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Newsletter

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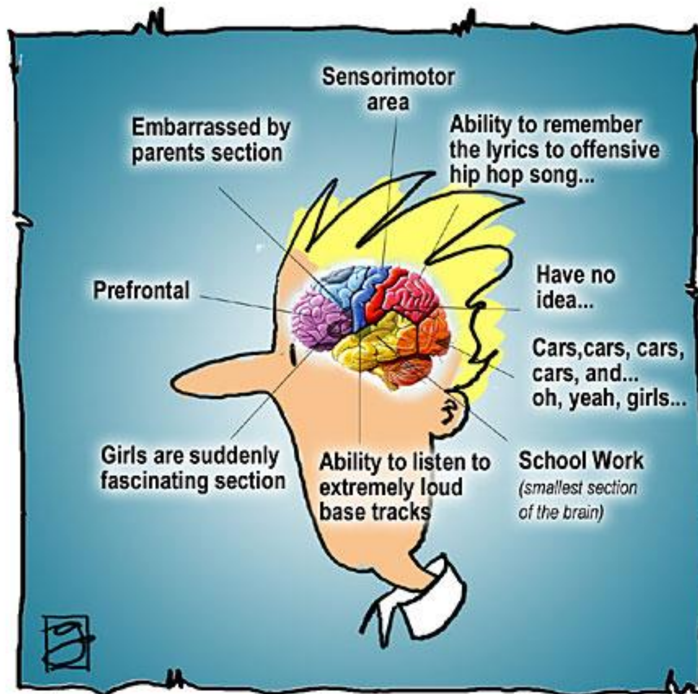
The Teenage Brain



Anatomy of a Teenager's Brain

What we now know about the teenage brain may surprise you. The study of the brain (neuroscience) has made great strides over the past decade due to the development of magnetic resonance imaging (MRI) that provides accurate pictures of the living, growing brain and of molecular biology.

We once thought that the brain was fully formed by the end of childhood, but research has shown that adolescence is a time of profound brain growth and change. We now know:

The greatest changes to the parts of the brain that are responsible for impulse-control, judgement, decision-making, planning, organization and involved in other functions like emotion, occur in adolescence. This area of the brain (prefrontal cortex) does not reach full maturity until around age 25!

Children's Hospital Boston neuroscientist Frances Jensen, MD, and neurologist David Urion, MD, are interpreting the outpouring of basic and clinical research to explain the unique features of teenagers' brains and, by extension, shedding light on the mystery of adolescent behavior.

Learning curve

Because an adolescent brain is still developing, it retains much of its plasticity, which allows it to be molded by the environment. This malleability boosts teenagers' abilities to learn, make memories and retain information. "They're like sponges," says Jensen. "While they're not learning quite as fast as young children, who can learn three new languages flawlessly because of plasticity, they still have quite a bit of that skill set left over, and more than the adult."

While all teens have turbocharged learning skills and fantastic memories, girls' and boys' brains develop at different rates; girls peak at age 12 to 14, about two years before boys. Naturally, this influences how ready teens are to learn and be challenged to their greatest extent. "Schools may be missing a window for each gender," says Jensen. "Things like high-level physics are being taught to teens when they're 16, but girls may be able to learn it earlier. With this new neuroscience information, we could address this kind of gap with the next generation."

Bad behaviour

Although teens' brains are superior in some ways, they're distinctly immature in one key area. The last part of the brain to fully connect up—well past the teenage years—is the frontal lobe, which houses judgment, insight, dampening of emotions and impulse control.

Since it isn't fully developed, there's a cognitive chasm between coming up with an idea and being able to decide if it's actually a good one. "This begins to explain why these smart little whippersnappers are so incredibly risk-taking and irrational," says Jensen. "These are people with very sharp brains, but they're not quite sure what to do with them."

Interestingly, the faculty of insight—the ability to judge one's own actions and predict consequences—develops in the frontal lobe in stages: First as the ability to be objective and judge others' actions and later as subjective analysis and to be able to consistently think, 'If I do this, something bad might happen.' "It's fascinating that teens can see their friend about to do the wrong thing and say, 'Don't do that!,' whereas they can't yet recognize their own behavior as dangerous," says Jensen. "They really can—and should—act as each others' keepers."

