June 2015

Neuroscience and Juvenile Justice

Jay D. Aronson

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I. INTRODUCTION

Recent advances in the field of neuroscience, especially improved magnetic resonance imaging (MRI) techniques, are providing scientists and decision-makers with an increasingly complex understanding of how our brains develop from birth to adulthood. While these studies are still in their infancy, they have already made it clear that the brain typically continues to develop long after the point at which an individual becomes a legal adult (i.e., at age 18), and that the slow maturation process that plays out in the social context is mirrored by a slow maturation process at the neural level. Despite the tentative nature and unsettled meaning of this information (i.e., we do not yet understand the actual link between brain structure and behavior), neuroscience is increasingly implicated in long-standing debates about the treatment of juveniles in the criminal justice system and the extent to which adolescents can be held legally responsible for their acts.

To date, the most notable example of this trend has been *Roper v. Simmons*,[1] in which the Supreme Court banned the death penalty for

* This is an expanded and modified version of an article which originally appeared as: Jay D. Aronson, *Brain Imaging, Culpability, and the Juvenile Death Penalty*, 113 PSYCHOL. PUB. POL'Y & L. 115 (2007). Adapted with permission.

1. 543 U.S. 551 (2005).

offenders under the age of 18.[2] The case revolved around the trial, sentencing, and habeas corpus petition of Christopher Simmons, who brutally murdered an elderly woman during the course of a burglary when he was 17 years old.[3] The Court held that although the execution of juveniles was once considered acceptable in American society, a national consensus had emerged that such a punishment was cruel and unusual and, thus, in violation of the Eighth Amendment.[4] The majority agreed with Simmons' claim that adolescents do not possess the emotional, intellectual, or biological maturity necessary to be reliably classified among the worst offenders.[5] Although adolescents should certainly be punished for their crimes, they should not pay the ultimate price for impulses that they were unable to control.[6] Simmons' argument was premised largely on new brain imaging evidence suggesting that the adolescent brain is not as well developed as the adult brain.[7]

The shortcomings of the teen brain have been showcased in the mainstream media as an explanation for violent and inappropriate adolescent behavior at least since the 1999 Columbine High School shootings.[8] In the last decade, newspapers, and mass-market weeklies have promised to "revolutioniz[e] our view of the adolescent mind—and

2. *Id.* at 570-71.

3. *Id.* at 556.

4. *Id.* at 564, 568.

5. *Id.* at 568-70.

6. *See id.* at 573-74.

7. Brief of Respondent at 20, Roper v. Simmons, 543 U.S. 551 (2005) (No. 03-633), *available at* http://www.abanet.org/crimjust/juvjus/simmons/partybrief.pdf [hereinafter Simmons' Brief].

8. *See*, *e.g.*, Sharon Begley, *Getting Inside a Teen Brain*, NEWSWEEK, Feb. 28, 2000, at 58; Shannon Brownlee et al., *Inside the Teen Brain*, U.S. NEWS & WORLD REP., Aug. 9, 1999, at 44; Duncan Graham-Rowe, *Teen Angst Rooted in Busy Brain*, NEW SCIENTIST, Oct. 19, 2002, at 16; Roberta Hotinski, *You Were Angry?*, U.S. NEWS & WORLD REP., Aug. 9, 1999, at 50; Claudia Wallis & Kristina Dell, *What Makes Teens Tick? A Flood of Hormones, Sure. But Also a Host of Structural Changes in the Brain. Can Those Explain the Behaviors that Make Adolescence So Exciting—and So Exasperating?*, TIME, May 10, 2004, at 56; *Teen Excesses are Linked to Brain Growth; New Research Suggests that Hormones Are Not Cause of Adolescent Angst*, SAINT LOUIS POST-DISPATCH, Dec. 31, 2000, at B7; Matt Crenson, *Brain Changes Shed Light on Teen Behavior*; *Old Theory Shattered by New Technologies; New Information Gained About Brain Development*, TIMES-PICAYUNE, Dec. 31, 2000, at 18; Fran Henry, *Dealing With Your 'Crazy' Teens; Bad Behavior May Not Be Their Fault—or Yours, Psychologist Says*, CLEVELAND PLAIN DEALER, Dec. 3, 2001, at E1; Curt Suplee, *Key Brain Growth Goes on Into Teens; Study Disputes Old Assumptions*, WASH. POST, Mar. 9, 2000, at A1; Shankar Vedantam, *Are Teens Just Wired That Way?; Researchers Theorize Brain Changes are Linked to Behavior*, WASH. POST, June 3, 2001, at A1.

