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Brain, Gender, Law: A Cautionary Tale

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I. INTRODUCTION

In 2003, the Gruter Institute sponsored a conference called Incorporating Biology and Neuroscience into the Law School Curriculum. Just last October, the MacArthur Foundation announced a $10 million grant to found the Law and Neuroscience Project, the "first systematic effort to bring together the worlds of law and science on questions of how courts should deal with recent breakthroughs in neuroscience as they relate to matters of assessing guilt, innocence, punishment, bias, truth-telling, and other issues."[1]

Despite the fact that it is, at best, "of mixed reliability," neuroscientific evidence is routinely introduced to argue mitigation during the sentencing phase of death penalty cases and, with increasing frequency, in criminal defense.[2] Neuroimaging techniques—fMRI, PET, EEG and SPECT[3]—are also used to argue diagnosis and causal relation in personal injury cases from toxic torts to medical malpractice, and to establish or disestablish mental competency. Combinations of techniques are expected soon to play an increased role throughout law—from lie detection and ferreting out hidden bias, to establishing medical causation, guilt, innocence, competence, capacity, and more.[4]

This is a valuable project, worthy of pursuit. Yet, although partnerships between law and science can be useful, and exposing judges and other legal practitioners to the true facts about neuroscience may be the best answer to the concerns I am about to express, I want to offer a cautionary note about the current romance with neuroscience. I worry that the importance of advances in neuroscience, at least as they relate to behaviors relevant to law, is greatly overstated. Most of the problems of law are not scientific ones, even in the area where neuroscience is most deployed today—to measure brain function in order to determine competence or culpability. The dividing line between competence and incompetence, or culpability and lack of it, is one of human judgment, not scientific determination. Advances in our understanding of the human brain do raise moral and ethical dilemmas—and concomitant legal ones—worthy of study. But the biggest dilemma may be how to keep advocates from promoting shoddy science and judges and juries from jumping to the conclusions that overheated media draw from the typically limited and

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1. *Fact Sheet: About the Law & Neuroscience Project*, Res. Networks Newsletter (MacArthur Found., Chi., Ill.), Oct. 9, 2007, *available at* http://www.macfound.org (follow "Newsroom" hyperlink; then follow "publications" hyperlink; then check box for "Research Networks & Special Projects"). The grant will be divided among twenty-five universities and three fifteen-member research groups. The project aspires to produce a primer for judges on neuroscience and law as well as create a textbook and syllabi for law school courses. *Id.* Funds will also be used to educate "judges, lawyers, legislators, reporters, and opinion leaders" on basic neurolaw issues during weekend retreats. *Id.*

2. Jeffrey Rosen, *The Brain on the Stand*, N.Y. Times, Mar. 11, 2007, § 6 (Magazine), at 49 (discussing The President's Council on Bioethics, An Overview of the Impact of Neuroscience Evidence in Criminal Law, (Sept. 2004) (staff working paper), *available at* http://www.bioethics.gov/background/neuroscience_evidence.html)).

3. fMRI (functional Magnetic Resonance Imaging), PET (positron emission tomography), EEG (electroencephalography), and SPECT (single photon emission computed tomography) are methods of visualizing brain function by mapping blood flow, electrical impulses, and other brain functions.

4. *See* Rosen, *supra* note 2, at 49.

qualified hypotheses of neuropsychologists. These hypotheses are particularly overheated when it comes to the issue of gender difference.[5]

II. LAW AND BRAIN SCIENCE: A BRIEF HISTORY

The U.S. legal system has a long history of romance with brain science—often junk science.[6] The nineteenth century phrenologists maintained that human personality could be determined by mapping bumps on the skull, and that various brain surfaces were responsible for different characteristics of personality.[7] The law used phrenology, among other things, to help determine the potential for violence and recidivism among criminals.[8] Phrenology came into American courts in the 1840s and remained there for seventy years, eventually being discarded, along with voodoo and astrology, as nonsense.[9] In the intervening period, many prominent figures accepted phrenology and had their heads examined, including Ralph Waldo Emerson, Oliver Wendell Holmes,[10] and three presidents: Tyler, Garfield, and Grant.[11]

I am particularly concerned, as a longtime feminist and advocate for women's rights, about the deployment of science to ratify and entrench false or skewed assumptions about male/female difference. For the craniologists, contemporaries of the phrenologists, the larger size of men's skulls and brains demonstrated their greater rationality and intelligence. Craniologists denied that women should be educated equally with men or allowed to pursue similar goals. A founder of social psychology and student of craniology, Gustave Le Bon, summarized their perspective:

> In the most intelligent races, as among the Parisians, there are a large number of women whose brains are closer in size to those of gorillas than to the most developed male brains. This inferiority is so obvious that no one can contest it for a moment; only its degree is worth discussion. All psychologists who have studied the intelligence of women . . . recognize today that they represent

5. For those who use the term "sex" to refer to genetically ordained (or biological) traits and "gender" to reference environmentally (culturally and socially conditioned) traits, one clear message of the new neurology is that the line between them is a spurious one. *See, e.g.*, Melissa Hines, Brain Gender 5–6 (2004); Eric R. Kandel, In Search of Memory: The Emergence of a New Science of Mind (2006). Brain development—literally the creation of neural pathways which awaken and develop some traits but not others—is influenced every millisecond by environmental conditions. The brain, of course, is part of and influences biological development. I therefore use the two terms interchangeably.

