

# The Amazing Adolescent Brain: Translating Science into Strategies

By Linda Burgess Chamberlain, PhD, MPH

Parents are well aware that adolescents do not think or behave like adults. While challenging adolescent behaviors such as mood swings, going to bed late, having trouble getting up in the morning, and not listening to adults are often blamed on raging hormones and puberty, recent scientific discoveries are helping us to better understand and respond to the sometimes unpredictable, frequently frustrating, and totally amazing adolescent years.

Some of the most exciting research has focused on adolescent brain development. What we have learned is that the adolescent brain is far from complete and many of the most important finishing touches in brain development occur during the second decade of life. Similar to early childhood, adolescent brain development is a period of “*use it or lose it*”---- brain connections that are stimulated and used repeatedly are strengthened while unused connections wither away.

Adolescence is a window of opportunity for the brain to become more efficient and develop more advanced skills, but it can also be a time of missed opportunities and vulnerabilities if teens are not challenging their brains or are using substances that are harmful to developing brain cells. How teens spend their time and use their brains influences the organization and capacity of their brains. This raises important questions for families about how much time a teenager spends with technology (television, computer games, videos) versus active learning and skill development whether it is learning a new language, playing a musical instrument, engaging in physical activities, or spending quality time with adults.

## “What Were You Thinking?”

How many times have you been puzzled or frustrated by a teenager’s apparent lack of rational thinking or bizarre behavior? While there are many shining moments when adolescents show good reasoning and judgment, the reality is that they do not yet have all of the hardware in their brains to think like an adult. The prefrontal cortex, often called the CEO of the brain, undergoes massive remodeling during adolescence. A mature prefrontal cortex is needed for good judgment, impulse control, problem-solving, goal-setting, organization and planning, and other essential skills. Following a growth spurt around age 9 or 10 when the prefrontal cortex actually thickens, this area of the brain goes through a pruning process to eliminate unused or damaged connections. During adolescence, a fatty substance called myelin is deposited on critical brain connections. Acting as insulation, myelin increases the speed that electrical and chemical messages can be transmitted throughout the brain. The prefrontal cortex is the last area of the brain to undergo the process of myelination.



# The Amazing Brain

Adolescence is the time that the brain develops the capacity for abstract and critical thinking. This is new terrain for the adolescent brain as teens develop more advanced cognitive skills to ask “how” and “why” questions, analyze more complex issues, and evaluate alternatives in decision-making. The teen brain is still developing the thought patterns and skills for rational thinking and decision-making. While part of adolescence is about seeking new experiences and independence, teenagers still need lots of quality time with healthy adults to promote healthy brain development and benefit from the guidance of adults’ mature prefrontal cortexes!

The adolescent brain develops an extraordinary capacity to memorize new information. Adolescence is a developmental window of opportunity for acquiring new knowledge and skills. Even so, prefrontal cortex functions such as prioritizing what is important and organizational skills are challenging for most teens. Asking a teenager to multi-task (i.e. “Clean your room, take the garbage out, and put your bicycle away”) can overwhelm an adolescent brain that is just learning how to sort and prioritize.

### **Strategies:**

- *Set reasonable limits on the time that teens spend with technology (television, video games) to allow time for active learning (reading, sports, etc.)*
- *Create opportunities for you and other healthy adults to spend quality time actively engaging with teens*
- *Communicate one task at a time and help adolescents to identify priorities*
- *Create reminders by posting notes, setting up calendars, using erasable message boards and other strategies to help adolescents identify and process tasks*
- *Remember that the adolescent brain is a work-in-progress that has not yet reached its adult potential!*

### **They’re Not the Same!**

Boys’ and girls’ brains are not the same. While male brains are approximately one-tenth larger than female brains, bigger does not mean better! There are, however, some important differences in brain development that can help us understand some of the behavioral patterns that we often see in boys and girls. The cerebral cortex is composed of gray matter and white matter. Gray matter is densely packed with cell bodies; white matter consists of myelinated axons that form the connections between brain cells. The female brain has a higher proportion of gray matter while boys have a higher proportion of white matter. It appears that having more gray matter helps girls to be more efficient in processing information, have stronger verbal skills, and often excel with juggling several activities. Having more white matter helps the male brain to transfer information throughout the brain which can enhance spatial skills such as aiming at targets, navigation, and mathematical problem-solving.