explain[ ] its mystifying ways."[9] These accounts argue that while we once explained teen unpredictability and excessive risk-taking by invoking "raging hormones" or the need to assert one's individual identity through rebellion, we now know that the evolving structure of the adolescent brain is the true cause.[10] As one leading neuroscientist said in a 2001 op-ed, "[T]o understand what goes wrong in the teenagers who fire the guns, you have to understand something about the biology of the teenage brain."[11]

Although brain development studies are rarely invoked as a legal defense (in other words, that "my immature brain made me do it"), they are increasingly being used by enterprising defense advocates as evidence that teenagers are not yet adults and that the legal system should therefore not treat them as such. In one recent case in the District of Columbia, defense lawyers used brain imaging studies showing that the brain is not fully developed until well into the third decade of life to suggest that a 19-year old male (who also showed clear signs of mental retardation) could not be held fully responsible for his crimes.[12] As stated in her *Memorandum in Aid of Sentencing*, Public Defender and juvenile justice advocate Santha Sonenberg wrote:

> Although chronologically Mr. W is just barely an adult, his mental age renders him a juvenile. As discussed more fully *infra*, 'since 2000, numerous brain scan studies have established that the human brain does not fully mature until an individual is in his or her early to mid-twenties.' [citation omitted] Thus, even without his serious cognitive deficits, at nineteen, his brain was not that of an adult.[13]

In another D.C. case, involving a high school junior named Gary Durant, who was charged with murder as an adult for a crime he committed at the age of 17, Sonenberg is hoping to use brain imaging studies to have him returned to the juvenile justice system where she feels he belongs.[14]

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9. TIME, May 10, 2004, at Cover.

10. Begley, *supra* note 8, at 58.

11. Daniel R. Weinberger, *A Brain Too Young for Good Judgment*, N.Y. TIMES, Mar. 10, 2001, at A13.

12. United States v. Kurt W., (D.C. Super. Ct. 2005) (Juvenile Criminal Case Under Seal).

13. Memorandum in Aid of Sentencing, United States v. Kurt W., at 7 (D.C. Super. Ct. 2005), *available at* http://www.pdsdc.org/calendar/summerseries/ss07252006/Sample%20Memorandum%20in%20Aid%20of%20Sentencing.pdf.

14. Laura Sessions Stepp, *He's a Man, as Charged; but Should Emerging Brain Science Affect Courts' Handling of Young Defendants?*, WASH. POST, May 6, 2008, at HE1.

In *Roper v. Simmons*, Christopher Simmons' legal team and its supporters (including the American Medical Association and the American Psychological Association) contended that the biological limitations rendered the death penalty a cruel and unusual punishment because teens do not have the brain structure necessary to fully control their actions.[15] The use of scientific evidence in *Roper* was interesting because brain images were not used to make gross pathologies of the brain visible, which is how neuroscience has traditionally been invoked in the criminal justice system over the past two decades (for example, in the case of John Hinkley).[16] Rather, the Simmons defense team sought to narrow the legal category of culpability by constructing a model of a normal, mature adult brain that was capable of supporting the functions of a reasonable man and contrasting that model with the developmental chaos of a teenager's brain.[17] They sought to have both anatomical and cognitive normalcy and pathology defined by age rather than by some diagnosable medical condition or mental state.[18] In other words, Simmons' legal team argued that, as a population, adolescents' brain structure and function have not yet matured to the level found in a normal population of adults.[19] Thus, Simmons sought to extend categorical exemptions to a group that had no obvious psychiatric diagnosis or medical problem.

