

## THE TEENAGE BRAIN: NEW KNOWLEDGE FROM NEUROSCIENCE

“In order to truly understand why teenagers are moody, impulsive and bored; why they act out, talk back, and don’t pay attention; why drugs and alcohol are so dangerous for them; and why they make poor decisions about drinking, driving, sex – you name it – we have to look at their brain circuits for answers....

While hormones can explain some of what is going on, there is much more at play in the teenage brain, where new connections between brain areas are being built and many chemicals, especially neurotransmitters are in flux. That is why adolescence is a time of true wonder. Because of the flexibility and growth of the brain, adolescents have a window of opportunity with an increased capacity for remarkable accomplishments. But the flexibility, growth, and exuberance are a double-edged sword because an “open” and excitable brain also can be adversely affected by stress, drugs, chemical substances, and any number of changes in the environment. And because of an adolescent’s often overactive brain, those influences can result in problems dramatically more serious than they are for adults.”

Dr. Frances Jensen, *The Teenage Brain: A Neuroscientist’s Survival Guide to Raising Adolescents and Young Adults* (2015) at 22-23.

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*The recent explosion in neuroscience research about teenagers’ brains, and the implications for adults who deal with teenagers, is most comprehensively and accessibly presented in The Teenage Brain, a 2015 book by Dr. Frances Jensen, Professor of Neurology and Chair of the Neurology Department at the University of Pennsylvania Perelman School of Medicine. This Information Sheet summarizes aspects of that research particularly relevant to teen dating violence. This Information Sheet is based on Dr. Jensen’s book, her interviews with various media, and publications by the National Institute of Mental Health and the MacArthur Foundation Research Network on Adolescent Development and Juvenile Justice. These resources and related online videos are fully cited following the commentary.*

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Until recently it was thought that youngsters who had passed through puberty were essentially adults without life experience. New neuroscience has shown that this is decidedly not the case. As Dr. Jensen writes, the teenage brain has unique strengths and weaknesses, but because of the structural rate at which the brain’s components grow and connect with one another, the teen brain has a long way to go to reach maturity.

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## ***How Do We Know This?***

The advent of functional magnetic resonance imaging (fMRI) made it possible to see not only the structures in the brain, but also how brain regions connect and how the brain functions in real time – learn more at <http://fmri.ucsd.edu/Research/whatisfmri.html>.<sup>1</sup>

Scientists at the National Institute of Mental Health (NIMH) took brain scans of children as they grew from early childhood through age twenty and were surprised by what they found. They saw that the connectivity of the brain, the way brain circuits build and brain regions interact with each other, grows from the back of the brain to the front, and that it takes a very long time to get there. The teenage brain does not look like an adult brain until we are in our twenties, with males being two to three years behind females in the rate of connection.

Researchers at the University of California built on the NIMH findings by comparing brain scans of teens 12 to 16 with scans of young adults 23 to 30. They found that myelin – the whitish (hence “white matter”) fatty protein that sheaths the axon fibers connecting nerve cells and is essential for the transmission of information via nerve impulses – continues to be produced beyond adolescence into the thirties, further enhancing connectivity between brain regions. Dr. Jensen writes,

“[T]he teen brain is only about 80 percent of the way to maturity. That 20 percent gap, where the wiring is thinnest, is crucial and goes a long way toward explaining why teenagers’ behave in such puzzling ways – their mood swings, irritability, impulsiveness and explosiveness; their inability to focus, to follow through, and to connect with adults; their temptations to use drugs and alcohol and to engage in other risky behavior. When we think of ourselves as civilized, intelligent adults, we really have the frontal and prefrontal parts of the cortex to thank.” (Page 37).

## ***How the Brain Matures***

NIMH describes the teenage brain as “still under construction.” The brain is composed of so-called “gray matter” and the “white matter” described above. Gray matter is the cells called “neurons” that are unique to the nervous system and make possible thought, perception, motion, and control of bodily functions. Brain regions communicate with each other via the myelinated axon fibers, the myelin being like insulation on an electrical wire, greatly increasing the speed at which impulses are transmitted from cell to cell and region to region. This connectivity governs how well brain regions work

together and relates to growth in intellectual abilities. Brain regions that are wired together fire together. NIMH describes this connectivity as “a little like providing a growing city with a fast, integrated communication system.” Dr. Jensen writes,

“[T]he brain of an adolescent is nothing short of a paradox. It has an overabundance of gray matter (the neurons that form the basic building blocks of the brain) and an undersupply of white matter) the connective wiring that helps information flow efficiently from one part of the brain to the other) – which is why the teenage brain is almost like a brand-new Ferrari: it’s primed and pumped but it hasn’t been road tested yet. In other words, it’s all revved up but doesn’t quite know where to go. This paradox has led to a kind of cultural mixed message. We assume when someone looks like an adult that he or she must be one mentally as well. Adolescent boys shave and teenage girls can get pregnant, and yet neurologically neither one has a brain ready for prime time in the adult world.” (Pages 27-28).

