The Developing Teenage Brain

Q&A with Frances Jensen, a leading neurologist, on the paradox of the strengths and vulnerabilities of adolescents' brains

BY LIZ GRIFFIN

When her teenage son, Andrew, informed her he wanted to add red streaks to his hair, Frances Jensen recalls that she first "calmed" herself before offering to take him to her own hair stylist. Several years later, another son, Will, squeezed an impulsive left turn into oncoming traffic and totaled the car. At that moment, Jensen experienced a flashback, thinking "Here we go again." This time, she says she was better prepared for dealing with "classic" teenage behavior, having read a considerable amount of the latest research on the functioning of the adolescent brain.

Jensen is a neurologist and neuroscientist with 30 years of experience studying children's brain development at Harvard Medical School before becoming chair of the department of neurology at the University of Pennsylvania's Perelman School of Medicine. She holds a researcher's fascination with the mysteries of the teenage brain and shares her understanding with educators, parents, young adults and teens.

The emerging findings and research data, along with her personal insights and anecdotes, have been woven into her latest book, *The Teenage Brain: A Neuroscientist's Survival Guide to Raising Adolescents and Young Adults* (Harper Collins, 2015). Once a largely neglected area of study, the teen brain is gaining rich attention.

In a recent interview with *School Administrator,* Jensen explores the teenage brain, its spectacular learning power and vulnerabilities, and

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some ways educators and teenagers might apply this knowledge to build on strengths and shore up weaknesses in its functioning.

This interview has been edited for clarity and length. A fuller version of Jensen's interview appears on the magazine's website.

You liken the adolescent brain to a Ferrari without brakes. What do you mean by that?

JENSEN: Adolescents will learn things faster and more easily than they ever will again. It's extraordinary! Every area of their brains is more active than adults. It's a point in brain development when nature has set the machinery for learning at very high levels.

Teens have more brain cells or neurons than adults do and are better at building brain connections, or synapses, than adults are. The process of molding the brain is called *synaptic plasticity*. These synapses are the crucial juncture where one cell passes information to another so learning can occur.

Teens go through a period of increased emotional fluctuation and are like a Ferrari with weak brakes. The emotional center of the brain, the limbic system, which controls emotions, is fully connected, but the frontal lobe that sharpens critical thinking isn't well-connected. That means the part of the brain that makes them pause and say to themselves, "Bad idea. Don't post that on Facebook because it might hurt my chances of getting a job in the future" or "don't jump in the

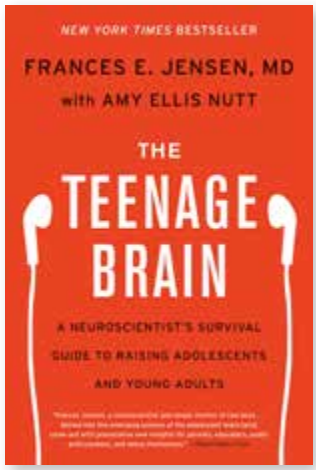
lake, there may be a rock," isn't mature.

It's a period when we as adults must be watchful. There is biology behind these poor decisions. Adolescence is a developmental period, and I tell parents and educators that, sometimes, teenagers desperately need a frontal-lobe assist.

How does the adolescent's brain differ from an adult's?

JENSEN: New brain imaging shows us that brain connections are built from back to front beginning with the most elementary functions (walking, eating, breathing) at the back and the more eloquent, higher-order functions (thinking and decision making) in the frontal lobes.

Executive function is an advanced skillset that includes setting priorities, using judgment and understanding cause and effect. Adolescents are better at building synapses than adults. They are fast learners but poor decision makers. Teens' lack of connections to the frontal lobes means they have trouble abstracting issues and making decisions in real time as rapidly as adults. This is why they can be geniuses on their SATs but forget to write their homework assignment in their planner.



Adolescence is a paradox. Teenagers are programmed for peak learning but their skills such as attention, task completion, self-discipline and controlling emotions are still inefficient.

Students today are under a lot of stress. What advice do you give?

JENSEN: We now know that when adolescents are stressed or fearful, their limbic system is activated

How Executive Function Helps Students Think Smarter

BY JACK A. NAGLIERI

At Mountain View Alternative High School in Centreville, Va., teachers are coaching students daily on what it means to think smart.

Educators at the 280-student school are focused on addressing executive function, also referred to as EF, which is responsible for intentionality, self-control, motivation, flexibility, creativity, and social and self-awareness. These, of course, are all key components of academic and life success.

Teachers at Mountain View help students use executive function to manage time, organize their work, regulate emotions and carry through an assignment to completion. The school, which is part of the Fairfax County Public Schools, is one of a growing number of schools that are applying what we have discovered about the brain's executive functioning in adolescents and pre-teens. The students report that the EF lessons help them do better in school, at home and on the job.


Jack Naglieri

Each week, Mountain View's teachers introduce a component, such as planning, and then encourage the students to "think smart and use a plan" during the week. A teacher may prompt students to consider how to approach their coursework assignments and reflect on the results by asking "How did that work for you?" Student strategies may include doublechecking their work, tackling the simplest problems first or drawing columns in multiplication problems to better organize the work.