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There are several structures in the limbic system, often called the emotional core of the brain, that grow differently in adolescent boys and girls. The hippocampus helps to transfer new information to long-term memory. The hippocampus is sensitive to the female hormone, estrogen, and grows faster in girls. Scientists believe that the larger hippocampus may explain girls' strong social skills--- sizing up social situations, being emotionally supportive, and coordinating complex relationships. The amygdala and the hypothalamus are sensitive to male sex hormones and grow larger in boys. Both of these structures are involved in the body's response to fear and danger, often called the "fight or flight" response. Enjoying contact sports, increased sexual desires, and being more assertive are behaviors that make sense with the male growth spurt in the amygdala and hypothalamus.

Patterns of sexual development have important implications for parents. Girls reach puberty two years earlier than boys and the age of first menstruation for American girls is getting younger (average age of menarche is 13 years). The onset of puberty and an immature brain can put teens at increased risk of making poor decisions about relationships. In addition, parents need to be aware of the hidden epidemic of dating violence. Physical, sexual, and emotional abuse by a dating partner is exceedingly common and starts early. By 9<sup>th</sup> grade, 1 out of 4 girls have experienced physical and/or sexual violence by a dating partner. Dating violence has serious long-term health effects including increased risk of teen pregnancy, depression, and substance abuse.

### Strategies:

- *Promote gender-specific enrichment activities that are tailored to an adolescent's interest*
- *Recognize that puberty occurs before the brain is mature*
- *Talk to teens on a regular basis about gender bias, healthy relationships, warning signs of unhealthy relationships, and whom they can talk to for help*

### Surviving the Drama

Parents sometimes say that life with a teenager can be like riding an emotional roller coaster. Teens describe being overwhelmed by the daily drama of school, relationships, and life in general. Research has shown that adolescents use a more primitive area of the brain, the limbic system, to process emotions compared to adults. Adults use their cortex to interpret and think through their emotions, while teens rely on the more impulsive, "gut" response from the limbic system. Teens are more likely to **react first and think later**, and are often inaccurate in interpreting other peoples' emotions. In one study where teens and adults were asked to interpret the same facial expressions, one-half of teens misinterpreted the expression that adults identified as "fear." Acting on their gut emotions, teens are more likely to misinterpret the emotions of others as anger. The developing adolescent brain is very vulnerable to stress and, in emotionally-charged situations, teens have a tendency to over-react.

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## Strategies:

- *Respond calmly and limit your emotions to keep from prompting or escalating an emotional (and often inaccurate) response*
- *Clearly state your feelings or concerns, one at a time, and try to minimize communicating your emotions through facial expressions, which teens often misinterpret*
- *Encourage teens to talk about their feelings by asking open-ended questions in a safe and supportive environment where their feelings can be acknowledged without judgment*
- *Help teens to find healthy ways to deal with stress such as physical exercise, journaling, and peer support groups*

## Why Do They Sleep So Much?

Teens need more sleep than adults. During adolescence, there is a dramatic shift in sleep patterns and in the brain chemicals that make us sleepy. These brain chemicals also help brain cells to build connections. Melatonin, a brain chemical that induces sleep, is released two hours later at night and stays in the brain later in the morning during adolescence. The deepest form of sleep, called slow wave sleep, decreases dramatically during adolescence.

Teens function best with about 9 ½ hours of sleep a night. Sleep deprivation not only compromises teenagers' ability to concentrate and regulate emotions, it can also short-circuit optimal brain development. No wonder some high schools are experimenting with starting school later in the morning.

## Strategies:

- *Help teens to create schedules that allow more time for sleep*
- *Avoid stimulating activities (computer games, exercise) and stimulants (drinks with caffeine) before teens get ready to go to bed*
- *Save discussions that may be emotionally-charged until morning!*

## Living on the Edge and Other Dangers

Whether it's skydiving, drag racing down a quiet street, or staying out all night, adolescents' attraction to taking risks is no coincidence. Puberty and changes in the adolescent brain motivate teens to seek new experiences and excitement. Teens perceive risk differently than adults---they are more enticed by the novelty or a dare than the reward or outcome. Teens are much more likely to take risks in the presence of other teens.