6. For a more detailed explanation of how some behavior science is junk science, see generally Paul Ehrlich & Marcus W. Feldman, *Genes, Environments and Behaviors*, 136 Daedalus 5 (2007); Stephen J. Gould, *Carrie Buck's Daughter: A Popular, Quasi-scientific Idea Can Be a Powerful Tool for Injustice*, Nat. Hist. Mag., July–Aug. 2002, at 14.

7. Stacey A. Tovino, *Imaging Body Structure & Mapping Brain Function: A Historical Approach,* 33 Am. J.L. & Med. 193, 196 (2007).

8. *See id.* at 201–02.

9. *See id.* at 202–04.

10. *See id.* at 200.

11. Jane M. Orient, Sapira's Art & Science of Bedside Diagnosis 173 (3d ed. 2005) (1990).

> the most inferior forms of human evolution and that they are closer to children and savages than to an adult, civilized man. They excel in fickleness, inconstancy, absence of thought and logic, and incapacity to reason.[12]

Today we know that, although women's brains are smaller, they contain roughly as many neurons as men's—some 10 billion of them—just more densely packed.[13] Hence, size is not all that matters.

The eugenics movement, enamored with misguided notions that persist today about the heritability of personality and brain-power, led to the sterilization of thousands of women, including that of Carrie Buck. In *Buck v. Bell*, Justice Holmes endorsed her sterilization, famously writing that "three generations of imbeciles are enough."[14] As Stephen Jay Gould has shown, Holmes was factually incorrect in believing that either Carrie or her mother were "imbeciles."[15] But he was even more mistaken in believing that the varied traits that were believed to indicate mental disease, or other behaviors thought to be problematic and deserving of elimination from human gene populations, were controlled and passed down by a single heritable gene or combination of genes. Multiple combinations of genes, together with virtually limitless variation in neural pathways, mean that with extremely rare exceptions, behaviors are not inherited.[16] As one columnist noted, "if a trait like aggressiveness is influenced by just 100 genes, and each of those genes can be turned on or off, then there are a trillion trillion possible combinations of these gene states."[17]

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12. Stephen J. Gould, The Mismeasure of Man 104–05 (W.W. Norton & Co. 1981).

13. Hines, *supra* note 5, at 187.

> [A]lthough the male brain is larger than the female brain, more subtle aspects of brain architecture could modify the functional importance of this difference. For instance, in at least some regions of the human brain, neurons are packed more densely in females than in males . . . . [T]he difference in packing density is similar in magnitude to the difference in brain size. Thus, although the male brain may be larger than the female brain, the number of neurons, the brain's primary functional units, may be similar in the two sexes. In addition . . . the female brain has a higher percentage of gray matter, greater cortical volume, and increased glucose metabolism, thought to reflect increased functional activity.

Id.

14. 274 U.S. 200, 207 (1927).

15. *See* Gould, *supra* note 6, at 14.

16. *See* Richard J. Haier, *Brains, Bias, and Biology: Follow the Data*, *in* Why Aren't More Women in Science? Top Researchers Debate the Evidence 113, 116 (Stephen J. Ceci & Wendy M. Williams eds., 2007) (noting that if one identical twin is schizophrenic, the other has only a fifty percent chance of sharing the condition, so something other than genetics is at work); Nicholas Wade, *Brainpower May Lie in Complexity of Synapses*, N.Y. Times, June 10, 2008, at F6; Carl Zimmer, *Expressing Our Individuality, the Way E. Coli Do*, N.Y. Times, Apr. 22, 2008, at F1 (deriding genetic determinism by pointing out that genetically identical *E. coli* bacteria exhibit widely varying behavioral traits due to environmental conditions and the "noise" of their own proteins, despite possessing only one fifth the number of genes as humans and far simpler systems).

17. David Brooks, *The Luxurious Growth*, N.Y. Times, July 15, 2008, at A19 (citing Jim J. Manzi, *Undetermined*, Nat'l Rev., June 2, 2008, at 26).

