

Under Construction:

Adolescent Brain Development and its Implications for Preventing Alcohol and Drug Abuse

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Why do teens act the way they do?

What are they thinking?

Why do they use drugs, drink and smoke when they know the risks?

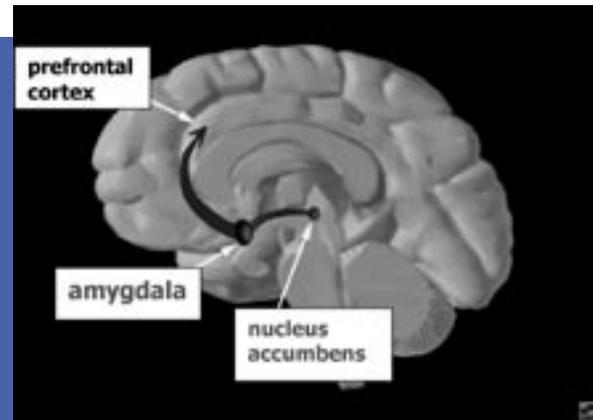
Counselors, teachers, and parents alike share their exasperation over these common questions about today's teens, just as their counselors, teachers, and parents asked similar questions a generation ago, and just as today's teens will be asking them at some point in their lives. Conventional wisdom used to explain that moodiness and poor judgment were just part of any teenager's normal developmental process – managing surging hormones while trying to fit in with the crowd.

Recent scientific discoveries, however, have uncovered a more complex tale. Not only is it insufficient to blame adolescent problems on their hormones or peer pressure, to truly understand what is going on requires some knowledge of the brain and how it develops. While it is true that one can legally drive at 16, vote and serve their country at 18, and purchase alcohol at 21, we now know that the brain is still maturing into the early 20s. It should not come as a surprise that car rental companies will not allow customers under the age of 25 to rent their vehicles. Because our ability to make sound judgment calls depends on a fully mature brain, adolescents are inherently at an elevated risk for numerous problems, including choices around substance use.

Work in progress

Advancing technology in brain imaging has provided a window into the developing brain.

Scientists are reaching a new understanding of the changes in pre-adolescent and adolescent brains. We once believed that the brain was fully formed at puberty, but mounting evidence is convincing us otherwise: the brain continues to mature in some very important ways until about age 24.



These brain changes are relevant to adolescent behavior. Prefrontal cortex (PFC) is pruned; not fully developed until mid-20's (Judgement) Amygdala (and n.a.) show less pruning and tend to dominate the PFC (Reward System)

There are three structures in the brain that continue to mature during youth: the nucleus accumbens, amygdala and prefrontal cortex. These structures are noteworthy because of their implications for understanding adolescent behavior. While scientists caution about making definitive links from neurodevelopmental findings to behavior, the discovery that brain construction is still a work in progress during adolescence provides us with the opportunity to consider some useful hypotheses.

The nucleus accumbens

Every living thing is willing to spend a certain amount of effort in order to seek rewards. The nucleus accumbens is the structure in our brain that directs our behavior when we are motivated to seek a reward. The nucleus accumbens in the teenage brain has not fully matured, leading us to believe that in

teenagers, there is still a disconnect between how much effort one is willing to expend to acquire a reward. Teenagers tend to prefer activities that require relatively low effort yet produce high excitement. Real-world observations bear this out: teenagers tend to favor activities such as playing video games, skateboarding, and, unfortunately, substance use.

The amygdala

When we are faced with a pleasurable experience, our amygdala aids us in reacting favorably. When we are faced with a dangerous experience, our amygdala likewise aids us in reacting to protect ourselves. Essentially, our amygdala is the tiny, tucked away brain structure that helps us respond emotionally to our entire range of experiences. While this structure is maturing, however, it can sometimes create more of a hindrance than a help. Perhaps you have noticed that teenagers are more likely to react to a negative situation in a heated way; as they and their brains mature, the same situation has a better chance of being responded to with controlled emotions. The maturing amygdala may be responsible for this automatic “hot” rather than “cool” response. It is also implicated in the propensity for youth to mis-read neutral or inquisitive facial expressions of others as a sign of anger. This means they likely feel that they live in a more hostile or dangerous world than adults live in, and their “hot” response to this world may include fights or other aggressive behavior.

The prefrontal cortex

The next time you make a good decision, thank your prefrontal cortex. Located just behind the forehead, this structure is one of the last areas to mature. It’s the area of the brain responsible for the complex processing of information – making judgments, controlling impulses, foreseeing the consequences of our actions, and setting goals and plans. **An immature prefrontal cortex is thought to be the neurobiological explanation for why teenagers show poor judgment and too often act before they think.**

The developing brain and drug use

Scientists are now beginning to explore how these new discoveries of neurodevelopment affect what we know about adolescent drug use and related impulsive behaviors. This is an important issue given that adolescence is a time of experimentation and novelty seeking. The 2003 Monitoring the Future study found that 70.1% of high school seniors had used alcohol in the past year and 34.9% had used marijuana. Over half had tried an illicit drug at least once in their lifetime. Even among 8th graders, 45.6% had already tried alcohol and 22.8% reported illicit drug use in their lifetime (Johnston et al., 2003). And we know that most adults who smoke regularly or meet alcohol abuse or dependence criteria took up their habit in adolescence (Clark et al., 1998).

