Deciphering the Teenage Brain

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As many parents can attest, the teenage years are a time of trial and triumph, a time for learning and adapting, and, for many teens, a time for risk-taking. This latter characteristic can be especially disturbing to parents and teachers. No matter their intelligence or level of engagement with peers and parents, teenagers simply make perplexing, disturbing, and sometimes dangerous decisions. Why are they such caldrons of contradiction?

"Teens are in a discovery mode," says Frances Jensen, MD, an HMS professor of neurology. "They're experiencing new things, and their brains are developing accordingly. There's simply a lot going on in their brains."

Jensen, who directs epilepsy research at Children's Hospital Boston, found herself taking a professional interest in the developmental arc of the teenage brain as she watched her two sons reach adolescence and "morph into other beings." That domestic prod led her to share her knowledge and research findings in public forums with parents and teachers as well as teens.

Throughout the past decade, a growing number of scientists have been using powerful technologies like functional magnetic resonance imaging (fMRI) to investigate how young brains change. This research has shown that for teenagers, brain cells rapidly form new connections with other neurons, allowing information to move quickly and learning to accumulate. This high degree of connectivity does not exist for all regions of the teenage brain, which may help explain teens' impulsive behavior and poor decision-making. Studies have, in fact, shown that the adolescent brain is only about 80 percent developed, findings that Jensen says make it clear that teenagers are not just "young adults with fewer miles."

Not Fully Online

From childhood through adolescence, the brain's billions of neurons and synapses form and re-form connections, giving it the plasticity needed for learning. Throughout the development continuum, says Jensen, the brain is like a sponge, soaking up experiences. That is why children and teenagers can master such skills as foreign languages and musical instruments more easily than adults can.

The teenage brain matures from back to front. The posterior regions, especially those above the spinal column, are largely responsible for motor control. Their earlier maturation helps account for the quick acquisition of locomotion and other movement skills by young people. Maturation of many sensory regions also occurs early, enabling a growing person to learn from the surrounding world. The maturing of the forward regions of the brain, particularly the frontal lobe, doesn't occur until late adolescence or early adulthood; some researchers say the region's maturation may not be complete until age 30.

The frontal lobe is the seat of executive function, a term for the cognitive processes that allow us to plan, make decisions and judgments, formulate insight, and assess risk. The delayed maturation of connections to the frontal lobe, Jensen says, contributes to teenagers' risk-taking. "Their frontal lobes," she says, "are simply not yet fully online."

The percentage of neurons in the adolescent brain that are myelinated is also lower than that in the adult brain. Myelin is the insulating coating that helps neurons pass signals along rapidly. As the brain matures, the number of myelinated neurons grows, forming a dense mass—the brain's white matter. To underscore the developmental track that myelination takes, Jensen points to fMRI studies that show myelinated cells beginning to appear in the brains of people in their early twenties.

Statistics also bear out the link between teenagers and such health- and life-imperiling behavior as dangerous driving, unsafe sex, poor dietary habits, and experimentation with alcohol and drugs. One area in which teens' recklessness and inexperience collide is motor vehicle crashes: Per mile driven, 16- to 19-year-olds are four times more likely to crash than older drivers. According to the U.S. Centers for Disease Control and Prevention, motor vehicle crashes are the leading cause of death among U.S. teenagers.

The Double-Edged Sword of Learning

The ease of learning that most teens enjoy, however, can carry a steep cost: addiction. "The brain builds itself as it responds to experiences," Jensen says. "With teens who experiment with drugs, this can result in addiction. It's the same pattern as learning—we want more, more, more."

At play in this scenario is the brain's limbic system—its pleasure-and-reward hub. This region matures earlier than the frontal lobe, which may explain in part why teenagers who experiment with drugs and alcohol often relish the attendant "highs" but fail to appreciate fully their associated risks. Two studies from 2004 support this supposition. Researchers at Emory University found that reward circuits involving pleasure and addiction in teen brains are hyperactive compared with adults, suggesting that teens may have a greater biological sensitivity to reward than adults do. Similarly, investigators with the National Institute on Alcohol Abuse and Alcoholism found that the teen brain's nucleus accumbens, part of the limbic system thought to play a central role in the reward circuit, responds to reward at a level similar to that found for adults, whereas teenbrain frontal lobes respond at a level similar to that of younger children.

No Free Pass

The challenge for parents, educators, clinicians and others who deal with teenagers is to determine whether their exasperating behavior is just the stuff of growing up or whether their moodiness and lack of judgment are indicative of a larger, perhaps pathological, problem. Many mental disorders begin to manifest during adolescence, including schizophrenia, anxiety, depression, eating disorders, and drug and alcohol abuse.

“The key,” says Jensen, “is to be aware of what’s going on with your kids. Teens today are exposed to more stress than ever before, including drugs, alcohol, and violence. We all have to be mindful.”

What is interesting, says Jensen, is that most adolescents are eager for information about how their brains change during their teen years. She adds, “Because of the amount of research being conducted and the findings that are available, these teens are the first generation to really know what’s going on in their brains. We need to tell them what the warning signs are for abnormal, risky behavior. This is a time of self-discovery, and these kids are ripe for this type of information.”

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