The myelination process that starts at the back of the brain and moves very slowly toward the front, at last reaches the pre-frontal cortex, which is the seat of executive function. This is the area that enables and controls decision making, understanding the long-term consequences of our actions, insight, judgment, and impulse control. As noted above, the fact that it is the last part of brain to be fully connected to the rest has critical implications for teens’ behavior. A brain scan experiment at Dartmouth College illustrates this with respect to risk-taking.

Researchers scanned adults’ and adolescents’ brains while the subjects responded to questions such as whether it was a good idea to swim with sharks, set your hair on fire or jump off a roof. It took adolescents about a sixth of a second more than adults to respond. Adults appeared to rely on nearly automatic images and respond viscerally to these questions about situations of obvious danger. Adolescents relied more on “reasoning” their way to an answer. Dr. Jensen writes, “The ability to quickly grasp the general contours of a situation and make a good judgment about costs versus benefits arises from activity in the frontal cortex... the parts of the brain that are still under construction during adolescence.” (Page 107).

Additionally, because myelination connecting the frontal lobes to the rest of brain proceeds so slowly, it takes teens longer than adults to decide when not to do something. A widely used research instrument is called the Go/No-Go task. Subjects are directed to press a button when a certain letter or picture appears and to do nothing when the letter X appears. Repeated studies find that children and adolescents are

equally accurate, but the reaction time it takes subjects to successfully inhibit the impulse to press the button decreases markedly between 8 and 20.

### ***Teenage Brains, Stress, and the Teen Dating Violence Victim***

Teenage brains are particularly susceptible to stress, with implications for teens' lifelong mental, physical, and emotional health, and for the courts.

Good stress – the kind that stretches us to grow and up our game – is good for everyone, but bad stress impacts teenagers differently than it does adults, and for the worse. Teens are especially vulnerable to emotional highs and lows because they cannot make full use of their frontal lobes – their executive function – to handle their emotions with less drama. In addition to less frontal lobe activity, teens' response to stress hormones is not like that of adults. For example, the stress hormone THP calms adults but ratchets up anxiety in teens. The stress hormone cortisol is already slightly higher in teens than in adults, especially in girls. When cortisol is further elevated and stays elevated over time --- as it does when a teen is being subjected to dating violence – it is especially damaging. Elevated cortisol not only exacerbates stress, worry, anxiety, and anger, long-term elevation of cortisol also shrinks the hippocampus, the part of the brain where memories are stored. This undermines learning, school performance, and lifetime earning capacity. The brain is highly plastic and is continuously shaped from day one by a combination of genes, emotions, and the environment, with lifetime impact, as demonstrated by the massive Adverse Childhood Experiences Study.<sup>2</sup>

*The Enduring Effects of Abuse and Related Adverse Experiences in Childhood: A Convergence of Evidence from Neurobiology and Epidemiology* is an article by nine neuroscientists, pediatricians, physicians, and public health experts who assessed the findings of the long-running Adverse Childhood Experiences (ACE) study in the context of the new knowledge from neuroscience. The ACE questionnaire includes questions about childhood exposure to domestic violence and adult perpetration. After reviewing the more than 17,000 responses from the mostly white, well-educated sample they wrote:

“[T]he detrimental effects of traumatic stress on developing neural networks and on the neuroendocrine systems that regulate them have until recently remained hidden even to the eyes of most neuroscientists. However, the information and data that we present herein suggest that this veiled cascade of events represents a common pathway to a variety of important long-term behavioral, health, and social problems.

The convergence of evidence from neurobiology and epidemiology calls for an integrated perspective on the origins of health and social problems through the lifespan.”<sup>3</sup>

The stress of living with dating violence in its varied forms – emotional, physical, sexual, stalking, cyberbullying and more – takes a tremendous toll on the teen victim. When traumatic stress is severe or prolonged, teens are more susceptible to developing PTSD than adults. 4

Teens are also liable to self-medicate their stress with alcohol, drugs, and cutting. Addictions of all kinds – alcohol, cigarettes, drugs, texting and the rest – take tenacious hold of the teenage brain. Because the teen brain has so many synapses eager to absorb whatever is in the environment, teens can learn faster and retain what they learn better than adults. But this also means that when addictions begin in adolescence they are more destructive and harder to eradicate than in adults.