Scientific pronouncements of gender difference were the foundation of the famous decision in *Muller v. Oregon*, upholding state legislation limiting the number of hours women could work. The Court grounded its decision on two propositions. First, the Court stated that a woman's "physical structure and a proper discharge of her maternal functions" required special protection in the public interest (for, as the Court put it, "the well-being of the race").[18] Second, the Court said a woman would not, when contracting for employment, be able adequately to bargain for herself since "there is that in her disposition and habits of life which will operate against a full assertion of those rights."[19] The Court's views were heavily influenced by attorney and later Supreme Court Justice Louis Brandeis's brief (put together in large measure by two female labor activists), which compiled medical opinions from legislative hearings throughout the world. The brief documented the deleterious effects of industrialization and their even more negative impact on women, who were "weaker than men in all that makes for endurance: in muscular strength, in nervous energy, in the powers of persistent attention, and application."[20]

Even when not opining directly on gender difference, scientific claims about brain function have been used in ways that are harmful to women. For example, the notion that physical symptoms of brain function could separate liars from truth-tellers has lead police departments throughout the United States to ignore the claims of the largely female victims of rape and domestic violence whenever polygraph examiners (the vast majority of them male) choose to interpret measures of blood pressure, respiration rate, and electrodermal skin response (or sweat) as signs of lying.[21] Based in part on the 1983 conclusion of Leonard Saxe, who was commissioned by the Congressional Office of Technology Assessment to digest existing studies of the polygraph, Congress passed legislation forbidding use of the polygraph to screen applicants for employment or as the sole basis of employee discipline.[22] Saxe concluded that there is no "Pinocchio effect"—it is not plausible that a machine that measures physiological responses to questions could detect lies.[23] Despite this legislation, our government, which is exempt from legislative prohibitions on its use, has continued to rely (mistakenly, as it appears in more than one recent case) on the

18. Muller v. Oregon, 208 U.S. 412, 422 (1908).

19. *Id.*

20. Brief for the State of Oregon at 18, Muller v. Oregon, 208 U.S. 412 (1908) (No. 107).

21. *See* Raymond Hernandez, *Lie-Detector Tests Are Banned on Victims Alleging Rape*, N.Y. Times, Mar. 6, 1996, at B5. New York State banned the practice of giving polygraph tests to rape victims after recognizing that "the emotional responses manifested by victims of sexual assault as they relive harrowing attacks during polygraph tests commonly result in false conclusions that they are lying." *Id.* (citation omitted).

22. *See* Employee Polygraph Protection Act of 1988 (EPPA), 29 U.S.C. § 2002 (2006).

23. *See* Office of Technology Assessment, U.S. Congress, Scientific Validity of Polygraph Testing: A Research Review and Evaluation II (1983).

polygraph to keep us safe from spies and terrorists.[24] Since those who interpret polygraph charts are overwhelmingly male, and many, if not most, are current or former law enforcement personnel, the gender stereotypes prevalent in that profession are all too likely to guide their interpretive leaps.

But, ever vigilant, our Homeland Security Department is funding research on newer and better methods of lie detection, emphasizing particularly the new neuroscience.[25] The hope is that brain-mapping techniques, such as fMRI, will reveal identifiable patterns of brain activity when subjects are lying.[26] But the new methods are no more likely to be effective than the old. Like the old, they import human gender biases because they require interpretation. It may be that our anterior cingulate cortex and superior frontal gyrus light up when we tell a simple lie under experimental conditions, and it may be that the regions lighting up at particular questions differ as between males and females in some experiments. But nothing can tell us why or whether those same regions might light up for reasons totally independent of lying when confronted with myriad stimuli outside the laboratory, much less whether male/female difference in brain processing has any behavioral impact.[27] Indeed, critics of the research point out that there are numerous different types of what we call lies,[28] and that it is highly likely that each lie utilizes different brain regions and varies by individual.

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24. *See* Dan Eggen & Shankar Vedantam, *Polygraph Results Often in Question*, WASH. POST, May 1, 2006, at A01 (discussing how Soviet spies Aldrich Ames and Robert Hanssen evaded detection and citing findings by a federal panel of distinguished scientists that in a group of 10,000 government employees (with 10 spies), 1600 innocent workers would fail polygraph examinations and 2 spies would pass).

25. *See* Robin Marantz Henig, *Looking for the Lie,* N.Y. TIMES, Feb. 5, 2006, § 6 (Magazine), at 47 (describing federal research incentives aimed at finding a "foolproof technology for deception detection: a brain signature of lying"). Henig points out the challenge if they purport to do so will be to "resist pressure to introduce new technologies before they are adequately tested and to fight the overzealous use of these technologies in places where they do not belong." *Id.* While law, with its evidentiary tests and reliance on reasoning would seem well positioned to do this, it has shown itself far from immune to the vagaries of public opinion and adversarial pressure.

