# Inside The Teenage Brain

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*by Judith Newman*

“I would rather give birth to a baby elephant than raise a teenager again. It would be less painful,” says Renee Cassis Hoering of New York City. “I cannot believe that my darling, sweet little girl has turned into a 16-year-old stranger who just wants money from me all the time.”

After seeing his son through the teen years, Bob Mittelsdorf is in favor of the Mark Twain approach to child-rearing: “When a child turns 12, he should be kept in a barrel and fed through the bung hole, until he reaches 16…at which time you plug the bung hole.”

The intensity. The sullenness. The drama. And it isn’t only the rebellious kids who suddenly turn on us. When my friend’s son — a straight-A student and all-around sweetheart — recently ended up in the hospital getting his stomach pumped because he went out drinking with friends for the first time and had no clue how much was too much, that’s when I realized: There is just no predicting. Even for the most responsible kids, there is always that combustible combination of youth, opportunity, and one bad night.

As recently as 15 years ago, parents (and even scientists) threw up their hands and cried, “Hormones!” when asked why our children become so nutty around the time of adolescence. Certainly an unholy passion for Justin Bieber or Selena Gomez doesn’t help, but it’s hardly the whole story. For that you have to turn to science.

In the past few years, research has shown that the brain of a teen really is different. Two technologies — PET scans (positron emission tomography) and fMRI (functional magnetic resonance imaging) — have enabled us to study how the brain changes over time. What researchers have shown is that the teenage brain is still very much a work in progress and functions quite differently from an adult’s. True, there are areas (particularly those dealing with motor control and hand/eye coordination) that are as well-honed as they will ever be. (That is one reason why your teen can already whip you at computer games.) But there are other areas — not surprisingly, the ones responsible for things like planning ahead and weighing priorities — that continue to develop well into our 20s. Which is something to remember the next time you find your daughter posting Girls Gone Wild–ish videos of herself on YouTube and failing to realize that this footage will be available to the people who may be interviewing her not that many years from now at some white-shoe law firm.

Truth is, the teenage brain is like a Ferrari: It’s sleek, shiny, sexy, and fast, and it corners really well. But it also has really crappy brakes. Here’s what’s going on under the hood.

**Why Is She Forgetting So Much of What She Knew?**

At birth, our brains have an operating system loaded and primed for growth. In a baby, each neuron (a cell that transmits electric signals) has around 2500 synapses; that increases over the next three years or so to around 15,000. These synapses are the wiring that allows our brains to send and receive information. Until recently, scientists thought this huge surge in brain wiring happened only once, when kids are young. Wrong. A study of 145 kids and adolescents scanned every two years at the NIH has shown that there's another huge surge right before adolescence, followed by a process of "pruning" those connections in a kind of use-it-or-lose-it strategy. In other words, says Jess Shatkin, assistant professor of child and adolescent psychiatry and pediatrics at the NYU Child Study Center and host of the Sirius/XM Radio show About Our Kids, "If you're a chess player or an athlete, the areas of the brain responsible for those skills will continue to develop — while other skills will fade away."

The skills you practice as a child and pre-teen become much sharper in the teenage years; and those practiced reluctantly, if at all, will diminish on your brain's hard-disk drive. "The brain is very efficient, allowing you to become adept at the life skills you're going to use — which is why these are the years to set good work habits in place," notes Ellen Galinsky, president of the Families and Work Institute and author of Mind in the Making: The Seven Essential Life Skills Every Child Needs. Adds Shatkin, "This synaptic pruning in a sense makes you become the person you'll ultimately be."

**If He's So Smart, Why Is He So Clueless?**

The phone rang at 2 a.m. Steven Weinreb, a physician in Hartford, Conn., answered, his heart pounding. It was two years ago, and his 18-year-old son, Jeff, was coming back from one of his band's concerts. What was wrong? Car accident? Drug overdose? "Dad, we're in New Jersey. We're lost. I think we've crossed the river twice. What do I do?" Jeff said.

"This is a boy who had it together enough to book dates for his own band; he had a GPS in his car; he had maps; he could at a gas station," Weinreb says. "Instead, he called me at two in the morning and practically gave me a heart attack. Oh, did I mention he got into Brown?"

Weinreb's son is Ivy League, but his prefrontal cortex probably isn't — yet. The frontal lobes, and particularly the prefrontal cortex, are one of the last areas of the brain to develop. Researchers now believe that the prefrontal cortex — responsible for things like organizing plans and ideas, forming strategies, and controlling impulses — is not fully developed until the late 20s.

