelton, *Juror Expectations for Scientific Evidence in Criminal Cases: Perceptions and Reality About the "*CSI *Effect" Myth*, 27 T.M. COOLEY L. REV. 1, 34 (2010) ("[J]uror expectations and demands for scientific evidence are the result of broader changes in our popular culture, fostered by the mass media and by litigants' beliefs that the effect exists.").

38 Susan E. Rushing, *The Admissibility of Brain Scans in Criminal Trials: The Case of Positron Emission Tomography*, 50 CT. REV. 62, 66 (2014).

39 *See* KAY REDFIELD JAMISON, AN UNQUIET MIND: A MEMOIR OF MOODS AND MADNESS 196 (1995) ("With PET, for example, a depressed brain will show up in cold, brain-inactive deep blues, dark purples, and hunter greens; the same brain when hypomanic, however, is lit up like a Christmas tree, with vivid patches of bright reds and yellows and oranges."); *see also* Owen D. Jones et al., *Brain Imaging for Judges: An Introduction to Law and Neuroscience*, 50 CT. REV. 44, 49 (2014) ("fMRI does not detect colors in the brain. fMRI images use colors—of whatever segment of the rainbow the researcher prefers—to signify the *result of a statistical test*. By convention, the brighter the color (say, yellow compared to orange) the greater the statistical significance of the differences in brain activity between two conditions.").

evidence."[40] And it is upon this foundation of speculative effects that empirical research into the influence of brain images is built.

In 2008, David P. McCabe and Alan D. Castel published a seminal study looking at the actual influence of brain images on individuals.[41] Across the first two of their three experiments, they compared how university students rated the scientific reasoning of fake articles, presented and rated sequentially, summarizing fictitious neuroscience research when the text was complemented by brain images, topographical maps of brain activation, bar graphs, or no visual portrayal.[42] These accompanying images, maps, and graphs were purely superficial; they simply displayed the written findings without adding any substantive information.[43] Still, students rated the scientific reasoning of the articles with brain images higher than those with other visual representations or no pictures at all.[44]

In their third experiment, McCabe and Castel also tested whether the presence of neuroimaging increased students' level of agreement with an actual BBC article summarizing real neuroscience research.[45] In relevant part, half of the participants rated their level of agreement with an article containing a brain image and the other half rated one without such an image.[46] Aligning with the previous results, students agreed more with the conclusion reached when the article included a brain image than when it did not.[47] This was despite the image once again simply providing redundant information to that presented in the text.[48] McCabe and Castel ultimately concluded that their "results lend support to the oft mentioned notion that

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40 Kristen M. Nugent, *Practical Legal Concerns*, *in* NEUROIMAGING IN FORENSIC PSYCHIATRY: FROM THE CLINIC TO THE COURTROOM 255, 259 (Joseph R. Simpson ed., 2012); *see also* Dean Mobbs et al., *Law, Responsibility, and the Brain*, 5 PLOS BIOLOGY 693, 699 (2007) ("[B]rain images are not only powerful, they can potentially be too powerful—an effect we have referred to as the 'Christmas tree phenomenon.' For example, in much the same way that a prosecutor may sway jurors with sympathetic pictures of the innocent victim, the defence may show brightly coloured images of the perpetrator's allegedly dysfunctional brain. The vividness and technological sophistication of the images may be over-weighted by the jurors, which can warp justice just as surely as can under-weighting of relevant evidence.").

41 David P. McCabe & Alan D. Castel, *Seeing Is Believing: The Effect of Brain Images on Judgments of Scientific Reasoning*, 107 COGNITION 343, 343 (2008).

42 *Id.* at 345–47.

43 *Id.* at 347.

44 *Id.* at 346–47.

45 *Id.* at 348–49.

46 *Id.* at 349.