An analysis of the scientific and legal arguments made in *Roper* is crucial because juvenile justice advocates are currently seeking to expand the scope of that decision and to use neuro-scientific evidence for a variety of non-death penalty related issues.[20] In a recent fact sheet entitled "Adolescent Brain Development: A Critical Factor in Juvenile

15. Simmons' Brief, *supra* note 7, at 9-10; Brief for the American Psychological Association and the Missouri Psychological Association as Amici Curiae Supporting Respondent at 2, Roper v. Simmons, 543 U.S. 551 (2005) (No. 03-633), *available at* http://www.abanet.org/crimjust/juvjus/simmons/apa.pdf; Brief for the American Medical Association et al. as Amici Curiae in Support of Respondent at 2, Roper v. Simmons, 543 U.S. 551 (2005) (No. 03-633), *available at* http://www.abanet.org/crimjust/juvjus/simmons/ama.pdf [hereinafter AMA et al. Amici Curiae Brief].

16. Jennifer Kulynych, *Psychiatric Neuroimaging Evidence: A High-Tech Crystal Ball?*, 49 STAN. L. REV. 1249, 1252 (1997).

17. Simmons' Brief, *supra* note 7, at 20-24.

18. *Id.*

19. *Id.*

20. *See* COALITION FOR JUVENILE JUSTICE, APPLYING RESEARCH TO PRACTICE: WHAT ARE THE IMPLICATIONS OF ADOLESCENT BRAIN DEVELOPMENT FOR JUVENILE JUSTICE? (2007), http://www.issuelab.org/click/download2/applying_research_to_practice_what_are_the_implications_of_adolescent_brain_development_for_juvenile_justice/resource_138.pdf (providing an explicit statement of the normative value of this strategy).

Justice Reform," the non-governmental organization Physicians for Human Rights proclaimed that "[h]ealth professionals can apply scientific findings regarding adolescent development to support advocacy campaigns on" a wide range of issues, including: raising the age of jurisdiction to be tried as an adult; limiting juvenile transfer to the adult criminal justice system; supporting clemency and reduced sentences for juvenile offenders who have already been tried and convicted as adults; and, finally, creating developmentally appropriate rehabilitation programs that take into account the physical and mental state of juveniles.[21]

Some pioneering juvenile justice advocates are also using this new evidence as the basis for a redefinition of culpability in criminal law. As one advocate, Simmie Baer, has argued, the reasonable man standard is no longer adequate for teens in light of "old soft and new hard" science.[22] Instead, a new standard of the "reasonable adolescent" should be created on the basis of the scientific and sociological understanding of teen brain anatomy and behavior.[23] In Baer's view, the new "hard science" produced by brain imaging would make such a move much easier. Finally, she argues that on the basis of the new brain imaging data, the legal system should consider adolescents to be in a "natural state" of diminished capacity and should treat them as such.[24]

II. THE SCIENCE OF BRAIN DEVELOPMENT

So what does the science of brain development have to say about violent and impulsive behavior in adolescents? The evidence, as we shall see, is rather ambiguous and experts cannot yet come to a consensus about what it means. There is widespread agreement that adolescents' level of intelligence and ability to reason are generally indistinguishable from adults by the age of 16, at least under ideal conditions (psychologists call this "cold cognition").[25] However, as

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21. Physicians for Human Rights, *Adolescent Brain Development: A Critical Factor in Juvenile Justice Reform*, *available at* http://physiciansforhumanrights.org/juvenile-justice/factsheets/braindev.pdf (last visited Mar. 12, 2009).

22. Simmie Baer, Teleconference at the American Bar Association Center for Continuing Legal Education: Roper v. Simmons: How Will this Case Change Practice in the Courtroom? (June 22, 2005).