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Chemical changes occurring in the adolescent brain also contribute to risk-seeking behaviors. Serotonin, a chemical messenger in the brain, has a calming effect that helps to control impulsive behavior. Dopamine is part of the brain's "feel good circuitry" that gives a sense of well-being. Risk-taking behaviors can elevate dopamine levels. Serotonin and dopamine levels are fluctuating as the adolescent brain develops. High levels of stress can affect dopamine and serotonin levels in the brain.

The tendency towards risk-seeking and novel experiences during adolescence increases the likelihood that a teen will experiment with alcohol and drugs. Most recreational drugs and alcohol cause very high levels of dopamine in the brain. By 9th grade, approximately 1 out of 4 teens have consumed five or more alcoholic beverages in a row in the past two weeks. Research on the impact of alcohol on the adolescent brain has led to some startling discoveries:

1. Teens are more likely to black-out (conscious but can't remember) than pass-out and are less likely to succumb to the sedative effects of alcohol
2. The hippocampus, which has an important role in forming new memories, is smaller in heavy adolescent drinkers
3. Young drinkers have more long-term memory impairment

### **Strategies:**

- *Provide opportunities for novel, challenging experiences such as hiking, rock-climbing, outdoor recreational activities, and chaperoned all-night teen events*
- *Give teens an active role in discussing family rules, curfews, and consequences for their behaviors and listen to how they evaluate risks and decide what is important*
- *Recognize that adolescents act differently under the influence of alcohol compared to adults and that there is no known level of alcohol consumption that has been determined to be "safe" for adolescent brain development*
- *Set boundaries for driving that limit a teen driver's opportunities to take risks such as limiting the number of friends that he/she can have in the car*

### **Promoting Peaceful Adolescence**

Nature saves the best for last as the brain goes through extensive remodeling during the second decade of life. Teens are acquiring the "hardware" in their brains to function like adults---but they are not there yet. Adolescents need us in their lives to provide a supportive, enriched environment that optimizes this developmental window of opportunity. What can we do to promote peaceful adolescence? First, we can anticipate some chaos, conflict, emotional peaks and valleys, risk-taking, and rule-breaking as teens navigate the tremendous physical and

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neurodevelopmental changes that will deliver them at the headwaters of adulthood. We can also take an active role in creating opportunities for teens to practice good decision-making, develop new skills, seek adventure through structured risk-taking, spend quality time with adult mentors, and adopt healthy lifestyles that minimize stress and allow for adequate sleep. All of these strategies promote resilience in youth that reduce the likelihood of risk behaviors such as substance abuse and increase teens' brain-building potential.

## Resources

- **Why Do They Act That Way?** By David Walsh. Free Press, NY, NY. 2005.
- **The Primal Teen: What the New Discoveries About the Teenage Brain Tell Us About Our Kids** by Barbara Strauch. Random House, NY, NY. 2003.
- **Your Child's Growing Mind: Brain Development and Learning from Birth to Adolescence** by Jane M. Healy, PhD. Broadway Books, NY, NY. 2004.

## Websites

[www.nimh.nih.gov/Publicat/teenbrain.cfm](http://www.nimh.nih.gov/Publicat/teenbrain.cfm)

A brief overview of research into brain development during adolescence.

[www.duke.edu/~amwhite/Adolescence](http://www.duke.edu/~amwhite/Adolescence)

Explores recent scientific evidence that alcohol affects adolescents and adults differently.

[www.cdvp.org/teens/](http://www.cdvp.org/teens/)

A teen relationship website talks about respect and abuse in relationships, provides links, and a chat room for teens.

## Linda Burgess Chamberlain, PhD, MPH

Dr. Chamberlain is the founding director of the Alaska Family Violence Prevention Project. An epidemiologist specializing in domestic violence, she is an internationally recognized speaker on the effects of violence on children and brain development. She lives on a rural homestead outside of Homer, Alaska with her dog team. A national Kellogg Leadership Fellow, Dr. Chamberlain is also a motivational speaker and uses "lessons from the trail" to promote key strategies for teamwork and leadership. She can be contacted via e-mail at [howlinghusky@gci.net](mailto:howlinghusky@gci.net)

(Dr. Chamberlain is a National Advisor to the Institute for Safe Families (ISF) in Philadelphia. ISF is collaborating with Dr. Chamberlain to produce materials for parents and providers on the Amazing Brain.)  
[www.instituteforsafefamilies.org](http://www.instituteforsafefamilies.org)

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