26. *See id.*

27. *See id.*; Alexis Madrigal, *MRI Lie Detection to Get First Day in Court*, WIRED SCIENCE, Mar. 16, 2009, http://blog.wired.com/wiredscience/2009/03/noliemri.html ("We don't know enough about [fMRI lie detection technology's] accuracy in realistic situations." (quoting Hank Greely, head of the Center of Law and the Biosciences at Stanford)).

28. *See id.* (discussing the criticism of Harvard psychologist, Steven Kosslyn). The frontal lobe (working memory) might be more active than usual during a spontaneously created lie, just as the right anterior frontal cortex (episodic retrieval memory) might be more active during rehearsed lies. *Id.* Both the prefrontal cortex (the reasoning part of the brain) and the anterior cingulate cortex (which helps us choose between conflicting options) are more active during some lies. *Id.* The roles played by the parietal cortex (associated with arousal) and the amygdala (associated with stress and emotion generally) are also ambiguous; their excitement may undermine the claim that newer devices test lies rather than the anxiety stemming from lying or from the test itself. *Id.*

Still, waste of government money is nothing new—so what's the big deal? For feminists, nothing less than a new wave of "separate spheres,"[29] or, in today's incarnation, "separate brains."

III. SCIENCE AND GENDER DIFFERENCE: SEEK, AND YE SHALL FIND IT

A great deal of the new neurology and related studies of brain development focus, quite logically, on gender difference because male and female brains differ in size and density, develop somewhat differently, and respond to certain types of hormonal stimulation in different ways.[30] Furthermore, brain-mapping experiments have revealed subtle gender differences in the regions of the brain that respond to certain questions or stimuli.[31] But, these differences are minuscule when compared to average gender difference in, for example, height and muscle size, which are themselves relatively small compared to their range *within* each gender.[32]

Yet, when it comes to gender, the danger of exaggeration, over-claiming, and just plain wrong-headedness is acute; perhaps more so when the research is well-intentioned.[33] Researchers have long noted the tendency of scientists to find the results they are seeking. Because behavioral gender difference is so prevalent in our culture and biological gender difference is so visible, the natural tendency is to connect the two and look for behavioral difference in biology and neurology. Yet, such connections need to be carefully examined and strenuously challenged because they are enormously subject to error. As long ago as 1974, in their foundational book *The Psychology of Sex Differences*, Eleanor Maccoby and Carol Jacklin pointed to four

29. *See* Bradwell v. Illinois, 83 U.S. 130, 141 (1876) (Bradley, J., concurring) (espousing the traditional Victorian view on women's rights).

> [T]he civil law, as well as nature herself, has always recognized a wide difference in the respective spheres and destinies of man and woman. Man is, or should be, woman's protector and defender. The natural and proper timidity and delicacy which belongs to the female sex evidently unfits it for many of the occupations of civil life. The constitution of the family organization, which is founded in the divine ordinance, as well as in the nature of things, indicates the domestic sphere as that which properly belongs to the domain and functions of womanhood.

Id.

30. *See generally* HINES, *supra* note 5.

31. Natalie Angier & Kenneth Chang, *Gray Matter and Sexes: A Gray Area Scientifically*, N.Y. TIMES, Jan. 24, 2005, at A1. The authors relate evidence purporting that female brains have more gray matter ("the prized neurons thought to do the bulk of the brain's thinking"), that male brains have more white matter ("the tissue between neurons"), and that the genders use different proportions of gray and white matter during problem solving. *Id.*

32. *See* HINES, *supra* note 5, at 10.

33. *See, e.g.*, United States v. Virginia, 518 U.S. 515, 537 n.9 (1996) (discussing three popular nineteenth century medical experts' opinions as to why women should not receive the same education as men); *see also* Deborah Tannen, *A Brain of One's Own: Deborah Tannen on Louann Brizendine's Provocative Theories About the Way Women Think*, WASH. POST, Aug. 20, 2006, at BW01 (reviewing LOUANN BRIZENDINE, THE FEMALE BRAIN (2006)) (reporting that a Harvard physician once claimed that women should be barred from higher education because "all the blood rushing to their brains would be drained from the womb . . . impairing their ability to have children").

dangers of sex research—dangers which persist today. Two are especially relevant to today's neuroscience findings. First, they noted that there is significant over-reporting of difference, or positive results—nineteen findings of little or no difference go unreported while there is a screaming headline for the one statistically significant finding of difference.[34] Second, they argued that the influence of stereotypes about sex differences on the perceptions of both researchers and participants tended to distort results.[35]

One sees these problems operating across the spectrum of media. Writers—both popular and scholarly—want to relate social behaviors to gender (men are from Mars, women are from Venus, after all) and to differences in male and female brains. There has been a spate of recent books approaching gender differences from contrasting perspectives.[36] Louann Brizendine's overstated and inaccurate *The Female Brain* asserts that "the female brain is so deeply affected by hormones that their influence can be said to create a woman's reality"[37] and that there are "sex-specific female brain circuits . . . for talking, flirting, and socializing."[38] Melissa Hines's more balanced *Brain Gender* offers a descriptive analysis of the research on male/female developmental difference, and suggests tentative conclusions about whether and how these differences might prove meaningful.[39]