Dopamine levels are also not yet at optimal levels during adolescence. Dopamine is the chemical messenger that allows us to do constant triage in day-to-day life, so we can figure out what to pay attention to and what is background noise. Without adequate levels, life can be a disaster. It's like: I'm crossing the street. There's a truck approaching me and…oh, look at the cute doggy!

**Why Can't She Rise and Shine, Darn It?**

Beginning in puberty and continuing into the early 20s, adolescents need from 8.4 to 9.2 hours of sleep on average a night, compared with 7.5 to 8 hours for adults. Perhaps even more critical — and obvious to anyone who has had to drag a once-perky kid out of bed by the heels at 7 a.m. — the circadian rhythms of teenagers shift.

In a pair of related studies published in 1993 and 1997 by Mary Carskadon, a professor of psychiatry at Brown University and director of the Sleep Research program at Bradley Hospital in Rhode Island, Carskadon and colleagues found that more physically mature girls preferred activities later in the day than did less-mature girls and that the sleep-promoting hormone melatonin rises later in teenagers than in children and adults. Translation: Teenagers are physically programmed to stay up later and sleep later.

It's no surprise, then, that previous research has shown that up to 20% of high-schoolers fall asleep during the first two hours of school. According to a study done by Kyla Wahlstrom at the Center for Applied Research and Educational Improvement at the University of Minnesota, later start times for high school students would be beneficial. Wahlstrom collected data from two districts in Minnesota that moved the start time for high school about an hour later; there was a significant reduction in dropout rates and depression.

**Why Is He So Quick to Flip Out?**

You're not imagining that teenagers often overreact to simple requests and misinterpret seemingly innocuous comments. Physiologically they may be less able than adults to accurately interpret facial expressions and the inflection in your voice.

University of Utah professor Deborah Yurgelun-Todd and a team of collaborators have been studying brain development. In an initial study at the McLean Hospital in Belmont, Mass., they wanted to see how teenagers registered emotions compared with adults. They hooked up 18 children between the ages of 10 and 18 to an fMRI machine and showed them photos of people in different emotional states. When presented with a photo of a woman and asked what emotion she was registering, 100% of the adults said "fear," which was correct. Only 50% of the teenagers correctly identified that emotion. Moreover, the teens and adults used different areas of the brain to process what they were feeling. Teens rely much more on the amygdala, a small almond-shaped region in the medial and temporal lobes that processes memory and emotions, while adults rely more on the frontal cortex, which governs reason and forethought.

This may explain the impulsiveness of some teens that has made headlines this year — like the tragic incident in September in which, allegedly, a Rutgers University student posted a video of his roommate kissing another boy, resulting in the roommate's suicide. Were the students who posted the video incapable of considering the ramifications of their act? And what about the boy? One can't help thinking that, with teenage lack of perspective, he imagined his family shamed and his life ruined — but could not imagine the agony his death would cause his parents.

So it is, too, with tragedies like Columbine. "There have always been adolescents who feel enraged, who want to get even, who feel ostracized. The adolescent brain is less able to control those stresses," says Daniel Weinberger of the National Institute of Mental Health. "The difference is that while 50 years ago there might have been punches thrown, now there are automatic weapons. You put one of those in the hands of an immature prefrontal cortex, and it is more likely to go off."

## 4 Stay-Sane Strategies

*You will survive. We promise. These tips can help.*

- Remind a distraught child that things will get better. Often during a rough spell, a teenager sees only his or her little world and can't imagine a tough situation changing. "This is where you have to try and modulate the impulsiveness," Shatkin says. "Give empathy but constantly reinforce adult perspective."
- Ask your teen to come up with his own solution. "If your child is chronically 'losing' homework, for example, ask what ideas he has for making this better," Galinsky advises. "Be open to trying different ideas. This feeds into the teen's desire for autonomy without getting into a blame game."
- Educate your child about sleep. Tell your kid you're not trying to enforce a curfew just to be annoying. As little as 40 minutes less sleep a night can cause difficulties in school, including falling asleep in classes.
- Don't excuse bad behavior. Understanding the complexities teenagers face isn't the same as saying, "It's fine if my kid is feral." It's not. "We aren't saying teenagers can't be responsible, can't think ahead," Weinberger says. "It's just that their level of brain development makes it more difficult."