23. *Id.*

24. *Id.*

25. MACARTHUR FOUNDATION RESEARCH NETWORK ON ADOLESCENT DEVELOPMENT AND JUVENILE JUSTICE, LESS GUILTY BY REASON OF ADOLESCENCE 2 (2006), http://www.adjj.org/downloads/6093issue_brief_3.pdf [hereinafter MACARTHUR REPORT]. *See also* Florin Dolcos & Gregory McCarthy, *Brain Systems Mediating Cognitive Interference by Emotional*

numerous psychosocial studies have demonstrated, adolescents are much less capable of making sound decisions under stressful conditions or when peer pressure is strong (otherwise known as "hot cognition").[26] Some researchers have referred to the years when cold cognition and hot cognition are not aligned as the "immaturity gap."[27] They have argued that this should be considered a mitigating factor when juveniles are facing criminal prosecution and that adolescents should not be tried in traditional adult courts.[28]

So what causes this gap? For most of the 20th century, experts believed that the most important period for human brain development was the first three years of a person's life.[29] The extent to which neural connections were made during this period would determine future intelligence and decision-making ability.[30] In the past few decades, however, neuroscientists have discovered that two key developmental processes, myelination (the disposition of a layer of fatty tissue around nerve fibers, providing the insulation necessary to efficiently transmit electrical signals from one neuron to the next)[31] and pruning of neural connections,[32] continue to take place during adolescence and well into adulthood. Pruning is thought to be crucial because individuals are left with far too many neurons after the massive growth spurt that takes place in the brain during the first years of life and, again, just before puberty.[33] As the brain matures, certain neural connections are used more than are others, as individuals learn, gain skills, and progress through life. Although the mechanism is not fully understood, during adolescence and into adulthood, the lesser-used connections shrivel away leaving those that remain more efficient.

Distraction, 26 J. NEUROSCIENCE 2072 (2006) (discussing a scientific study providing evidence of how emotional distracters detrimentally affect the decision-making process).

26. MACARTHUR REPORT, *supra* note 25; *see* Dolcos & McCarthy, *supra* note 25 (for an explanation of how emotional distracters stimulate regions of the brain associated with "hot" emotional processing).

27. *See*, *e.g.,* MACARTHUR REPORT, *supra* note 25.

28. *Id.* at 3.

29. *See generally* JOHN T. BRUER, THE MYTH OF THE FIRST THREE YEARS: A NEW UNDERSTANDING OF EARLY BRAIN DEVELOPMENT AND LIFELONG LEARNING (1999).

30. *Id.*

31. *See* P.R. Huttenlocher, *Synaptic Density in Human Frontal Cortex: Developmental Changes and Effects of Aging*, 163 BRAIN RES. 195 (1979); P.R. Huttenlocher et al., *Synaptogenesis in Human Visual Cortex: Evidence for Synapse Elimination during Normal Development*, 33 NEUROSCIENCE LETTERS 252 (1982).

32. Paul I. Yakovlev & André-Roch Lecours, *The Myelogenetic Cycles of Regional Maturation of the Brain*, *in* REGIONAL DEVELOPMENT OF THE BRAIN IN EARLY LIFE 3-70 (Alexandre Minkowski ed., 1967).

33. *See* Huttenlocher, *supra* note 31.

As early anatomical studies showed, different parts of the brain become fully myelinated and pruned at different times, with some maturing very early in life and some continuing myelination through many decades of life.[34] In both cases, it appeared that the brain regions responsible for basic life processes and sensory perception tend to mature fastest, whereas the regions responsible for behavioral inhibition and control, risk assessment, decision-making, and emotion tend to take longer to mature.[35] Many of these higher order processes are centered in the frontal lobe. The results of both of these processes can be seen with modern MRI techniques. The visible result of myelination is an increase in the amount of white matter found in the brain, whereas the visual result of pruning is a decrease in the amount of gray matter present in the brain. Beginning in the late 1990s, researchers at UCLA and NIH confirmed that these processes continue well into a person's early adulthood, thus providing conclusive evidence that the brain of an adolescent is on average less myelinated and pruned than an adult's.[36] In one study, UCLA researchers took MRIs of 10 healthy 12-16 year olds and 10 healthy 23-30 year olds and compared brain structures.[37] In another study at NIH, researchers took MRI images of healthy individuals at 4 year intervals from ages as young as 4 until ages as old as 22.[38] Although this research team found significant inter-individual variation in cerebral cortex development among the 145 study participants, they saw a clear pattern of linear increases in the volume of white matter found in this region but nonlinear changes in the volume of gray matter.[39] In terms of gray matter volume, they saw a general trend toward preadolescent increases and postadolescent decreases, with region-specific changes.[40]