Entire fields—or as noted population scholar Paul Ehrlich would have it, "neo-fields"—like that of evolutionary psychology, have sought to show that behaviors such as male rape and female nurturing likely have their origins in genetically programmed and evolutionarily-driven behaviors. Their views are taken up by those who argue that brain scans will be able not only to predict male violence, but also to explain women's lack of propensity for it.[40] Yet, evolutionary psychology is based, as Paul Ehrlich and Marcus Feldman demonstrate, on "the misconception that genes are somehow determining our everyday behavior and our personalities."[41] Sophisticated neurologists make clear that environment is operating on neural

34. *See* Eleanor Maccoby & Carol Jacklin, The Psychology of Sex Differences: Vol. I/Text 4–5 (1974).

35. *See id.* at 7. Maccoby and Jacklin also cite as dangers of sex research the "situational specificity" of sex differences and the disagreement in experimental results when data are obtained in different ways. *See id.* at 165. The problems outlined by Maccoby and Jacklin still persist. *See* Hines, *supra* note 5, at 5.

36. *See, e.g.*, Deborah Blum, Sex on the Brain: The Biological Differences Between Men & Women (1998); Brizendine, *supra* note 33; John Gray, Men are from Mars, Women are from Venus (HarperCollins 1992); Ann Moir & David Jessel, Brain Sex: The Real Difference Between Men & Women (1989).

37. Brizendine, *supra* note 33, at 3.

38. *Id.* at 36.

39. *See* Hines, *supra* note 5.

40. *See generally* Ehrlich & Feldman, *supra* note 6.

41. *Id.* at 5.

pathways every millisecond and that those pathways are in no way predetermined or uniform within a gender.[42]

IV. LAW, GENDER, AND THE DANGER OF SCIENTIFIC MISREPRESENTATION

Ehrlich and Feldman point to erroneous conclusions drawn by scientists, as well as by science media writers, about heritability of conditions affecting the brain. But, the danger of error when these and newer theories based on neurological data are deployed in the legal arena is far greater than that of mere media hype. Lawyers seize upon scientific hypotheses as if they are facts, and judges are reluctant to exclude neuroscience experts even when the issue is one unrelated to mental capacity (for which brain imaging might provide valid evidence).[43] Juries are generally ill-equipped, even with the help of opposing experts, to weigh the validity of scientific claims,[44] and neuroscience evidence has been shown to be quite persuasive irrespective of its relevance to an argument or an argument's quality.[45] Jury experts, who study the cultural myths to which juries tend to turn when evidence is complex, confirm that one of the richest and deepest sources of myth is that of gender difference.[46]

Moreover, because the nature of legal inquiry differs so sharply from that of science, erroneous findings that have not been subject to sufficient scientific examination are likely to sway decision-making. As Columbia University Law Professor Patricia Williams has noted, the aims of science and law are quite different:

> Scientists hold themselves open to a wide, sometimes endless range of variables that might contribute to cause and effect, right down to the clichéd flapping of butterfly wings in the Amazon causing storms in British

42. *See, e.g.*, KANDEL, *supra* note 5, at 109–10 (noting that each human brain has "about 100 billion neurons each with about 100 thousand synapses . . . or 1 quadrillion synaptic connections"). Each synapse contains about one thousand different proteins, and these, in turn, operate within smaller units of proteins, varied in composition. Each of these synapses has evolved into a highly complex mechanism, and each such mechanism is influenced each millisecond by environmental inputs which affect and alter its functioning.

43. In cases in which mental illness or brain injury is claimed, fMRI can support behavioral evidence by showing that regions of the brain have been injured or are entirely non-functional. One court has even held that the exclusion of imaging evidence from a PET-scan in a capital sentencing case is reversible error. *See* Hoskins v. Florida, 735 So. 2d 1281 (Fla. 1999) (per curiam).

44. Because they see the "battle of the experts" as more likely to confuse than to enlighten fact-finders, the Australians have been experimenting with "hot-tubbing," a system by which experts speak with one another at the direction of the court, and the attorneys remain silent. Adam Liptak, *In U.S., Expert Witnesses Are Partisan*, N.Y. TIMES, Aug. 12, 2008, at A1. While this might well be an improvement on the current U.S. system, there remains the problem of the overall seductiveness of neuroscientific explanation.

45. *See* Deena Skolnick Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, 20 J. OF COGNITIVE NEUROSCIENCE 470, 475–77 (2008) (showing that neuroscience evidence interferes with the ability to judge the quality of explanations for everyone but experts in the field).

