Medical Xpress

Teen behavior, as explained by a neuroscientist

April 2 2024, by Julie Rafferty

Credit: Unsplash/CC0 Public Domain

Teenagers are known for their sometimes-unpredictable behavior. One moment they're mature and clear-thinking, and the next they're irrational or engaging in risky behavior. Neurologically speaking, they can't help it, though that's probably of little comfort to parents' frayed nerves. Still, it might help to understand that scientists theorize that three interconnected processes of adolescent brain development are the culprit.

"There is a lot going on in adolescence, not only in terms of hormonal changes, but also in the development of the brain's structure, chemistry, and synapses, which are the points at which nerve cells are talking to each other," says Ayesha Sengupta, research assistant professor of neuroscience at Tufts University School of Medicine.

While there is still much more research to do, the science so far points to ways adolescent brain development influences how teens think and behave in ways that are different from adults.

One such difference has to do with how the brain stores, or maps, what's happening in our environment. "Because environmental mapping of how we experience the world is so impactful in adolescence, different generations may develop different environmental maps," she says.

"Events may be unique to that time. Gen Z may have much greater concerns and awareness around school shootings and climate change than prior generations, for example, because they are experiencing their effects more than prior generations did as teens."

Brain development order

The most complex section of the brain, particularly in humans, is the prefrontal cortical structures. This area manages higher order thinking processes and executive functioning. It's the section of the brain that helps us plan, weigh incoming information, and make informed decisions. It controls how we behave and interact with others. These are the last structures in the brain to mature, and most of that happens in adolescence and our early 20s.

A section of the brain called the amygdala, along with other structures in the temporal lobe of the brain, are thought to be more in charge during adolescence because they develop earlier. These sections of the brain trigger emotions and immediate responses to stimuli.

"For survival, it's important to have quick reactions, which can be triggered by the amygdala. For example, if you see a piece of rope on the ground, the amygdala could cause you to assume, 'Oh, that's a snake!'" says Sengupta. "Overall, it's important to also have that more reflective ability that occurs in the prefrontal cortex, which would help you see the rope is not a snake and calm you down."

During adolescence, teens are more likely to react impulsively because subcortical structures such as the amygdala have matured while the prefrontal cortex is still developing. The connections between the frontal cortex and the amygdala and related regions of the brain also are not yet fully formed.

Brain chemistry

Sengupta and other scientists theorize that adolescence is a time when both brain structural and chemical development is incomplete, leading to less inhibition and more intense emotions. Two neurotransmitters—GABA and glutamate—are the primary chemical messengers of signals between nerve cells in the brain. Other neural signaling chemicals, including serotonin, dopamine, norepinephrine, acetylcholine, and hormones also exert changes in brain activity and can modulate the effects of GABA and glutamate as well.

"One hypothesis is that there is less GABA, which is an inhibitory transmitter, in the adolescent brain," Sengupta says. "We also believe there are different levels or functions of the modulating neurotransmitters in the adolescent brain than the adult brain."

Sengupta's own research looks at communications in the brain's amygdala and the prefrontal cortex, examining the role of glutamate and how it may be modulated by dopamine and serotonin. "One thing we see across species in adolescence is that when an adolescent learns a simple fear memory—for example, in rodents we test the effects of learning and unlearning the association of a tone paired with a negative stimulus—it's much harder to extinguish that fear than if it is learned as children or adults," she says.

Sengupta's work is focused on fear and reward learning, and why such emotional learnings are less easy to extinguish in adolescence. She's examining what happens when positive and negative stimuli are presented together in the same environment to compete for decision making outputs in adolescence.

Synaptic pruning and environmental maps

Cell-to-cell communication in the brain at the level of individual synapses is also under development in the teen years. In the aforementioned fear extinction studies, adult rodents demonstrating a greater ability to change than adolescents correlates with something in their synaptic plasticity, or the ability of neurons to modify their connections, differently in adult brains than in teen brains.

"During adolescence, we also see something called synaptic pruning, where the brain removes synapses it doesn't need," Sengupta explains. "This could be particularly relevant since adolescence is a period characterized by new experiences, novelty seeking, learning what the effects of things in your environment will be, and navigating the world more independently."

The emotional pressures social media places on teens are also far greater than those experienced by prior generations, and so they experience them far more intensely. Sensation seeking and novelty seeking may occur more in adolescents who are learning their limits without having the regulating effects of a more developed prefrontal cortex or brain chemistry, she adds. "Everything feels more in adolescents. Therefore, it is more memorable, and makes adolescents more vulnerable to its effects."

Part of an adolescent's neurological makeup—such as a predisposition to anxiety or certain mental illnesses—will be inherited. Many of these illnesses first manifest themselves in adolescence.

"Some mouse models of human genetic traits demonstrate that inherited anxious behaviors are already apparent at adolescence, such as reluctance to explore, and freezing behaviors when faced with negative stimuli," Sengupta says.

Learned fearfulness also occurs throughout life. But experiences are felt more deeply and shaped more intensely in adolescents and seem to be less likely to be "unlearned" than if those experiences occur as children or adults, she adds.

"Adolescents are learning their limits while their executive functioning, brain chemistry, and synaptic connections are in flux," Sengupta says. "This impressionable window of new, salient experiences may be why we see more auto accidents, eating disorders, and suicides during this time-period."

U.S. courts are increasingly acknowledging that adolescent and adult brains are quite different as well, changing the way the criminal legal system handles teenage offenders. As of 2023, 27 states and the District of Columbia have banned the practice of sentencing children and teens under the age of 18 to life without parole.

While we hope that most teenagers make it to adulthood without major problems, families, schools, and increasingly the courts, are recognizing that "adolescence is a vulnerable period of brain development," she concludes.

Provided by Tufts University

Citation: Teen behavior, as explained by a neuroscientist (2024, April 2) retrieved 2 May 2024 from https://medicalxpress.com/news/2024-04-teen-behavior-neuroscientist.html