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The Amazing Teen Brain; Science suggests ways to promote growth while preventing disaster

Nancy Shute. **U.S. News & World Report**. Washington: Feb 1, 2009. Vol. 146, Iss. 1; pg. 36

Abstract (Summary)

When Monique Ernst, a child psychiatrist and neurophysiologist at NIMH, uses functional MRI to watch teenage and adult brains engaged in playing a gambling game, she finds that the "reward" center lights up more in teens than in adults when players are winning, and the "avoidance" region is less activated in teens when they're losing. In fact, study after study has shown that one of the most powerful factors in preventing teenage pregnancy, crime, drug and alcohol abuse, and other seriously bad outcomes is remarkably simple: time with responsible adults.\n Neuroscientists have learned that addiction uses the same molecular pathways that are used in learning, most notably those involving the neurotransmitter dopamine.

Full Text (2250 words)

Behold the American teenager, a lump in a hoodie who's capable of little more than playing "Grand Theft Auto," raiding the liquor cabinet, and denting the minivan, thanks to a brain so unformed that it's more like a kindergartner's than a grown-up's. That's the message that seemed to emerge from the past decade's neuroscientific discoveries: that the brain, once thought to be virtually complete by age 6, is very much a work in progress during adolescence and *not* to be trusted. But experts now are realizing that the popular parental response--to coddle teens in an attempt to shield them from every harm--actually may be counterproductive.

Yes, teenagers make woefully errant decisions that factor big in the 13,000 adolescent deaths each year. And yes, their unfinished brains appear to be uniquely vulnerable to substance abuse and addiction. But they also are capable of feats of learning and daring marvelous enough to make a grown-up weep with jealousy. How they exercise these capabilities, it now appears, helps shape the brain wiring they'll have as adults. "You have this power you're given," says Wilkie Wilson, codirector of DukeLEARN, a new program at Duke University designed to teach teenagers how to best deploy their brains. Far from coddling the kids, he says, Mom and Dad need to figure out how to allow enough "good" risk-taking to promote growth and prevent wasted talent--while also avoiding disaster.

It can be a nerve-racking exercise. "These kids are such a crazy mix of impulsiveness and shrewdness," says Marcia Harrington, a survey researcher in Silver Spring, Md. She recalls the time she thought her then 16-year-old daughter, Alexandra Plante, had sleepover plans, but the girl instead ditched school and flew to Chicago to visit an acquaintance she'd met briefly during a family trip. The scheme was revealed only because bad weather delayed the flight home. Alex returned unharmed and has never conceded that the escapade was too risky. "She's going to be a great adult someday," says Harrington. "But, boy, there are moments that are terrifying." Further along the road to adulthood now, Alex has applied her daring spirit to becoming an emergency medical technician and volunteer for the local fire department, and to heading off to college 2,500 miles from home.

Still pruning. While society has known since forever that adolescents can be impulsive risk-takers, it wasn't until the 1990s, when MRI scans became a common research tool, that scientists could peek into the teenage cranium and begin to sort out why. What they found astonished them. The brain's gray matter, which forms the bulk of its structure and processing capacity, grows gradually throughout childhood, peaks around age 12, and then furiously "prunes" underused neurons. By scanning hundreds of children as they've grown up, neuroscientists at the National Institute of Mental Health have been able to show that the pruning starts at the back of the brain and moves forward during adolescence. Regions that control sensory and motor skills mature first, becoming more specialized and efficient. The prefrontal cortex, responsible for judgment and impulse control, matures last. Indeed, the prefrontal cortex isn't "done" until the early 20s--and sometimes even later in men.

Meantime, the brain's white matter, which acts as the cabling connecting brain parts, becomes thicker and better able

to transmit signals quickly. Recent research shows that this myelination process of white matter continues well past adolescence, perhaps even into middle age.