46. *See generally* Nancy S. Marder, *Gender Dynamics and Jury Deliberations*, 96 YALE L.J. 593 (1987) (describing numerous ways jurors' individual gender and gender stereotypes may affect the outcome of a trial).

> Columbia. Truth to lawyers, on the other hand, is a "due" process, an obligatory series of steps that re-enact or recapture an event that occurred in another time and place. Its goal is closure, rather than eternal exploration.[47]

In other words, a group of scientists may announce a finding and propose a hypothesis to explain it, but thousands of other scientists throughout the world will question, challenge, and re-evaluate it before accepting it as valid. But law—whose business is to resolve particular and concrete problems—seizes upon those findings, however tentative, to justify a particular and concrete outcome in a particular case or controversy, often distorting the science in the process.

When it comes to gender, lay readers, media, and scientists themselves share a propensity to misread or erroneously extrapolate differences from the data. Take, for example, the swirl of controversy a few years back after Larry Summers, then president of Harvard,[48] suggested that the dearth of women in math and science might be due in part to women's lesser aptitude for math and science.[49] In response, the American Psychological Association published a volume of essays entitled *Why Aren't More Women in Science*, to present the data on gender difference in science, and its interpretation by "top researchers on gender difference in cognition in the United States, Canada, and the United Kingdom."[50] Although contributors were selected because their "scholarship in this area is well known, respected and evidence-based," and despite their reliance on "the same or similar data," the inferences they drew from it lead them to rather different conclusions about the degree and importance of gender difference.[51]

The contributors agree that the evidence to date is clear that males and females have, on average, equally strong math and verbal skills, although at the extreme ends of the ability curve, as measured by a variety of tests, males seem to have a superior, although dwindling, lead in math while women show a small verbal advantage.[52] Males, although they more heavily populate the very bottom of the math ability curve, also are more prevalent at the upper end of the curve, and are at all levels significantly better than women at the mental rotation of objects in space.[53] Many, like Summers, see this data as demonstrating that the dearth of women in tenured

47. Patricia J. Williams, *Divining Demeanor*, The Nation, June 25, 2007, at 10.

48. Lawrence Summers was appointed as the director of the National Economic Council by Barack Obama. Jonathan Weisman, *Geithner, Summers to Take the Lead on New Economic Team*, Wall St. J., Nov. 24, 2008, at A4.

49. *See* Angier & Chang, *supra* note 31 (explaining how Summers anecdotally supported his theory that women might shy away from science because it appears too cold and impersonal by stating that his young daughter treated her toy trucks as dolls, calling them "Daddy truck" and "baby truck"); Sam Dillon, *Harvard Chief Defends His Talk on Women*, N.Y. Times, Jan. 18, 2005, at A16.

50. Stephen J. Ceci & Wendy M. Williams, *Introduction: Striving for Perspective in the Debate on Women in Science*, *in* Why Aren't More Women in Science? Top Researchers Debate the Evidence, *supra* note 16, at 3, 4.

51. *Id.*

52. *See id.* at 11–13.

53. *See id.* at 13.

positions in science, technology, engineering, and math (the so-called "STEM" fields) reflects the outcome of natural selection based on innate ability.[54]

Suppose we are jurors trying to assess, for purposes of a tenure case, whether or not the dearth of women (or grants given to women) in a given math or science department (or the smaller labs or offices) is evidence of discrimination—what should we make of data of this sort? Does it mean that because universities pick top scholars and males score significantly higher at the extremes of math curves (which is essential to sciences like physics and fields like engineering and technology), males are more likely to be qualified and therefore hired, as well as being more likely to succeed? Or might it be that false assumptions about women's commitments to the workforce or capacity for abstract reasoning, together with narrow views about the ingredients of success and the long-documented tendency of those doing the hiring to favor those more like themselves, have operated to exclude women?

Will the arguments of those who, like physicist Howard Georgi, emphasize the impossibility of correlating success to any particular ability or quality (let alone race or gender), be able to trump the "hard data" of graphs, statistics, and pie charts?[55] Will his reminder that "talent can be developed and enhanced by education, encouragement, self-confidence and hard work"[56] seem convincing in the face of colorful neuroscience brain images purporting to establish that while problem-solving, male brains light up in regions believed related to those where reasoning takes place, whereas women's brains show greater activity in regions associated with feeling and emotion?[57]

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54. *See* Dillon, *supra* note 49. In addition, Summers alluded to social and environmental causes of gender differences, such as the greater willingness of males to forgo a role in nurturing and family to "get ahead." *See id*.

