

Adolescent Brain Science

While most young adults may stop growing vertically by age 17 and 18, their brains continue to develop into their mid-to late 20s. Advancements in science in the last 20 years, particularly research involving MRIs and then functional MRIs, enhanced our knowledge about the differences not only in the architecture between adolescents' and adults' brains but the functional pathways.

The growth period referred to as "adolescent brain development" typically begins at puberty and is roughly defined as lasting from age 10 to 25.ⁱ During this period of brain growth, American adolescents live in a "precarious middle ground" and legal status between innocence and immaturity and responsibility and accountability.ⁱⁱ

Contrary to popular belief, hormones and sex drive are not the only source of risky behavior for this age group; Adolescence is a tricky time because of a variable growth rate across different regions of the brain. The neural circuitry needed to produce an executive response is already there in adolescence, but an adolescent's ability to access these systems in a sustained and reliable way is variable.ⁱⁱⁱ Studies have shown that adolescents' greater involvement than adults in risk taking does **not** stem from ignorance, irrationality, delusions of invulnerability, or faulty calculations but **from use of the emotional center of their brain, rather than the executive.**^{iv}

The frontal lobes, including the prefrontal cortex (thought of as the seat of executive functioning), are the last area of the brain to fully develop.^v Because the frontal cortex is the last to develop, teens rely heavily on parts of the brain that house their emotional centers (the **limbic system** of the temporal lobe) when making decisions.^{vi} This late maturation of the frontal lobe explains some of the characteristics of a "typical teenager" such as short attention span, impulsive behavior, and forgetting homework.^{vii}

The Temporal Lobe contain the **limbic system**, a region of the brain that activates in response to emotions (anger, pleasure), survival instincts (fear, fight or flight), goal-directed behavior or motivation, such as thirst, appetite for food, and other things like social interaction.^{viii} It makes teens especially sensitive to emotional cues, information, and rewards.^{ix} **The limbic system can overtake the frontal lobes' executive functions in a teen, especially when stressors are involved.**^x

This, in part, explains why peer acceptance is extremely important to an adolescent. **Peer rejection, pressure and influence** greatly impact adolescents' emotions and therefore decision-making. Even the mere **presence** of peers can greatly influence an adolescent's decision-making.^{xi}

Combining peer influence with unstable neurotransmitters can explain poor decision making. GABA, an inhibitory neurotransmitter, and Dopamine, a neurotransmitter (and hormone) that influences memory, concentration, problem-solving and other mental functions, **are not at their most effective level in adolescence.**^{xixiii} "Dopamine is critical to the brain's reward system—creating a neurochemical loop that links a stimulus with pleasure and satisfaction."^{xiv} In multiple studies, youth with **higher levels of dopamine** exhibited adult levels of cognitive control and impulse control when a short-term reward was involved.^{xv xvi} A small percentage of youth engage in extremely risky behavior, which is a problem for juvenile justice systems, but according to researchers, it is "a side effect of the helpful, adaptive function of risk-taking that propels teens into adulthood."^{xvii}

The above information is generally true for all adolescents but for those with brain injuries or atypical brain development, good decision-making can be even more difficult. Disruption of functions associated with the frontal lobe may lead to impairments of foresight, strategic thinking, and risk management.^{xviii} **Disruptions or dysfunction may result from traumatic events (both physical or emotional trauma), chronic toxic stress or substance use.** Toxic stress causes prolonged activation of stress response systems in the absence of protective relationships and occurs with strong, frequent and/or prolonged adversity such as physical or emotional abuse, chronic neglect, and addiction.^{xix}

"[T]oxic stress limits the ability of the hippocampus to promote contextual learning, making it more difficult to discriminate conditions for which there may be danger versus safety, as is common in posttraumatic stress disorder. Hence, altered brain architecture in response to toxic stress in early childhood could explain, at least in part, the strong association between early adverse experiences and subsequent problems in the development of linguistic,

cognitive, and social-emotional skills, all of which are inextricably intertwined in the wiring of the developing brain.”^{xx}

One “hallmark of frontal lobe dysfunction is difficulty in making decisions that are in the long-term best interests of the individual.”^{xxi} Risky decision-making and lack of discrimination between danger and safety is not always a “bad choice” by a youth exercising free will but a neurological predisposition due to adverse childhood experiences, trauma, or chronic toxic stress. Research shows that supportive, responsive relationships with caring adults as early in life as possible can prevent or reverse the damaging effects of the toxic stress response. Risk factors can be offset by protective factors. The presence of one dependable and caring adult can make a difference.^{xxii} This can include trauma-informed professionals working with youth crime victims or justice-involved youth. Safe, stable, and nurturing relationships and environments can have a positive impact on a broad range of health problems and on the development of skills that help adolescents reach their full potential.

ⁱ ACT4JuvenileJustice, *Adolescent Brain Development & Juvenile Justice Fact Sheet*, JJDPA Fact Book, accessed August 7, 2023, www.gvsu.edu/cms4/asset/903124DF-BD7F-3286-FE3330AA44F994DE/ad_brain_development_jj_fact_sheet.pdf.

