Conventional wisdom has always placed the blame for teen angst on hormones, but neuroscience developments within the past 10 years have revealed that human brain development is actually a bigger instigator of adolescent unrest. Scientists used to believe that the brain was almost fully developed by age 6, the age by which the brain has grown to 95 percent of its adult size. They also thought the brain underwent its most rapid development of neural connections between birth and age 3. But thanks to the enhancement of magnetic resonance imaging (MRI) technology, which allows researchers to take 3D images of the brain without the use of radiation, we’re now discovering that the human brain experiences a second explosion of growth during early adolescence.

Most of the brain development occurring during the teenage years takes place in the frontal lobes. One of the last areas to fully mature is called the prefrontal cortex, which functions as the “CEO” of the brain. This “executive center” controls how you experience an emotion, assess risk and keep track of time. It’s also home to your “working memory”—the ability to keep two ideas in your mind at once. For instance, your working memory allows you to connect past experiences with new information and link potential consequences with different scenarios. This area of the brain isn’t fully developed until the early 20s. In other words, just as adolescents are exposed to new, adult experiences and expected to take on increased responsibilities, their brains are just beginning to develop the ability to consider the long-term consequences of their actions.

There’s a reason why Marty McFly and Peggy Sue went back to high school instead of middle school: Early adolescence wouldn’t be anyone’s top time machine destination. The years between 10 and 15 are awkward, to say the least. Nothing makes sense at that age. Rapid mood swings, risky behavior and a hostile worldview are just a few of the tribulations early adolescents—and their parents and teachers—must endure.


Convention reveals why we can’t place all the blame on hormones.

By Kate Johanns

by kate Johanns
The brain’s growing pains

What physical changes occur in the teenage brain? For starters, there’s a second overproduction of gray matter just prior to puberty. (The first starts in the womb and continues during the first 18 months of life.) Gray matter is the thinking part of the brain; it’s composed of neurons (the basic elements of the brain) and synapses (the connections between neurons). At maturity, the human brain contains at least 10 billion neurons that have formed more than 100 trillion connections. Neurons form synaptic connections through a process called “arborization,” so-called because connections grow in a manner similar to a tree’s branches. As the “branches” become more complex, so does the capacity for thought. These changes manifest themselves physically as crevices and folds on the cortex, or surface, of the brain. (The development of crevices and folds peaks by the late teens and remains stable throughout adulthood.)

So much gray matter is produced during this growth period that the brain can’t even use it all. Thus, it begins a process called “pruning.” Connections are shaped and refined, and those that aren’t effective or efficient are eliminated. MRI studies show that the level of the gray matter within the brain does not stabilize until the third decade of life. (Discoveries about the pruning process have led some scientists to form a “use it or lose it” hypothesis: They think there could be a relationship between positive learning experiences and the complexity of the brain. It’s possible that a teenager can shape his own brain development by spending his time practicing a musical instrument instead of watching TV.)

Another adolescent brain change is known as myelination. Brain signals are sent along fibers called axons, which are wrapped in a fatty substance called myelin. Myelin helps the axon send brain signals faster—much like insulation makes electrical wires more efficient. The amount of myelin within the brain increases significantly during the teenage years. In fact, the prefrontal cortex is not fully coated with myelin until a person’s 20s.

Reason versus passion

If the areas of the brain responsible for reasonable, measured response are still under construction, what parts of the brain are teenagers using? Scientists believe that they’re relying on areas such as the amygdala, which controls your gut reactions and impulses.

If you’ve ever had an adolescent completely misinterpret your emotional reaction, the amygdala was likely responsible. Scientists at Harvard University’s McLean Hospital, a leading center for neuroscience

A BRAIN IN TRANSITION

The brain undergoes rapid changes just before puberty. There’s an overproduction of gray matter (the “thinking” part of the brain) followed by a period of pruning, when inefficient and ineffective connections are eliminated.

Amygdala—The amygdala controls your gut reactions and impulses. Research conducted at a Harvard University hospital suggests that young adolescents activate this area of the brain instead of their prefrontal cortex, making them more prone to mood swings and miscommunication.

Prefrontal cortex—The “CEO” of the brain is one of the last areas to develop; it doesn’t fully mature until the third decade of life. This area of the brain controls how an individual experiences an emotion, assesses risk and keeps track of time. It’s also home to the “working memory,” which gives humans the ability to connect past events with current ones.

NEURONS AND SYNAPSES

The basic building block of the brain is the neuron. Neurons form synapses, or connections, with each other.

Axon—Neurons send brain signals to each other along fibers called axons.

Myelin sheath—During adolescence, the brain undergoes rapid myelination. Axons are coated with a fatty substance called myelin, which acts as insulation to make these fibers more efficient conductors of brain signals.
research, used MRI technology to determine the area of the brain used to identify emotions. Both teenagers and adults were studied. Each subject was shown photographs of a human face and asked to name the emotion expressed. Across the board, younger teenagers were more likely than older teenagers and adults to incorrectly label a fearful face as angry. When identifying the emotions, the younger teenagers activated the amygdala, while the older teenagers and adults used their frontal lobes. This research suggests that early adolescents aren’t able to fully activate the more logical areas of their brains, which could lead them to misinterpret their interactions with others.

Here comes the sun

So: Adolescents are prone to being emotional and underestimating risk. That’s not really a news flash, is it? But although the research doesn’t tell us anything ground-breaking about how teenagers behave, it does offer a biological explanation for why they act the way they do. This should be a comfort to anyone frustrated by interaction with an adolescent. As those who have weathered the storm of the teenage years know, you eventually realize that your parents and teachers are pretty smart. You just have to prune your gray matter and myelinate your axons first.