55. *See* Howard Georgi, *Talent, Skills in Math and Science Hard to Quantify*, The Harv. Crimson, Jan. 21, 2005, *available at* http://www.thecrimson.com/article.aspx?ref=505377. Georgi reminded Harvard undergraduates:

> 1. Talent is not a unitary thing, [but] multidimensional and difficult to measure . . . .
> 2. Many different kinds of talents are critical to the advancement of . . . any . . . science interesting enough to be worth doing.
> 3. The spread of talents within any group, sex, race, etc., is very large compared to any small average differences that may exist between such groups.
> 4. Talent can be developed and enhanced by education, encouragement, self-confidence and hard work.

Id.

56. *Id*.

57. *See* Margaret Talbot, *Duped: Can Brain Scans Uncover Lies?*, The New Yorker, July 2, 2007, at 52. Talbot, in reviewing the data purporting to claim that fMRI can successfully detect liars, writes that despite the few, small, peer-reviewed studies of fMRIs and lie detection, "the idea has inspired a torrent of media attention, because scientific studies involving brain scans dazzle people." *Id*. Talbot goes on to give several examples of grandiose extrapolations from the extremely limited data, quoting Stanford Law School professor Hank Greely, that "[w]hen we make speculative leaps like these . . . it increases, sometimes in detrimental ways, the belief that the technology works." *Id*. She goes on to note that "[o]ne can easily imagine judges being impressed by these pixellated images, which appear so often in scientific journals and in the newspaper." *Id*. *See generally* Ruben C. Gur & Raquel E. Gur, *Neural Substrates for Sex Differences in Cognition*, *in* Why Aren't More Women in Science? Top Researchers

A good deal of data suggest that math and science ability, at least as measured by standardized testing, is at least as influenced by nurture as nature, and that gender differences in test outcomes within a culture are far smaller than the effects of culture and learning. On international math tests since the 1960s, *girls* from Japan have been outperforming American *boys* by substantial margins, and recently Singaporean *girls* have been outperforming both. An International Report for 2002–2003 suggested a 2 to 5 point higher score for males than for females in both Japan and the United States, but a 62 point advantage for Japanese girls over American boys and a *104 point advantage* for Singaporean girls.[58] In 2006, American students posted math scores lower than the average in twenty-three other countries,[59] and science scores lower than those in sixteen other countries.[60] Yet the tendency to emphasize innate gender difference in ability and aptitude as explaining differences in women's absence from certain fields (and even greater absence from top positions in most fields) remains overwhelming.

V. THE SEDUCTIVENESS OF NEUROSCIENCE

Studies have confirmed that neuroscience explanations are particularly persuasive to those outside the field, and hence likely to be subject to misuse.[61] It will be extremely difficult for judges and jurors to resist the temptation to use those that purport to demonstrate gender difference in brain function from confirming preexisting stereotypes about men and women. If reputable scientists and psychologists draw unwarranted conclusions about male and female ability and aptitude, how much more likely is it that others will take their opinions (which reflect, even if they do not accurately explain, everyday observation) as gospel, especially when buttressed by colorful charts revealing brain activity that seems to differ by gender?[62] Indeed, despite neuroscience's relative infancy and inability to explain human behavior, legal practitioners seem eager to embrace and run with it.[63]

Debate the Evidence, *supra* note 16, at 189, 194–95 (discussing how blood flows in the brain differ during various tasks between the sexes).

58. Ina V.S. Mullis et al., TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings from a Developmental Project 12 (2005).

59. Stephane Baldi et al., Highlights From PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context II (2007).

60. *Id.* at 5.

61. Weisberg et al., *supra* note 45, at 475–77 (showing that neuroscience evidence interferes with the ability to judge the quality of explanations for everyone but experts in the field).

62. *See* Leonid Rozenblit & Frank Keil, *The Misunderstood Limits of Folk Science: An Illusion of Explanatory Depth*, 26 Cognitive Science 521, 522 (2002) (stating that "knowledge of complex causal relations is particularly susceptible to illusions of understanding").

63. *See, e.g.*, Stephen Morse, *Brain Overclaim Syndrome and Criminal Responsibility: A Diagnostic Note*, 3 Ohio St. J. Crim. L. 397 (2006) (reviewing state of neuroimaging technology and pointing out its weaknesses); *see also* Benedict Carey, *Searching for the Person in the Brain*, N.Y. Times, Feb. 5, 2006, § 4, at 1 (quoting Dr. J. Anthony Movshon, director of the Center for Neural Science at New York University, about how neuroimaging technology has been disappointing inasmuch as it "has told us nothing more

Moreover, when judgments are made within a culture that believes deeply that everyday differences in the behavior of men and women reflect a deep gender divide (Mars versus Venus) and are reinforced by the hyperbole of science writers, like Ronald Kotulak of the *Chicago Tribune*,[64] and popular writers like Brizendine,[65] the gains of feminism are in danger.