Building on this work, in 2004, researchers from UCLA and NIH collaborated and put together a composite time-lapse sequence of brain development among 13 healthy children whose brains had been scanned

34. *See* Ruben C. Gur, *Brain Maturation and Its Relevance to Understanding Criminal Culpability of Juveniles*, 7 CURRENT PSYCHIATRY REPORTS 292 (2005) (providing a brief review of this topic and its relevance to adolescents); *see also* Staci A. Gruber & Deborah Yurgelun-Todd, *Neurobiology and the Law: A Role in Juvenile Justice?*, 3 OH. ST. J. CRIM. LAW 321 (2006).

35. *See* Yakovlev & Lecours, *supra* note 32.

36. *See* Elizabeth R. Sowell et al., *In Vivo Evidence for Post-Adolescent Brain Maturation in Frontal and Striatal Regions*, 2 NATURE NEUROSCIENCE 859 (1999); Jay N. Giedd et al., *Brain Development During Childhood: A Longitudinal MRI Study*, 2 NATURE NEUROSCIENCE 861 (1999).

37. Sowell et al., *supra* note 36, at 859.

38. Giedd et al., *supra* note 36, at 861.

39. *Id.*

40. *Id.*

every 2 years for 8–10 years.[41] These time-lapse sequences showed that the regions of the frontal cortex responsible for higher order thinking and behavior management matured after the regions responsible for lower order sensory and motor activities, whose function they integrate.[42]

Although all of these studies have severe limitations (including small sample size and sample selection biases, such as an average IQ of 125 for one study), all available evidence seems to suggest that many important regions of the brain continue to develop through adolescence and into adulthood. What remains to be determined, however, is the extent to which these developmental milestones are causally related to changes in decision-making capacity.

In addition to these structural studies, researchers have also begun to use functional MRI, which essentially amounts to making a movie of changes in blood flow in the brain as test subjects are exposed to stimuli or perform various tasks. Blood flow is taken as a proxy for brain activity in these images.[43] Although fMRI studies are far from scientific maturity, they played an important role in the debate over the juvenile death penalty. Of greatest relevance in this context was the work done by psychologists Abigail A. Baird of Dartmouth University and Deborah Yurgelun-Todd, who was at Harvard at the time, on the activation of a brain structure called the amygdala.[44] The amygdala is a part of the limbic system that is known to be involved in interpreting emotion and, in particular, in determining whether another organism or situation is threatening.[45] Thus, the amygdala is a central component of the brain system that detects danger and generates fear responses.[46]

Of particular interest to researchers is the fact that the amygdala also seems to play a role in the recognition of facial expressions and the ability to attach emotional meaning to them.[47] In a 1999 study, Baird, Yurgelun-Todd, and colleagues subjected 12 individuals between the ages of 12 and 17 years to photographs of fearful faces while they were

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41. Nitin Gogtay et al., *Dynamic Mapping of Human Cortical Development during Childhood through Early Adulthood*, 101 PROC. NAT'L ACAD. SCI. 8174, 8174 (2004).

42. *Id.*

43. Robert Mathias, *The Basics of Brain Imaging*, NIDA NOTES., Nov.-Dec. 1996, *available at* http://www.nida.nih.gov/NIDA_notes/NNVol11N5/Basics.html.

44. Abigail A. Baird et al., *Functional Magnetic Resonance Imaging of Facial Affect Recognition in Children and Adolescents*, 38 J. AM. ACAD. CHILD & ADOLESC. PSYCHIATRY 195 (1999).