47 *Id.*

48 *Id.* at 350.

there is something particularly persuasive about brain images with respect to conferring credibility to cognitive neuroscience data."[49]

Following this study, subsequent works offered further support for the "neuroimage bias."[50] Research showed increased findings of guilt by mock jurors when fMRI images suggested a suspect was lying versus when polygraph or thermal imaging tests suggested the same thing or when no lie detection evidence was presented.[51]

Another study found that participants reading neuroscience text accompanied by brain images judged their comprehension of the information to be higher than those reading the same text on its own or accompanied by bar graphs.[52] This was despite successive testing showing that actual participant comprehension was the same in all three cases.[53] Moreover, in comparing results between when the same text was accompanied by brain images or bar graphs, the study further found that participants judged the text containing brain images to be more credible.[54]

The research outlined above purports to show that the presence of neuroimaging skews individuals' assessments of information by making presentations accompanied by brain images appear more understandable and trustworthy. Their findings implicate how factfinders might evaluate neuroimaging evidence, and they alarmed medical and legal professionals to the extent that a multidisciplinary consensus conference was organized, which produced recommendations for mitigating the neuroimage bias at trial.[55]

Assuredly, if one were to rely on just the studies presented thus far, it would appear that the prosecution in the *Weinstein* case made a prudent decision in settling for a plea deal. But things are rarely so simple.

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49 *Id.* at 349.

50 Baker et al., *supra* note 31, at 3–4.

51 David P. McCabe et al., *The Influence of fMRI Lie Detection Evidence on Juror Decision-Making*, 29 BEHAV. SCI. & L. 566, 566 (2011).

52 Kenji Ikeda et al., *Neuroscientific Information Bias in Metacomprehension: The Effect of Brain Images on Metacomprehension Judgment of Neuroscience Research*, 20 PSYCHON. BULL. & REV. 1357, 1362 (2013).

53 *Id.*

54 *Id.*

55 C.C. Meltzer et al., *Guidelines for the Ethical Use of Neuroimages in Medical Testimony: Report of a Multidisciplinary Consensus Conference*, 35 AM. J. NEURORADIOLOGY 632, 633 (2014).

## III. COUNTERING THE "CHRISTMAS TREE EFFECT"

In addition to studies supporting McCabe and Castel's findings,[56] the last several years have seen a number contradicting them. In fact, the latter outnumber the former. Studies modeled on McCabe and Castel's third experiment and analyzing participants' level of agreement with articles with or without brain images have failed to duplicate their results, including through both similarly constructed trials[57] and attempts at systematic recreation of the original experiment.[58] This mounting lack of scientific support has muddied the waters of the popularly touted neuroimage bias.

Further chipping away at belief in the seductive powers of brain images are findings that people are actually unduly swayed by the presence of neuroscience explanations *generally* rather than neuroimaging *specifically*. In a study exemplifying these findings, researchers sought to control for the specific influence of neuroimaging by presenting subjects with explanations of fabricated research results that contained either no neuroscience information, irrelevant neuroscience information in text form, or irrelevant neuroscience information accompanied by an irrelevant brain image.[59] Explanations with irrelevant neuroscience information in text form were rated higher than those without.[60] But, more importantly for the purposes of this Essay, the presence of a brain image was found to have no effect on the perceived quality of an explanation beyond that caused by textual neuroscience information.[61]

With regard to the impact of neuroimages in a court setting, there are several relevant studies. One such undertaking presented participants with a

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56 *E.g.*, Ikeda et al., *supra* note 52; McCabe et al., *supra* note 51.

57 *See* Cayce J. Hook & Martha J. Farah, *Look Again: Effects of Brain Images and Mind-Brain Dualism on Lay Evaluations of Research*, 25 J. COGNITIVE NEUROSCI. 1397, 1398 (2013).

58 *See* Robert B. Michael et al., *On the (Non)Persuasive Power of a Brain Image*, 20 PSYCHON. BULL. & REV. 720, 721 (2013); *see also id.* at 723 ("We know that images can exert powerful effects on cognition—in part, because they facilitate connections to prior knowledge. For instance, when pictures clarify complex ideas (such as the workings of a bicycle pump) and bridge the gap between what nonexperts know and do not know, people comprehend and remember that material better . . . . But a brain image depicting activity in the frontal lobes is different. To people who may not understand how fMRI works, or even where the frontal lobes are, seeing an image of the brain may not be any more helpful than seeing an ink blot.").

