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## Inside their heads: Rebellious teen behavior could stem from biology

By Jodi Mailander Farrell

A memo to parents of teenagers: Don't blame your angst-ridden Rebels Without a Cause as they dive into a summer of sleeping in and testing boundaries. Blame their brains.

Scientists used to believe that teenage brains were like adult brains. Now we know differently. New research shows the prefrontal cortex -- the area that controls judgment, organization, emotions -- is largely immature in a teenager's head. So when he or she forgets the list of chores you just told him or explodes when you ask her to turn down the music, there's actually a scientific explanation.

'Kids are the worst between 15 and 17 -- I call those the `hell years,' " says Becki Eikevik, a Parkland mother of seven who, with husband Ike, has survived raising five teens and is about to embark on another wild ride with her two youngest, twins Keith and Todd, 12.

**Deborah Yurgelun-Todd**, an associate professor at Harvard Medical School who has led groundbreaking research on the teen brain, says parents shouldn't assume that because they've ``laid out an argument or presented an idea that teenagers are interpreting it the same way you do. The frontal cortex is continuing to develop, and if you don't have the neural structure in place, the adolescent cannot really think things through at the same level as an adult."

The good news: Teenagers' brains are still pliable. What happens during these critical years can arguably shape teenagers into adults -- and possibly turn around a life headed in the wrong direction.

Many parents have embraced the zero-to-three movement, the recognition that the first three years of a child's life are critical in brain development. They've bought classical music, flashcards and mobiles for babies.

It's easy to fawn over a sweet-smelling infant, but a teenager with attitude can be another story. Yet neuroscientists say the greatest spurts of brain growth after infancy occur just around adolescence. "I would not want to take attention away from those early years because they're critical, but we need to have recognition that adolescence is an equally important time of life," Yurgelun-Todd says. ``We need more focus on teaching our kids skills for decision-making, planning and organizing. Where this could really make a difference is in the juvenile justice system. There are kids who can be reversed and get back out there and function well."

### HOW THE BRAIN GROWS

The brain of a baby grows by over-producing brain cells, or neurons, and connections between brain cells called synapses. The infant brain starts to prune synapses back around age 3. The process is compared to pruning a tree: By cutting back weak branches, others flourish.

Scientists have long known about the early years of synapse over-production, but were surprised to find evidence of a second spurt of synapse formation in the frontal cortex just before puberty, followed by a pruning back in the teen years.

The prefrontal cortex, where all this activity is occurring, is just behind the forehead. It acts as the CEO of the brain, exerting control over planning, working memory, organization and regulating mood. As the area matures, teens can reason better, develop more control over impulses and make judgments better.

Teens who exercise their brains by learning to organize their thoughts, weigh their impulses and understand abstract concepts are laying their neural foundations. In other words, do you want your teen studying and exploring art, music and sports or lying on a couch watching TV?

"The brain is like a muscle -- the more you exercise it, the stronger it gets," says Alan Delamater, a professor of pediatrics and psychology at the University of Miami's Mailman Center for Child Development. "They may have an adult-like body, but inside these teenagers are kids."

## **WHY WE DISAGREE**

When adults and teens don't agree, it may be due to biology more than rebellion. In one study led by Harvard's Yurgelun-Todd, a small group of adults and teens were shown standardized pictures of fearful faces. All of the adults correctly identified fear in the facial expressions, but many of the teens guessed wrong at least once, picking emotions such as anger, shock or discomfort. Brain scans showed the teens relied more on the primitive emotional center of the brain and less on the region tied to judgment than adults did.

"When I started this work, my kids were 7 and 5. It was a non-issue," laughs Yurgelun-Todd, whose children are now 17 and 15. "Everybody would come up to me and say, 'My teenager is driving me crazy' and I didn't know what they were talking about."

That's changed -- and so has Yurgelun-Todd's parenting. She and her husband, a psychiatrist, are "more on the conservative side" when it comes to curfews and keeping tabs on their kids.

"We try to keep them engaged in sports and activities, so they're not just hanging out," she says. "They would complain that we're overly controlling, but I do think that part of the problem is that our culture has become too permissive."

"There's this assumption that teenagers can decide for themselves. Parents will say, 'Well, they need to learn to choose well.' I agree, but how do they do that if they don't have the tools yet?"

Adding to the emotional liability: a burst of hormones coursing through kids as they enter puberty. The hormones affect not only a teenager's sex drive, but also lead to temporary aggressiveness and moodiness, researchers believe.