It is easy to demonstrate differences in typical or average male/female brain development and physiology. Our hormones surge at different times and in different amounts (indeed, development of male and female sex characteristics and behaviors is, at least in rats, heavily hormone dependent). Our bodies and brains develop differently as a result, and maps of brain activity reflect different patterns between male and female human test subjects when certain simple tasks are performed, images are viewed, or questions are asked.[66] But, before we jump to any quick conclusions about male/female brain difference, we would do well to remember that, in virtually every study to date, the differences demonstrated *within* each gender are far greater than those demonstrated *between* genders, popular wisdom notwithstanding. The fact that developmental differences exist does not mean that they produce significantly different performance outcomes. It certainly does not mean that different outcomes—differences, for example, between the presence of males and females in computer science—are driven by innate gender-based differences, neurological or otherwise.

The daily findings of neuroscience are enormously exciting. We are learning that not only does the brain begin the process of adapting to environmental inputs in the womb, but that very early education alters brain wiring and makes strong imprints. For example, young musical performers develop enlarged brain regions for the limbs they perform with that are gigantic compared to the same region in the rest of us.[67] Taxi drivers develop larger hippocampi, the brain region correlated with spatial representation (and learning routes), but recent research suggests that with the increased gray matter came a lessened ability to learn new routes.[68] We are

than what a neurologist of the mid-20th century could have told you about brain functions and where they're localized").

64. *See* Ronald Kotulak, *Gender and the Brain; New Evidence Shows How Hormones Wire the Minds of Men and Women to See the World Differently*, Chi. Trib., Apr. 30, 1996, at C1 (noting that scientists are "getting a lot closer to understanding what makes [male and female] brains so different" and why men and women "think differently").

65. *See* Brizendine, *supra* note 33.

66. As my friend Chris Stone, a criminal defense attorney, opined when guest lecturing in my evidence class: it is well known among attorneys that "whoever has the biggest exhibit wins." The same might be said about the most attractive scientific-looking images.

67. *See generally* Oliver Sacks, Musicophilia: Tales of Music and the Brain 100–01 (2008) (citing 2003 research by Harvard's Gottfried Schlaug and colleagues).

68. *See* Diane F. Halpern, *Science, Sex, and Good Sense: Why Women Are Underrepresented in Some Areas of Science and Math*, *in* Why Aren't More Women in Science? Top Researchers Debate the Evidence, *supra* note 16, at 121, 127 (pointing to data showing, for example, that areas of the brain related to spatial skills were enlarged in London cab drivers); Eleanor A. Maguire et al., *London Taxi Drivers and Bus Drivers: A Structural MRI and Neuropsychological Analysis*, 16 Hippocampus 1091, 1099 (2006).

continuously seeing just how miraculous the brain's ability is; it can repair malfunctions and adapt to necessity by redeploying regions dedicated to one type of function to another type of function. We are learning, above all, how very complex the brain is, and how remote the possibility is that we can predict or understand human behavior by exploring and measuring the brain's individual parts or their separate responses to stimuli.

VI. CONCLUSION

The study of neuroscience is not only exciting, but enormously valuable. It has already taught us that the path to justice lies in ensuring that all young brains receive adequate stimulation—stimulation sufficient to fully develop all regions and capacities—and protection from experiences that stunt or harm that capacity, to the maximum extent feasible. What neuroscience can not offer, however, is the explanations for the multiplicity of behavioral problems and conflicts that have generated, and continue to fuel, the engines of law—especially when they involve questions of gender. We can surely find neurological differences between any two or more groups we measure. But, to find structural or physiological response differences is not to explain behavioral differences, nor to affix responsibility for those differences. Legal practitioners would do better to turn to science for clarification of the questions.

In the end, law is about justice rather than truth. That is why justice is as much concerned with burdens of proof as with proof itself. When it comes to gender justice, the burden must remain with those who would explain behavioral or societal gender differences in terms of biology or innate qualities rather than historical and cultural factors. The neuroscientific contribution to carrying that burden is, so far, minimal. But, the hype surrounding its purported findings is not. I hope that law will carefully distinguish the reality from the hype, and I write simply to urge that it do so.

The honorary chair of the MacArthur Foundation's Law and Neuroscience Project is former Supreme Court Justice, Sandra Day O'Connor. Ever cautious, Justice O'Connor once wrote, "[w]hen gender distinctiveness becomes a mantra, I worry that, in our voyage from the eighteenth century to the present, we have not really traveled very far at all."[69] Hopefully, her prestige and influence will ensure that, when it comes to gender, legal practitioners will not follow the popular press by misinterpreting neuroscience to reinforce questionable gender stereotypes, but will instead approach such claims with caution and skepticism. If it is otherwise, the claims of neuroscience may one day join those of the phrenologists and craniologists, under the label of "junk science."

69. Sandra Day O'Connor, The Majesty of the Law: Reflections of a Supreme Court Justice 167 (Craig Joyce ed., 2003).