Sleep and learning

If you've ever seen a teenager who literally can't keep his eyes open, you might wonder if he's lazy or just completely disinterested. Turns out it's neither. Researchers have found that sleep cycles naturally shift forward during adolescence for biologically programmed reasons, and sleep plays a crucial role in a teen's ability to learn.

These differences in sleep cycles may have big implications for the timing of optimal learning periods, as researchers have discovered that the ideal time for learning starts two hours after a person's biologically set wake-up time. "This means that the ideal high school would start in late morning and end in late afternoon," says Urion. "Unfortunately, this isn't the norm. Obviously, it would be much better to present new material to people when they could actually learn it, and early morning isn't the best time for teenagers to conjugate Latin verbs."

In getting up early enough to avoid the tardy slip, teens are struggling to function on a sleep cycle that's out of synch with their internal clocks, and living with a constant sleep deficit. "This makes their bodies rebel and try to get them to catch up with sleep on weekends," Urion says. "The problem is that it gets their whole machinery more off-line and the cycle goes on and on. It's a huge problem and one that continues, as best we can tell, through college."

Drugs, alcohol and addiction

Plasticity is paradoxical: Just as it allows teens to learn and retain a lot of information, it also makes them susceptible to negative influences. "If a teen's nervous system sees alcohol or a drug, their synapses have locked onto that drug and form strong connections that underlie their affinity for it," Jensen says. The process of addiction actually uses the same neurochemistry as general learning. "Specific neuronal connections readily form from exposure to stimuli, like drugs and alcohol, and become irreversibly imprinted on their brains," she says. That means that when teens drink or smoke, they're laying down a lasting sensitivity that can easily lead to addiction.

Teens suffer longer-lasting consequences from alcohol; it dampens down learning by blocking synapses from sending any signals, and in excess, kills vastly more brain cells in teens than adults. This is especially problematic when it comes to binge drinking. "If a 17-year-old pounds down Jack Daniels with uncle Joe, uncle Joe will have a wicked hangover, but will function in a few days," says Jensen. "But that teenager has a low threshold for brain injury and may not bounce back 100 percent."

Similarly, marijuana's negative effects are more long-lasting: Its active chemical blocks learning at the cellular level at multiple points—in the very early and later stages of making lasting memories. "What a teenager does on the weekend is actually still with him when he takes a test on Thursday," Jensen says. "And in the meantime, he's been trying to study with what's essentially a self-induced learning disability."

Too much information

Since teenagers are so susceptible to their environments, one of neuroscience's hot button topics is exploring what effects modern society has on their brains. A big concern is media messaging, especially advertisements. "Many companies, including big tobacco, know that in order to grow their markets they have to get to people who have a vulnerability that adults don't have," says Urion. "They depend on this neurobiology and target teens. So we need to consider the impact of media on children, not just from a social standpoint but from a neurobiological one."

Another area ripe for exploration is how teen brains deal with multi-tasking and sensory overload, since they're constantly interacting with fast-paced, sensory-filled stimuli from computers, TVs, Sidekicks, text messages and video games. "Brains, evolutionarily, have never been subjected to the amount of cognitive input at the rate that's happening today," says Jensen. "Modern teenagers have 25 things coming at them all the time, and this overload of stimulus could be altering the way their brains are getting wired. The effects may be mixed, and we might be developing new abilities, as we do for any newly acquired skill. But we don't know if we're sacrificing another skill set to become proficient multi-taskers."

Jensen and Urion are busily bringing these messages to teachers, parents and teens themselves through lectures at high schools and institutions like Boston's Museum of Science. "We want to help teens understand their unique status and begin to consider how to manage this increasingly complex environment," Jensen says. "This is the first generation to have access to information about how their own brains are developing and the fact that they're living through this incredibly precious period. It truly is a brave new world."

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