45. Joseph LeDoux, *The Amygdala*, 17 CURRENT BIOLOGY at R868, R870 (2007).

46. *Id.*

47. *Id.* at R873-74.

undergoing MRI.[48] They found that the amygdala became very active during facial recognition activities in adolescents.[49] In addition, they found that adolescents were prone to misreading fearful facial expressions, characterizing them as angry, confused, surprised, and happy.[50]

In subsequent work, Yurgelun-Todd and her colleagues at Harvard examined how the recognition of emotion in facial expressions might differ in adolescents and adults. In the Brief of the American Medical Association, et al. As Amici Curiae in Support of Simmons, Yurgelun-Todd was cited for her research showing that adolescents and adults use different parts of the brain to identify emotions in facial expressions.[51] Specifically, she found that the frontal lobe is much more active in adults during this process than it is in adolescents, who, as reported above, rely more heavily on the amygdala.[52] In other words, while the adults relied on the part of the brain that is involved in "planning, goal-directed behavior, judgment, [and] insight," the adolescents relied on what she characterizes as "the more emotional region or that gut response region."[53] Further, Yurgelun-Todd reported that in this pilot study, adults were much better at recognizing fear in facial expressions. According to statements she made in an interview for the PBS documentary series, "Frontline," adults identified fearful expressions 100% of the time, whereas adolescents chose the correct emotion only about half the time.[54] Thus, according to Yurgelun-Todd, there was something inherently biological about the way teens reacted to the world around them. Despite the excitement that this research generated in the juvenile justice community, however, numerous flaws have been identified in Yurgelun-Todd's work—including that the teenagers were thrown off by the fact that the images were black and white and created

48. Baird et al., *supra* note 44, at 196.

49. *Id.* at 197.

50. *Id.* at 198.

51. AMA et al. Amici Curiae Brief, *supra* note 15, at 15 n.52-53 (citing Interview by Sarah Spinks with Deborah Yurgelun-Todd, Director, Neuropsychology and Cognitive Neuroimaging of McLean Hospital, broadcasted as *Inside the Teenage Brain* on FRONTLINE (Airdate 1/31/2002), *available at* http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/interviews/todd.html.).

52. Interview by Sarah Spinks with Deborah Yurgelun-Todd, Director, Neuropsychology and Cognitive Neuroimaging of McLean Hospital, broadcasted as *Inside the Teenage Brain* on FRONTLINE (Airdate Jan. 31, 2002), *available at* http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/interviews/todd.html.

53. *Id.*

54. *Id.*

in the 1970s.[55] It is also worth noting that, at least to the best of my knowledge, the results of this research have never been formally published in a peer-reviewed journal.

III. THE USE OF BRAIN SCIENCE IN THE COURTROOM

Returning to the legal side of things, *Roper v. Simmons* represented the culmination of a series of juvenile death penalty appeals in which this brain imaging research was invoked by the defense. In the 2002 case of *Commonwealth v. Huertas*,[56] for example, the defense asked the judge to bar Pennsylvania from pursuing the death penalty for the defendant (who was 17 years old when he committed the crime in question) on the basis of a combination of existing law and new scientific discoveries about the brain.[57] In a brief to the court, the defense team wrote that, "a growing body of objective factors . . . point to a 'modern societal consensus' that obviates the *Stanford* Court's reluctance to categorically invalidate capital punishment for juvenile offenders above 15 years of age."[58] Huertas's legal team noted that the scientific consensus in the era of *Stanford v. Kentucky*[59] was that brain development was complete before puberty, and they argued that a majority of justices on the *Stanford* court would have found the current state of knowledge of this process relevant to Eighth Amendment analysis.[60] Although the impact of the scientific evidence is difficult to ascertain, Huertas did not ultimately receive the death penalty.

In 2002, a similar effort was made to spare the lives of Kevin Stanford (of *Stanford v. Kentucky*) and Toronto Patterson, a Texas death row inmate who was convicted of killing a woman and her two daughters during the course of a robbery when he was 17 years old. In a petition to the U.S. Supreme Court, Patterson's defense team used an affidavit about brain development by Dr. Ruben Gur as evidence that

55. *See* Amanda Schaffer, *Head Case:* Roper v. Simmons *Asks How Adolescent and Adult Brains Differ*, SLATE, Oct. 15, 2004, http://www.slate.com/id/2108284.