Unique Teaching

Ample research now shows that students can be taught the value of using their executive function when doing academic work in school as well as everyday tasks outside of school. Encouraging students to use their executive function improves classroom performance and standardized test scores — and those benefits last. Why? Because helping students use executive function means they are thinking smarter and will more likely succeed.

The brain's frontal-lobe ability is best defined as "*how* we do what we decide to do." It is a neurocognitive ability unique to humans.

The front part of the brain is the seat of executive function, and the part of the brain that acts like an orchestra leader, expertly directing how all parts of the brain play in unison. EF starts with an intention that grows into a solution that one tries, evaluates and modifies, if needed, while emotions are regulated so that the goal is achieved.

Strategic Direction

This understanding of EF has considerable implications for teachers — specifically this: Should the teacher or the student be the orchestra leader? That

twice as high as a child's or adult's. In the moment, their reaction to small things is the way our adult brains would react to an international incident.

I hope we can engender greater understanding in adults and realize that ridiculing or criticizing their behavior will likely make matters worse. It may alienate them.

Frances Jensen, M.D.

Why is pruning and growth critical to the adolescent brain and learning?

JENSEN: Nature builds a brain that is customized to its environment. When we learn a new skill or recall a memory or idea, the brain's synapses grow and are strengthened. When synapses are not used, they wither and die. It's the use-it-or-lose-it principle.

Losing brain connections may sound like a bad idea. But the brain has one trillion synapses, which is a large surplus. Pruning in adolescence makes the brain's circuitry more efficient so it's a leaner, meaner learning machine.

The brain also becomes more efficient during a process called myelination. This is when a fatty substance called myelin grows slowly and wraps itself around miles of brain cells to better insulate them. Insulation makes the brain more efficient at sending and receiving signals. Myelination is a slow process that finishes in the mid-20s.

will depend on the student's age. Young children's frontal lobes are very immature, explaining why they have short attention spans and limited control of thinking and behaving. It's why they need directing by teachers and parents.

The path to full maturation is long, and it is not until the early 20s that this part of the brain is more fully mature. This means teachers should gradually turn over that responsibility to make decisions as students mature. In practical terms, it means educators should facilitate the students' use of EF by students by encouraging them to think smart by using a thoughtful approach to solving problems, but to do so in a way that is consistent with the developmental path all students take to maturity.

My research and others' work show two effective ways to teach executive function. One method is by direct instruction — teach students a strategy for a specific academic task. Another is an indirect approach that involves group discussion, which helps students gain an appreciation of the value of being thoughtful and deliberate in the way they approach, for example, a group of math problems or a reading comprehension task.

The advantage of the indirect approach is that it facilitates growth and ownership because the thinking is directed by the student. This increases the likelihood that the student will learn to generalize. This is exactly what happens.

JACK NAGLIERI is a research professor at University of Virginia in Charlottesville, Va., and senior research scientist at the Devereux Center for Resilient Children. E-mail: jnaglieri@gmail.com

Additional Resources

Author Jack Naglieri suggests these informational items relating to executive function in K-12 education:

- EF in the Classroom (*www.efintheclassroom.net).* Lead developer Tim McElroy is a special education teacher at Mountain View Alternative High School, Centreville, Va.
- *Executive Skills in Children and Adolescents,* 3rd ed., by Peg Dawson and Richard Guare, Guilford Press, New York, N.Y. (forthcoming January 2018).
- "A Five-Dimensional Model of Executive Function: Cognition, Behavior, Social-Emotional, Academics and Impairment!" by Jack A. Naglieri. PowerPoint available at *www.jacknaglieri.com/executive-function.html.*
- *Handbook of Executive Function* by Sam Goldstein and Jack A. Naglieri (editors), Springer, New York, N.Y., 2015.
- *The New Executive Brain: Frontal Lobes in a Complex World* by Elkhonon Goldberg, Oxford University Press, New York, N.Y., 2009.

What does science say about gender differences and individual differences between brains?

JENSEN: In adolescence, on average girls are more developed by about two to three years in terms of the peak of their synapses and in their connectivity processes. Of course, some boys mature early and some girls are slow to do so. This fact is no surprise to most people if we think of 15-year-old boys and girls.

The truth is girls may be only *relatively* more organized than boys because the myelination process is further along, so both teenage girls and boys can benefit from educators' added attention to developing executive functions.

6 Misconceptions About Adolescent Brains

Neurologist Frances Jensen of the University of Pennsylvania's Perelman School of Medicine identified six myths about the teenage brain that she says science has refuted over the past 15 years. The adolescent brain is exceedingly quick at learning new skills yet is vulnerable to illicit substances and impulsive behavior.

NO. 1: ADOLESCENTS ARE ADULTS WITH FEWER MILES ON THEM. Actually, adolescents' brains have more plasticity than adults, meaning they make connections between brain cells more quickly so learning is easier.

NO. 2: THE BRAIN IS DONE DEVELOPING BY AGE 12. In fact, the brain is the last organ in the body to fully mature. It is completed by the mid- to late 20s.