59 Diego Fernandez-Duque et al., *Superfluous Neuroscience Information Makes Explanations of Psychological Phenomena More Appealing*, 27 J. COGNITIVE NEUROSCI. 926, 926 (2015).

60 *Id.* at 930.

61 *Id.*

mock criminal trial complete with evidence and legal instructions.[62] The evidence contained expert testimony that supported the accused suffering from a mental disorder that prevented him from possessing the requisite mental state for the crime.[63] But, across presentations, this testimony varied in terms of being accompanied by a brain image, graphs, or a neutral image (such as a courtroom).[64] Subjects were asked to evaluate the evidence and arrive at a verdict.[65] Neuroimages were found to have no more influence on mock-juror judgments than other presentations of neuroscience information.[66]

Another study similarly exposed participants to a mock criminal trial.[67] Subjects were alternatively presented with testimonial expert evidence containing psychological, neuropsychological, neuroscience, or neuroimage-accompanied neuroscience information supporting the defendant's claim of being not guilty by reason of insanity.[68] Neuroscience evidence was found to be the most persuasive, but brain images did not produce their own independent effect.[69] This was so despite mock-jurors who were not presented with neuroimages saying that such evidence would have been the most helpful kind in evaluating the accused.[70]

The studies above appear to seriously degrade the theory that the presence of neuroimaging has a unique persuasive effect on finders of fact.

## IV. LEAVING SPACE FOR INFLUENCE

The body of literature critical of the neuroimage bias does, however, possess an important deficiency: no study has exactly replicated McCabe and Castel's first two experiments in which subjects *sequentially* viewed and rated fake scientific articles accompanied by brain images, topographical maps of brain activation, bar graphs, or no visual portrayal. That is, rather than gathering and comparing ratings from people who saw only one form of information presentation, subjects in these experiments saw more than one

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62 N.J. Schweitzer et al., *Neuroimages as Evidence in a Mens Rea Defense: No Impact*, 17 PSYCHOL. PUB. POL'Y & L. 357, 367–68 (2011).

63 *Id.* at 367.

64 *Id.* at 368.

65 *Id.*

66 *Id.* at 372.

67 N.J. Schweitzer & Michael J. Saks, *Neuroimage Evidence and the Insanity Defense*, 29 BEHAV. SCI. & L. 592, 592 (2011).

68 *Id.* at 595.

69 *Id.* at 600.

70 *Id.* at 603.

form at a time, one after the other, and were therefore able to directly compare them.[71] So far, all published studies critiquing the findings of McCabe and Castel have only required participants to rate different presentations *in isolation* of one another. This leaves a key situation in which the neuroimage bias may still hold sway: direct comparison between presentations containing brain images and those that do not.

Another study supports this suggestion in that, similar to the first experiments conducted by McCabe and Castel, it required subjects to rate different presentations introduced in a sequence.[72] Participants in the study were presented with two summaries of scientific research in succession that contained no neuroscience language and either no image or a brain image.[73] The order in which the summaries were presented and which one was accompanied by the neuroimage were randomized.[74] After each presentation, subjects rated the extent to which they believed or were persuaded by the passage.[75] The resulting data showed that ratings of the second summary were substantially impacted by the brain image.[76] Specifically, participants were more persuaded by the second summary if it contained the image and the first did not and less persuaded by the second summary if it did not contain the image and the first did.[77] The picture therefore lent or subtracted credibility depending on whether the second passage was the one containing it.[78]

To be sure, this study would be of much more value if the text presented had contained neuroscience explanations since, as noted above, a number of studies have argued that neuroimages have no effect separate from that of neuroscience information generally.[79] Broadly, however, it should inspire further research into the effect of brain images on the sequential assessment of neuroscience information.

If this "sequential neuroimage bias" exists, can it materially impact a criminal trial? Given that trials generally consist of extensive presentations

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71 *See supra* notes 40–42 and accompanying text.