56. Commonwealth v. Huertas, No. CP 0009–0941 (Pa. Ct. Com. Pl. 2002).

57. Motion to Preclude the Commonwealth from Seeking the Death Penalty Against a Juvenile and Consolidated Memorandum of Law at 3-4, 37-38, Commonwealth v. Huertas, No. CP 0009–0941 (Pa. Ct. Com. Pl. 2002), *available at* http://www.internationaljusticeproject.org/pdfs/HUERTASfINALjUVENILEcHALLENGEmOTION.pdf.

58. *Id.* at 37

59. 492 U.S. 361 (1989), *overruled in part by* Roper v. Simmons, 543 U.S. 551, 574 (2005).

60. Motion to Preclude the Commonwealth from Seeking the Death Penalty against a Juvenile and Consolidated Memorandum of Law, *supra* note 57, at 38.

Patterson's age should preclude him from execution.[61] In both cases, the Supreme Court declined to hear the petition.[62] The dissent in *In re Stanford*, however, argued that a national consensus against the juvenile death penalty had emerged since Stanford's original trial in the late-1980s and that recent brain imaging studies "make the case even stronger that adolescents 'are more vulnerable, more impulsive, and less self-disciplined than adults.'"[63] Although Patterson was executed on August 28, 2002,[64] Stanford's sentence was commuted to life imprisonment in 2003 by Kentucky's governor Paul Patton, a long-time foe of the juvenile death penalty.[65]

In deciding in favor of Simmons, the Supreme Court certainly took notice of the scientific evidence just discussed, but mentioned it only in passing in the majority opinion.[66] Instead, they focused on evidence that a national consensus seems to have emerged among the states and in international law that individuals who commit crimes as juveniles should not be sentenced to death.[67] One reason for this situation is that these developmental studies have not yet been ruled admissible in any court of law in the country.[68]

IV. DISAGREEMENT ABOUT THE MEANING AND VALUE OF BRAIN DEVELOPMENT STUDIES

Such caution on the part of the highest court in the land has not deterred supporters of juvenile justice reform from hailing neuroscience as a key component to their long-term strategy to ensure that individuals under the age of 18 are treated as vulnerable juveniles in the criminal justice system and not as adults. Many juvenile justice advocates believe that brain imaging studies provide the hard evidence they need to finally convince lawmakers and the general public about problems inherent in treating juveniles as adults in the legal system.

61. Affidavit of Ruben Gur, Petitioner's expert, Patterson v. Texas, 528 U.S. 826 (1999) (No. 98-8907), *available at* http://www.abanet.org/crimjust/juvjus/Gur%20affidavit.pdf (last visited Mar. 12, 2009).

62. *In re* Stanford, 537 U.S. 968 (2002); Patterson v. Texas, 528 U.S. 826 (1999).

63. *In re* Stanford, 537 U.S. at 971 (Stevens, J., dissenting).

64. *See* David Carson, Texas Execution Information Center, Information on Toronto Patterson (Aug. 28, 2002), http://www.txexecutions.org/reports/279.asp.

65. *See* Death Penalty Information Center, Clemency, http://www.deathpenaltyinfo.org/clemency (last visited Mar. 12, 2009).

66. *See* Roper v. Simmons, 543 U.S. 551, 569 (2005).

67. *Id.* at 564, 578.

68. *See* Jay D. Aronson, *Brain Imaging, Culpability and the Juvenile Death Penalty*, 13 PSYCHOL. PUB. POL'Y & LAW 115, 136-37 (2007).