The good news is that teens can also be resilient. In her recommendations for parents Dr. Jensen writes,

“Resilience isn’t something you’re either born with or not. It’s actually something that’s learned, and for that reason teenagers, while particularly vulnerable to the negative effects of stress, are also better equipped than most adults to learn how to positively respond to stress. As an adult you are in a position to convey that information to your teenage sons and daughters, to tell them to take care, take control, and take time out. They can take care of themselves physically by eating right and getting enough sleep. They can take control of their lives by setting goals, even small ones, and working toward them one step at a time. And they can take time out from the Internet, from texting, from Facebook, and instead talk out their problems with a good listener they trust.” (page181).

Taking control is not easy when, in addition to the other internal and external stressors of a teen’s life, she or he has a dating partner who is trying to assert and maintain control. How judges, court personnel, and court-related professionals respond to teen dating violence victims seeking orders of protection, or having a child in common with their abuser, or facing delinquency charges for criminal activity into which their abuser coerced them -- whether these professionals understand the seriousness of teen dating violence and have available the support services and programs these teens need – is a significant factor in whether teen dating violence victims develop the resiliency they

need to take control of their own lives, move forward, and break the cycle of domestic violence for their own and the next generation.

## **Resources**

Publications by and Interviews with Dr. Francis E. Jensen, Professor of Neurology and Chair of the Department of Neurology at the Perleman School of Medicine at the University of Pennsylvania:

- THE TEENAGE BRAIN: A NEUROSCIENTIST'S SURVIVAL GUIDE TO RAISING ADOLESCENTS AND YOUNG ADULTS (2015).
- *Teenage Brains: Why Do They Do What They Do? The Science Behind Teen Behavior*, Psychology Today, Posted March 8, 2015, <https://www.psychologytoday.com/blog/the-teenage-brain/201503/teenage-brains-why-do-they-do-what-they-do>.
- *Why Teenagers are Impulsive, Addiction Prone, and Should Protect Their Brains*, An Interview with Dr. Jensen on NPR Fresh Air, Jan. 28, 2015. Audio and transcript at <http://www.npr.org/sections/health-shots/2015/01/28/381622350/why-teens-are-impulsive-addiction-prone-and-should-protect-their-brains>.
- *Q & A with Dr. Francis Jensen*, C-Span 2, Feb. 1, 2015, video and transcript at <http://www.c-span.org/video/?323965-1/qa-dr-frances-jensen>.

MacArthur Foundation Research Network on Adolescent Development and Juvenile Justice, [www.adjj.org](http://www.adjj.org), *Less Guilty by Reason of Adolescence*, [http://www.adjj.org/downloads/6093issue\\_brief\\_3.pdf](http://www.adjj.org/downloads/6093issue_brief_3.pdf).

National Institute of Mental Health, *The Teen Brain: Still Under Construction*, [http://www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/index.shtml?utm\\_source=LifeSiteNews.com+Daily+Newsletter&utm\\_campaign=2c0fa9560b-LifeSiteNews.com+Intl+Full+Text+12+18+2012](http://www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/index.shtml?utm_source=LifeSiteNews.com+Daily+Newsletter&utm_campaign=2c0fa9560b-LifeSiteNews.com+Intl+Full+Text+12+18+2012).

And in booklet form at [http://www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/teen-brain\\_141903.pdf](http://www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/teen-brain_141903.pdf).

### **Videos Available Online:**

Several videos about the teenage brain are available on YouTube:

- This 3-minute video presents comprehensive information about teenage brains and adult responses in an extraordinarily compact way. DNews, *The Teen Brain: Under Construction*, <https://www.youtube.com/watch?v=f9Ya0mHslgM>.

- The public television program Frontline broadcast a 60 minute show titled *Adolescent Brains Are Works in Progress*. It can be viewed online at <http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/view/>.

### **A Comprehensive Resource on “Neurolaw” for All Aspects of Law**

Francis X. Shen, *Keeping Up with Neurolaw: What to Know and Where to Look*, 50 COURT REVIEW 104 (2014). Available online at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2516052](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2516052).

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### **Endnotes**

1. University of California San Diego School of Medicine’s Center for Functional MRI In the Department of Radiology, “What is fMRI?” Information Page, accessible at <http://fmri.ucsd.edu/Research/whatisfmri.html>.
2. Lynn Hecht Schafran, *Domestic Violence, Developing Brains, and the Lifespan: New Knowledge from Neuroscience*, THE JUDGES’ JOURNAL, Summer 2014 at 32.
3. Robert F. Anda, Vincent J. Feitti, J. Douglas Bremner, John D. Walker, Charles Whitfield, Bruce D. Perry, Shanta R. Dube & Wayne H. Giles, *The Enduring Effects of Abuse and Related Adverse Experiences in Childhood: A Convergence of Evidence from Neurobiology and Epidemiology*, EUR. ARCH PSYCHIATRY CLIN. NEUROSCIENCE, April 2006 at 174, reprinted in NIH Public Access, accessible at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3232061/pdf/nihms340170.pdf> at 8.