72 *See* N.J. Schweitzer et al., *Fooled by the Brain: Re-Examining the Influence of Neuroimages*, 129 COGNITION 501, 507 (2013).

73 *Id.*

74 *Id.*

75 *Id.*

76 *Id.*

77 *Id.*

78 *See* Jillian M. Ware et al., *Neuroimagery and the Jury*, THE JURY EXPERT (Aug. 20, 2014), http://www.thejuryexpert.com/2014/08/neuroimagery-and-the-jury/ ("The findings suggested that the persuasive effects of neuroimages may be present only when decision makers have something to which they can compare a neuroimage.").

79 *See, e.g.*, *supra* note 66–65 and accompanying text.

of evidence by both sides beyond solely expert testimony accompanied by neuroimages, it is hard to predict the degree to which the sequence of any brain image display might affect the ultimate outcome of a case. Its potential impact on how a judge or jurors assess contradicting neuroscience presentations specifically, however, may be more discernible.

Imagine, for example, that the prosecution presents expert testimony containing neuroscience information *unaccompanied* by neuroimages supporting the culpability of an accused or the position that a criminal defense, like insanity, does not apply to him. The defense subsequently presents its own expert testimony containing neuroscience information *accompanied* by a brain image supporting the argument that the accused lacked the requisite mental state for the crime or qualified for a criminal defense. The sequential neuroimage bias would suggest that the prosecution's presentation would be discounted by a judge or jurors relative to that of the defense. This indicates a possible practical impact on criminal legal proceedings of material importance.[80]

As yet, however, the sequential neuroimage bias has not been adequately shown through studies. But further investigations of such a phenomenon could prove valuable in parsing out the potential for brain images to inappropriately impact the determinations of factfinders.

## CONCLUSION

Given the general lack of evidentiary value that neuroimaging procedures currently provide in determining a defendant's mental abilities and state at the time of an alleged crime,[81] and the increased use of such

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[80] *Cf.* Lucille A. Jewel, *Through a Glass Darkly: Using Brain Science and Visual Rhetoric to Gain a Professional Perspective on Visual Advocacy*, 19 S. CAL. INTERDISC. L.J. 237, 238 (2010) ("When one side incorporates a compelling visual theme into its case but the other side does not have a counter visual strategy, one-sided results occur. On the other hand, where both sides weave a visually-based narrative into their argument, a more level playing field emerges." (footnote omitted)). Certainly, neuroimaging evidence would almost never be presented to finders of fact in a vacuum. Rather, it would be presented as part of a given expert's testimony to serve as a visual aid to that individual's statements, and the expert would be subject to cross-examination. This means that the explanation that the brain images are used to support would undergo criticism from counsel, as well as potentially from the opposing party's own expert(s). Relevantly, in their 2008 study, McCabe and Castel found that individuals agreed less with an article presenting a neuroscience explanation when it was accompanied by text of a researcher criticizing the conclusion reached than when unaccompanied by such a critique. McCabe & Castel, *supra* note 41, at 348–49. However, subsequent reproductions of this experiment have failed to yield similar results. *See, e.g.*, Michael et al., *supra* note 58, at 720; Schweitzer et al., *supra* note 62, at 506.

[81] *See supra* notes 11–29 and accompanying text.

evidence to reveal exactly this,[82] examinations of the possible excessive influence of brain images on factfinder assessments in this regard are of significant import to criminal law and procedure. We will never know exactly how the presentation of "that big, black hole" in Weinstein's brain might have swayed jurors in a murder trial,[83] but researchers are homing in on the possible general effects on factfinders of presenting neuroimaging evidence in support of mens rea and defense assessments. Popular beliefs as to their impact have been discounted and fruitful avenues for further study opened up. Although the literature does not support brain image evidence as having a meaningful absolute effect on factfinder determinations, such evidence may have a sequential effect. That is, factfinders may give undue weight to neuroimaging presentations when they have alternative presentations lacking such images to which they can compare . Hopefully, with time this potentiality will be further explored and the true nature and extent of neuroimage bias made more vivid.

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82 *See supra* note 10.

83 Davis, *supra* note 8.