

## The five ages of the brain: Adolescence

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### Wired, and rewiring

Teenagers are selfish, reckless, irrational and irritable, but given the cacophony of construction going on inside the adolescent brain, is it any wonder? In the teenage years, our brains may be fully grown, but the wiring is certainly still a work in progress.

Psychologists used to explain the particularly unpleasant characteristics of adolescence as products of raging sex hormones, since children reach near adult cerebral volumes well before puberty. More recently, though, imaging studies have revealed a gamut of structural changes in the teens and early 20s that go a long way towards explaining these tumultuous teenage years.

Jay Giedd at the National Institute of Mental Health in Bethesda, Maryland, and his colleagues have followed the progress of nearly 400 children, scanning many of them every two years as they grew up. They found that adolescence brings waves of grey-matter pruning, with teens losing about 1 per cent of their grey matter every year until their early 20s (*Nature Neuroscience*, vol 2, p 861).

This cerebral pruning trims unused neural connections that were overproduced in the childhood growth spurt, starting with the more basic sensory and motor areas. These mature first, followed by regions involved in language and spatial orientation and lastly those involved in higher processing and executive functions (*Proceedings of the National Academy of Sciences*, vol 101, p 8174).

Among the last to mature is the dorsolateral prefrontal cortex at the very front of the frontal lobe. This area is involved in control of impulses, judgement and decision-making, which might explain some of the less-than-stellar decisions made by your average teen. This area also acts to control and process emotional information sent from the amygdala - the fight or flight centre of gut reactions - which may account for the mercurial tempers of adolescents.

As grey matter is lost, though, the brain gains white matter (see graph). This fatty tissue surrounds neurons, helping to conduct electrical impulses faster and stabilise the neural connections that survived the pruning process.

These changes have both benefits and pitfalls. At this stage of life the brain is still childishly flexible, so we are still sponges for learning. On the other hand, the lack of impulse control may lead to risky behaviours such as drug and alcohol abuse, smoking and unprotected sex.

Substance abuse is particularly concerning, as brain imaging studies suggest that the motivation and reward circuitry in teen brains makes them almost hard-wired for addiction. Throw in a lack of impulse control, poor judgement and a woeful underappreciation of long-term consequences and you have a hooked teen. And since drug abuse and stressful events - even a broken heart - have been linked to mood disorders later in life, this is the time when both are best avoided.

On the plus side, as teens rush towards adulthood and independence, they carry with them the raw potential to sculpt their brains into lean, mean processing machines. Making the most of this time is a matter of throwing all that teen energy into learning and new experiences - whether that means hitting the books, learning to express themselves through music or art, or exploring life by travelling the world. But whether they like it or not, while their decision-making circuits are still forming, tender teen brains still need to be protected, if only from themselves.

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