Are adolescents more vulnerable than adults to abuse drugs?

A developing prefrontal cortex increases the propensity of teenagers to act impulsively and then to shrug off the negative consequences of their behavior. Additionally, a developing nucleus accumbens increases the adolescent’s tendency to seek out activities that are exciting but require little effort. And a developing amygdala may be responsible for the heightened pleasurable social experience while drinking alcohol that adolescents report compared to their adult counterparts. All of these effects of the developing brain – **poor impulse control, favoring low-effort yet thrilling experiences, and heightened sensitivity to the social benefits of intoxication – may contribute to an initial decision to use drugs and make the experience rewarding enough to repeat it.** While we must use extreme caution in drawing conclusions for humans from rat studies alone, the human and rat brains are undeniably similar and rat studies can offer some insights (Panksepp, 2004). It may be telling that, in studies of adolescent rats, they are observed to be less sensitive to the effects of intoxication than adult rats.

They typically consume two to three times as much alcohol for their body weight as adults (Spear, 2002). Adolescent humans also show this diminished sensitivity to intoxication; their higher metabolic rates allow them to consume higher amounts of alcohol (Spear, 2002). This may explain why young people are often capable of drinking large amounts of alcohol while reporting that they do not feel very intoxicated. It is important to remember that regardless of whether a drinker feels intoxicated, the damage the alcohol can do to their body and brain remains.

This “perfect storm” may be complete with the inclusion of surging adolescent hormonal activity. These hormones encourage novelty seeking and promote social competitiveness. These were worthy attributes when our adolescent ancestors needed to have the courage to strike out on their own in fairly dangerous environments (Spear, 2002), and to some extent, these attributes may continue to serve them today. However, this revved-up hormonal production of adolescence may also promote drug use, given the extent that drug involvement represents a novel experience woven with an opportunity to win social approval and inclusion from peers.

Arrested development?

There is considerable concern in our society that teens that drink will get into car accidents, fights, and other situations that put themselves and others in harm’s way, and this concern is sadly substantiated by a number of data sources. There is an additional concern, however, that rarely makes it onto our radar screen, and it cannot be prevented by “supervising” young people who drink or taking their keys away.

Preliminary research has shown that the developing brain can be damaged by alcohol use. Adolescent rats exposed to various amounts of alcohol have significantly more brain damage in their frontal cortex than their adult counterparts (Spear, 2002). They also show greater damage to their working memory, which means that it’s harder for them to complete tasks that require them to

remember one thing while doing another. With long-term alcohol use, adolescent rats have shown massive loss of neurons in their cerebellum, basal forebrain, and neocortex (Spear, 2002). The loss represents a **decreased ability for the various parts of the brain to communicate and coordinate with each other**. In studies involving humans, adolescents with alcohol use disorders had nearly 10% less volume in the hippocampus, our primary brain structure for memory. These adolescents have a more difficult time accessing their memories than their peers (Brown et al., 2000).

Why should we care and what should we do?

Parents, teachers and prevention practitioners are in the business of helping young people develop – full of hopes, dreams, skills, and capabilities. It’s an important job because so much is at stake for these kids we care so much about. The more we know about their social, emotional, cultural, cognitive and biological realities, the better position we will be in to understand what they are going through and help them navigate the often turbulent waters. Neuroscientific discoveries are tools that we can use in our ever-growing toolkit. Knowing what is going on in young people’s heads should encourage us to strengthen a number of our approaches. While role modeling for and guiding young people toward positive expectations, we must have sensitivity to what their cognitive constraints may be. **Making good decisions all of the time is not a reasonable expectation** of the mature brain, let alone for the developing brain. However, we can talk about what kinds of decisions are on the horizon – before young people reach that horizon – so that they are better prepared when they get there. And, inevitably, when some not-so-great decisions are made, we can make them learning opportunities to prepare for the next round of decisions. A developing brain is still an amazingly powerful tool, and



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young people should be educated about their own brain development. They should be encouraged to play up their strengths and be cautious of their limitations.

In helping them do just that, we need to ensure that the options available to young people err on the side of greater safety over greater risk. Providing alcohol-free events and parties, locking up or eliminating alcohol in the home, and enforcing curfews, for example, are means of establishing some boundaries around behavior that reduce the immediate access to sensation-seeking, peer-approving and temptation. Increasing freedom to make riskier choices (such as a later curfew) should only come as the responsibility to make consistently safe decisions is demonstrated.

Those parents that are tempted to provide alcohol to their kids in hopes of keeping tabs on their drinking behavior should be educated about the permanent damage that drinking can have on their kids' developing brains. This damage can have a profound effect on their ability to learn new skills and concepts and to access those they have already learned. (This comes in addition to the risks of developing an alcohol use disorder, harming oneself or someone else, or even experiencing fatal alcohol poisoning.)

It is not reasonable, however, to expect that parents should be the only ones with the responsibility to promote healthy youth development. With the information now available about the potential for serious harm when young people are exposed to alcohol and other drugs, **fundors and policymakers must also be educated about the role they can play in ensuring that prevention is prioritized.**

Adolescents deserve respect and recognition for all of the new ways that they are able to use their minds and bodies. They also deserve a safety net that will support them every step of the way, and more than just a little compassion for all of the changes that they're going through while their brains are still "under construction."

Let's Hear From You!

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prevention
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