"Teenagers are awash in hormones and that affects their brains and behavior and ability to concentrate," says Andrew Brickman, a clinical researcher who heads a Miami-Dade County health initiative called HealthConnect. Spearheaded by The Children's Trust, part of the project aims to address kids' mental and physical health by placing teams of nurses, health aides and social workers in public schools.

"There's probably no way to avoid conflict," Brickman says. "It's the adolescent's job to keep pushing the boundaries. It's the parent's job to make sure those boundaries don't put a child in a place that is dangerous."

## **RISKY BUSINESS**

Teens, we know, love to push the boundaries. Driving without a seat belt, sneaking out at night, drinking alcohol until they puke or pass out.

Some researchers think teens' risky choices tap into neurons that can produce feelings of intense pleasure. They are particularly vulnerable to drugs and alcohol because the balance of chemicals in their still-developing brains can be altered.

"A typical teenager may be motivated to do well in school because it makes him feel good. The rewards are internal," Brickman said. "But if he's smoking or using cocaine or other types of drugs, those drugs are hitting the opiate receptors in the brain. The normal stimuli are insufficient to fire it anymore. To get those kinds of pleasures, they have to turn to using drugs. When not taking drugs, they sink into depression and perhaps even experience pain. Some of those changes can be permanent and very, very harmful."

Just because there's a neurobiological explanation for irrational teen behavior doesn't rule out environmental and social influences -- and it doesn't mean teens shouldn't be held accountable.

When a series of students at Palm Springs Middle in Hialeah began cutting their arms and necks with razors and box cutters earlier this school year, the school, fearing an outbreak of copycat behavior, immediately moved to have the students involuntarily committed to a psychiatric hospital for three days under Florida's Baker Act.

"It demanded a no-nonsense response," says Liz Steele, a TRUST counselor at the school. "Some of the kids needed serious counseling and medication. Some were followers and wannabes. It was high drama. It shows just how easily kids this age can be overcome by emotions and make poor decisions."

In the fall, 140 students at Palm Springs will take part in a Youth Empowerment Seminar that will teach them breathing techniques, yoga and exercises to help them manage stress and communicate better.

Although research is still needed, most scientists believe human brains aren't fully formed until the early 20s.

"I don't think anybody would say, 'Hey, you're done at 17,'" Yurgelun-Todd says. "The question is, 'Are you done enough?' Should we be sending people this young to war? Giving them licenses? Allowing them to be lifeguards? We give a fair amount of responsibility to people in their late teens. If they're not fully formed, is that OK?"

## Research on teens

- **Risky business:** When contemplating risky decisions, teens show less activity in regions of the brain that regulate decision-making, compared with adults, according to a new National Institute of Mental Health study.
- **Emotional highs:** A series of MRI studies at Harvard's McLean Hospital scanned brain activity in teens and adults while they identified emotions on pictures of faces on a computer screen. Young teens, who generally misinterpreted the emotions, activated a brain center that mediates "gut" reactions, while adults used the frontal lobe, leading to more reasoned perceptions.
- **Learning languages:** Fiber systems influencing language learning grow more rapidly before and during puberty, and fall off shortly after, according to a study at the University of California at Los Angeles. The finding reinforces studies on language acquisition that show the ability to learn new languages declines after age 12.
- **Catching zzzzzs:** Research at sleep labs at Stanford and Brown universities show that teens need more sleep than they did as children, and their biological clocks tell them to catch those extra winks in the morning. Most teens need at least nine hours of sleep a night, possibly because hormones that are critical to growth and sexual maturation are released mostly during sleep.

Teens who don't get enough sleep miss out on the phase of sleep that boosts memory and learning. Without enough REM sleep, teens become cranky and depressed; their memory and judgment are impaired; and they perform poorly on tests of reaction time.

- **Moody blues:** The hormone THP, which serves to calm adults and younger children in stressful situations, does exactly the opposite for those going through puberty, say scientists at the State University of New York's Downstate Medical Center. Instead of calming a person, it appeared to increase a teen's stress. The theory is that adolescent "raging hormones" are to blame.
- **Unhealthy habits:** Most American teens have exercise and diet habits that put their health at risk, according to a study in the February issue of the *American Journal of Preventive Medicine*. The study found that of 900 kids, ages 11 to 15, about 55 percent didn't meet physical activity guidelines; and only 11.9 percent ate enough fruits and vegetables.