Yet at the same time, there is nothing even approaching consensus within the scientific community that these brain imaging studies ought to guide legal decision-making and public policy in the context of juvenile justice.[69] On one side are psychologists like David Fassler and Ruben Gur, who believe that preliminary brain imaging evidence is strong enough to be used by courts to create a categorical exemption for juvenile offenders.[70] Ronald Dahl from the University of Pittsburgh believes that although the connection between particular anatomical markers and the act of decision-making will eventually be proven correct, the evidence is not yet strong enough for widespread use in the legal system.[71]

Others, such as Elizabeth Sowell from UCLA and Bradley Peterson from Columbia University, are uncomfortable with introducing neuroscientific evidence into the legal system before it is understood exactly how specific brain traits relate to the real-life decision making and behavior of teens in high-stress situations.[72] They point to our lack of understanding about when individuals cross the threshold of brain development that makes it possible to know right from wrong and to make sound decisions in the heat of the moment—or even whether brain structure plays a major role in this shift.[73] Further, there is also the very real problem of how to deal with the significant inter-individual variations that are seen in brain development and also the possibility that currently unknown brain structures or neural networks might compensate for delays in the development of particular brain regions.

Finally, some commentators, such as Harvard University psychologist Jerome Kagan, believe that there is no place for science in the debate over the death penalty. In their view, capital punishment is an ethical and moral issue, not a scientific one.[74] Further, Kagan points out that one can only understand brain development in a cultural and historical context. Although adolescent brains presumably develop at the same rate around the world, teen violence and murder rates range from very low to very high, from country to country. Furthermore, in many other cultures, and until very recently even in Western societies,

69. Bruce Bower, *Teen Brains on Trial: The Science of Neural Development Tangles with the Juvenile Death Penalty*, 165 SCI. NEWS 299, 299 (2004).

70. *Id.*

71. *Id.* at 301.

72. *Id.*

73. *Id.*

74. *Id.* at 299.

people functioned as adults at a much earlier age—certainly by age 16—than they do today.

The fact that there are so many diverse opinions on the role that neuroscience may play in the way that juveniles are treated in the criminal justice system suggests that most scientists, lawyers, and commentators involved in the debate have not quite made up their minds about why we are turning to science to resolve these questions in the first place. Is it because neuroscience actually might say something new and unique about adolescent behavior and decision-making that we don't already know? Or because we hope it will resolve problems that we as a society tend to disagree about? Or is it because advocates of a particular normative position are hoping to use the cultural authority of science to achieve their particular view of how the criminal justice system ought to operate? Or is it because the legal system relies on expertise more generally to make decisions about complex social problems?

V. CONCLUSION

Whatever the case, it is clear that the use of brain imaging in the juvenile justice debate suggests that the allure of biological explanations for criminality continues to appeal to American society and our criminal justice system. While few people would disagree with continuing efforts to understand why certain people commit crimes and others do not, we must not submit to a new kind of biological determinism which posits that behavior is merely the "calculable [consequence] of an immense assembly of neurons firing."[75] Violence and criminality, like all human actions and attributes, are irreducibly complicated products of the interaction of the biological and the social. The plain and simple truth is that the vast majority of adolescents do not commit violent crimes and are able to control their impulses when it matters most. This suggests that the feedback network between the brain and lived experiences is incredibly complex—even in teens. Thus, if adolescence were truly a significant "ongoing 'condition' of development"[76] (in the sense of a serious, well-defined, diagnosable medical problem like bipolar disorder) that seriously impaired decision-making in all individuals all over the world, we would be in serious trouble. Marauding youths would be killing each other, their teachers, their elders, and their parents—and civilization as we know it would probably come to an end.

75. Dean Mobbs et al., *Law, Responsibility and the Brain*, 5 PLOS BIOLOGY 693, 693 (2007).
76. Gruber & Yurgelun-Todd, *supra* note 34, at 331.

The fact that it has not, and that when adolescents do commit heinous crimes it is almost always considered newsworthy, suggest that factors other than myelination and pruning are equally, if not more important than biology in determining why some subset of adolescents commit violent crimes.

While it is indeed possible that teens who commit crimes are on average biologically different from those who do not, the current state of neuroscience (which has so far failed to make a conclusive link between brain structure and adult-like decision-making capacity) leaves us in no position to make a claim one way or the other. Further, it would be nearly impossible to determine whether the brain structure present in criminal adolescents was caused by social and environmental factors (which are typically considered mitigating in the sentencing phase of criminal trials) or independent of these non-biological factors. Thus, it seems that neuroscience does not (at least at present) offer a way out of the vexing problems at the heart of juvenile justice.