Now, dozens of researchers are studying how all these changes might affect adolescent behavior, and also shape adult skills and behavior, for good and for ill. The maturation lag between emotional and cognitive brain centers may help explain why teenagers get so easily upset when parents see no reason, for example; teens seem to process input differently than do adults. In one experiment, young teenagers trying to read the emotions on people's faces used parts of the brain designed to quickly recognize fear and alarm; adults used the more rational prefrontal cortex. Deborah Yurgelun-Todd, the researcher at McLean Hospital in Belmont, Mass., who led this work, believes young teens are prone to read emotion into their interactions and miss content. Therefore, parents may have better luck communicating with middle-schoolers if they avoid raising their voice (easier said than done) and instead explain how they're feeling.

Other experiments shed light on why even book-smart teenagers come up short on judgment: Their brain parts aren't talking to each other. When Monique Ernst, a child psychiatrist and neurophysiologist at NIMH, uses functional MRI to watch teenage and adult brains engaged in playing a gambling game, she finds that the "reward" center lights up more in teens than in adults when players are winning, and the "avoidance" region is less activated in teens when they're losing. There's also less activity in teens' prefrontal cortex, which adults use to mediate the "yes!" and "no" impulses from other brain regions. "The hypothesis is that there is this triumvirate of brain regions that needs to be in balance" in order to produce wise judgments, says Ernst, whether that's to wear a seat belt or use contraception.

Adult guidance. There is as yet no proven link between bright blobs on an MRI and real-life behavior, but researchers are hard at work trying to make that connection. In a 2005 study by Laurence Steinberg, a developmental psychologist at Temple University, teenagers in a simulated driving test were twice as likely to drive dangerously if they had two friends with them--and brain scans showed that the reward centers lit up more if teens were told that friends were watching.

A savvy parent might conclude that what's needed in the teen years is more guidance, not less. In fact, study after study has shown that one of the most powerful factors in preventing teenage pregnancy, crime, drug and alcohol abuse, and other seriously bad outcomes is remarkably simple: time with responsible adults. "It doesn't have to be parents, necessarily," says Valerie Reyna, a professor of psychology at Cornell University. But it does mean that teenagers are directly monitored by someone responsible so they have less chance to get in trouble. Reyna thinks adults also need to teach what she calls "gist" thinking, or the ability to quickly grasp the bottom line. Instead, she says, teenagers often overthink but miss the mark. When Reyna asks adults if they'd play Russian roulette for $1 million, they almost universally say no. Half of teenagers say yes. "They'll tell you with a straight face that there's a whole lot of money, and they're probably not going to die. It's very logical on one level, but on another level, it's completely insane."

If it's any comfort, the evidence suggests that teenagers' loopy behavior and combativeness is hard-wired to push them out of the nest. Adolescent primates, rodents, and birds also hang out with their peers and fight with their parents, notes B. J. Casey, a teen brain researcher who directs the Sackler Institute at Weill Medical College of Cornell University in New York City. "You need to take risks to leave your family and village and find a mate."

The revved-up adolescent brain is also built to learn, the new research shows--and those teen experiences are crucial. Neurons, like muscles, operate on a "use it or lose it" basis; a teenager who studies piano three hours a day will end up with different brain wiring than someone who spends that same time shooting hoops or playing video games. A 16-year-old who learns to treat his girlfriend with care and compassion may well develop different emotional brain triggers than one who's thinking just about the sex.

Only in early childhood, it turns out, are people as receptive to new information as they are in adolescence. The human brain is designed to pay attention to things that are new and different, a process called salience. Add in the fact that emotion and passion also heighten attention and tamp down fear, and teenagerhood turns out to be the perfect time to master new challenges. "You are the owners of a very special stage of your brain development," Frances Jensen, a neurologist at Children's Hospital Boston, tells teenagers in her "Teen Brain 101" lectures at local high schools. "You can do things now that will set you up later in life with an enhanced skill set. Don't waste this opportunity." (She was motivated to create the talks by her own befuddling experiences as a single mother of two teenage boys.)

Jordan Dickey is one teen who seized opportunity. As a 14-year-old high-school freshman, he asked his father for something unusual: a $26,000 loan to start a business. The Dickey family, of Ramer, Tenn., raised a few cattle, and Jordan had noticed that people paid a lot more for hay in square bales than for the same amount in less-convenient

round bales. After doing a feasibility study as an agriculture class project, Jordan convinced his dad to give him a three-year loan to buy a rebaling machine. He worked nights and weekends, mowing, raking, and rebaling; paid friends $7 an hour to load the bales into a trailer; and hired drivers to deliver the hay to local feed marts, since he was too young to drive. "It taught me how to manage my own money," Jordan says.