NO. 3: TEENAGERS ARE MORE RESILIENT THAN ADULTS. Untrue. Teens are more sensitive to stress. In adults, the stress hormone makes them calmer. In teens, the same hormones make them more anxious.

NO. 4: THE IQ OF A TEENAGER IS ESTABLISHED AS A CHILD. Actually, at least two-thirds of people change their IQ in their teen years.

NO. 5: ADOLESCENTS WON'T GET ADDICTED. THEY'LL BOUNCE BACK. In reality, teens get addicted more easily than adults do, and it's harder for them to quit. Addiction is a form of learning. Cognitive impairment after smoking marijuana lasts longer in teens. It can last four days in teens, meaning Sunday's high can affect what happens on Thursday's test.

NO. 6: TEENAGERS ARE NATURALLY LAZY. Untrue. They sleep late because their circadian clock is set differently. While adult brains release melatonin at 8 to 9 p.m., teenagers' brains don't release it until 11 p.m.

Currently, testing to pinpoint weaknesses and strengths is administered to the bottom 20 percent of students who are struggling. Wouldn't it also be great if kids knew their strengths and weaknesses? If they knew the problem was trouble decoding or if they knew they were visual learners? Ideally, brain research could apply to individualizing curriculum so all students can reach their best potential.

What does nature and nurture mean for IQ growth?

JENSEN: We used to think IQ was fixed at puberty. But we have great data now that show adolescence is a window where teenagers have incredible neural plasticity, and they can increase their IQ. Brain development responds to nature and nurture. We know experts build more synapses in areas of the brain where they're an expert. This process continues through adolescence.

That means high school teachers are teaching students at a time when their brains are being modified in really profound ways. Adolescents can be encouraged to build out synapses and become experts. This is a time they can hone academic and athletic skill sets. Teenagers love knowing this stuff.

You've talked more about peer pressure and the adolescent brain, especially bullying.

JENSEN: We need to have conversations with kids about how to protect themselves if a bully approaches them. What should they say? We all learn through trial and error, and schools could create safe places for kids to practice and make mistakes.

We know adolescents are great learners. But in the heat of the moment, they can't abstract and foresee what may happen. It's hard for them to respond. Teens' brains are not going to have those words ready when that happens unless they have a rote-learned response.

Perhaps educators could guide conversations and thinking. They might ask: "What will you say when that person starts to bully you?" Role playing or a video game or a virtual app could allow them to rehearse repeatedly.

The potent tools of today's online environment pose dangers to adolescents. What are your thoughts?

JENSEN: Educators need to have conversations with teenagers about how to manage themselves in an online environment. Inappropriate posts can travel instantly around the world. Teens are at an age when they act impulsively. That is what they do. They make mistakes and the conse-

Neuroscientist Frances Jensen (left) meets with students at Loyola Academy in Wilmette, Ill.

PHOTO COURTESY OF FRANCES JENSEN

quences can be serious.

In earlier generations, pranks and bullying had more limited impact. But today, adolescents are playing with fire. We all know the tragedy of the Rutgers student who committed suicide after his roommate posted a video of him having sex. That act screamed "adolescent brain" all over it.

It greatly concerns me. This is the first generation that has been exposed to this level of information and stimulation (digital invasion) coming at them. Teenagers need to be engaged with adults in helping determine how to manage the panoply of input and options.

How might educators apply their knowledge about the adolescent brain?

JENSEN: Educators are still thinking about how to apply our knowledge. There are many issues when it comes to how people learn, what time the school day should start, how personalized learning should be tailored, the implications of gender differences and what it means for bullying.

Teenagers are appropriately self-absorbed, and they love to learn about themselves. I believe adding information about the adolescent brain could give them some insights into themselves. As learners, they can realize they have weaknesses at this point in their lives and vulnerabilities, such as poor executive functions or susceptibility to addiction. It may help them make better decisions. Teenagers also may be rather relieved to learn why they did that stupid, impulsive thing on Saturday night and that they will be less prone to impulsive behavior as their brain matures. ■

LIZ GRIFFIN is managing editor of *School Administrator*. E-mail: lgriffin@aasa.org

Additional Resources

Author Frances Jensen recommends these informational resources for understanding the unique strengths and weaknesses of the adolescent brain.

- "Adolescence as a Sensitive Period of Brain Development" by Delia Fuhrmann, Lisa J. Knoll and Sarah-Jayne Blakemore, *Trends in Cognitive Sciences,* October 2015.
- "Adolescent Neuroscience of Addiction: A New Era" by Jay N. Giedd, *Developmental Cognitive Neuroscience,* December 2015.
- "The Amazing Teen Brain" by Jay N. Giedd, *Scientific American;* June 2015, *www.scientificamerican.com/article/the-amazing-teen-brain.*
- "The Development of Social Cognition in Adolescence: An Integrated Perspective" by Emma J. Kilford, Emily Garrett and Sarah-Jayne Blakemore, *Neuroscience & Biobehavioral Reviews,* November 2016.
- *The Teenage Brain: A Neuroscientist's Survival Guide to Raising Adolescents* by Frances E. Jensen, Harper Paperbacks, New York, N.Y., 2015.