That's an understatement. Not only did he pay off the loan in one year, he made an additional $40,000. Now 17 and a senior, he has saved enough money to pay for a big chunk of college, much to his parents' delight. "He likes for the job to get done and get done right," says Perry Dickey, who owns an electroplating shop. "It was a big responsibility for him, and I'm glad he took the lines and produced."

Teens can apply the new findings to learn more without more study, notes Wilson, whose DukeLEARN program will be tested in ninth-grade health classes next year. Key points:

-- Brains need plenty of sleep because they consolidate memory during slumber.

-- The brain's an energy hog and needs a consistent diet of healthful food to function well.

-- Drugs and alcohol harm short- and long-term memory.

Teens' predisposition to learn has a bearing on the vexing issue of teenage drinking, smoking, and drug use. Neuroscientists have learned that addiction uses the same molecular pathways that are used in learning, most notably those involving the neurotransmitter dopamine. Repeated substance use permanently reshapes those pathways, researchers say. In fact, they now look at addiction as a form of learning: Adolescent rats are far more likely to become hooked than adults.

And epidemiological studies in humans suggest that the earlier someone starts using, the more likely he or she is to end up with big problems. Last month, a study tracking more than 1,000 people in New Zealand from age 3 to age 32 found that those who started drinking or using drugs regularly before age 15 were far more likely to fail in school, be convicted of a crime, or have substance abuse problems as an adult. "You can really screw up your brain at this point," says Jensen. "You're more vulnerable than you think."

A "safe" age? The new brain science has been used as a weapon by both sides of the drinking-age debate, though there is no definitive evidence for a "safe" age. "To say that 21 is based on the science of brain development is simply untrue," says John McCardell, president of Choose Responsibility, which advocates lowering the drinking age to 18. But there's also no scientific basis for choosing 18. The bottom line for now, most experts agree: Later is better.

Jay Giedd, an NIMH neuroscientist who pioneered the early MRI research on teen brains, is fond of saying that "what's important is the journey." Researchers caution that they can't prove links between brain parts and behavior, or that tackling adult-size challenges will turn teenagers into better adults. But common sense suggests that Nature had a reason to give adolescents strong bodies, impulsive natures, and curious, flexible minds. "Our generation is ready for more," insists Alex Harris, 20, of Gresham, Ore., who, with his twin brother, Brett, writes a blog and has published a book urging teens to push themselves. Its title: "Do Hard Things."

Growing a Grown-up Brain

Scientists have long thought that the human brain was formed in early childhood. But by scanning children's brains with an MRI year after year, they discovered that the brain undergoes radical changes in adolescence. Excess gray matter is pruned out, making brain connections more specialized and efficient. The parts of the brain that control physical movement, vision, and the senses mature first, while the regions in the front that control higher thinking don't finish the pruning process until the early 20s.

Gray matter becomes less dense as the brain matures.

More dense

Less dense

Frontal lobe: Planning, emotional control, problem solving

Temporal lobe: Memory, hearing, language

Occipital lobe: Vision

Parietal lobe: Spatial perception

Gray matter: Nerve cell bodies and fibers that make up the bulk of the brain's computing power.

Age:

Gray matter density

Adolescence

5

20

[Illustration]
[Picture omitted]: -Nitin Gogtay et al. Photograph by David Arky for USN&WR

[Illustration]
[Chart omitted]: Growing a Grown-up Brain -Source: "Dynamic mapping of human cortical development during childhood through early adulthood," Nitin Gogtay et al., Proceedings of the National Academy of Sciences, May 25, 2004; California Institute of Technology; STEPHEN ROUNTREE--USN&WR

[Illustration]
[Picture omitted]: GOOD RISK. Alex Plante began volunteering for the local fire department in 11th grade. -JEFFREY MACMILLAN FOR USN&WR

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