ⁱⁱ *Id.*

ⁱⁱⁱ Emily Underwood, “Teens can have excellent executive function—just not all the time,” *Knowable Magazine*, April 20, 2023, knowablemagazine.org/article/mind/2023/executive-function-in-teen-brains.

^{iv} Valerie Reyna and Frank Farley, “Risk and Rationality in Adolescent Decision Making,” *Psychological Science in the Public Interest* 7, no. 1 (2006): 1–44, doi.org/10.1111/j.1529-1006.2006.00026.x; Valerie Reyna and Frank Farley, “Is the Teen Brain Too Rational?” *Scientific American Mind* 17, no. 6 (June 2007), www.scientificamerican.com/article/is-the-teen-brain-too-rational/.

^v Lindzi Wessel, “The Teen Years” *BrainFacts.org*, September 26, 2019, <https://www.brainfacts.org/thinking-sensing-and-behaving/childhood-and-adolescence/2019/the-teen-years-092619>.

^{vi} Child Welfare Information Gateway, *Child Maltreatment and Brain Development*.

^{vii} Lindzi Wessel, “The Teen Years.”

^{viii} JoAnn Deak & Terrence Deak, *The Owner’s Manual for Driving Your Adolescent Brain* (San Francisco: Little Pickle Press, 2013) 15.

^{ix} Harvard Health Publishing, “The adolescent brain: Beyond raging hormones,” March 7, 2011, www.health.harvard.edu/mind-and-mood/the-adolescent-brain-beyond- raging-hormones.

^x *Id.*

^{xi} Amanda E. Guyer, Jennifer S. Silk, and Eric E. Nelson, “The neurobiology of the emotional adolescent: From the inside out,” *Neuroscience & Biobehavioral Reviews* 70 (November 2016): 74–85, doi.org/10.1016/j.neubiorev.2016.07.037

^{xii} Deak, *The Owner’s Manual*, 50.

^{xiii} ACT4JuvenileJustice, *Adolescent Brain Development & Juvenile Justice*, citing Linda Patia Spear, “Neurodevelopment During Adolescence,” in *Neurodevelopment Mechanisms in Psychopathology*, ed. Dante Cicchetti and Elaine F. Walker (Cambridge University Press, 2003); Coalition for Juvenile Justice, *What are the Implication of Adolescent Brain Development*.

^{xiv} Chris Murphy, *The Violence Inside Us: A Brief History of an Ongoing American Tragedy* (New York: Random House, 2020), 38.

^{xv} Underwood, “Teens can have excellent executive function.”

^{xvi} Daniel Siegel, “Dopamine and Teenage Logic,” *The Atlantic*, January 24, 2014, www.theatlantic.com/health/archive/2014/01/dopamine-and-teenage-logic/282895/. Also discussed in National Juvenile Justice Prosecution Center in partnership with NDAA, OJJDP, DOJ, Juvenile Prosecutor Training Curriculum, Instructor Manual, Module 2, Child and Adolescent Development, 28, citing Coalition for Juvenile Justice, *What Are the Implications of Adolescent Brain Development*.

^{xvii} Tim Vernimmen, “Inside the adolescent brain,” *Knowable Magazine*, June 30, 2022, knowablemagazine.org/article/mind/2022/inside-adolescent-brain.

^{xviii} See M.-Marsel Mesulam, “Behavioral Neuroanatomy,” in *Principles of Behavioral and Cognitive Neurology*, 2d ed., ed. M.-Marsel Mesulam (Oxford University Press, 2000), 47–48.

^{xix} See Brainfacts.org, “Wired for Danger: The Effects of Childhood Trauma on the Brain,” video created by Jasmine Purnomo, October 19, 2020, www.brainfacts.org/thinking-sensing-and-behaving/childhood-and-adolescence/2020/wired-for-danger-the-effects-of-childhood-trauma-on-the-brain-101920; Hillary A. Franke, “Toxic Stress: Effects, Prevention and Treatment,” *Children* 1, no. 3 (November 2014): 390–402, doi.org/10.3390/children1030390.

^{xx} Jack P. Shonkoff et al., “The Lifelong Effects of Early Childhood Adversity and Toxic Stress,” *Pediatrics* 129, no. 1 (2012): e232–e246, doi.org/10.1542/peds.2011-2663, citing National Scientific Council on the Developing Child, *Excessive Stress Disrupts the Architecture of the Developing Brain*.

^{xxi} See Antonio R. Damasio and Steven W. Anderson, “The Frontal Lobes,” in *Clinical Neuropsychology*, 4th ed., ed. Kenneth M. Heilman and Edward Valenstein (Oxford University Press, 2003), 404, 434.

^{xxii} Tian Dayton, “ACE’s Adverse Childhood Experiences: A Message from Dr. Robert Anda and Oprah Winfrey,” *Thrive Global*, March 28, 2018, medium.com/thrive-g-global/aces-adverse-childhood-experiences-a-message-from-dr-robert-anda-and-oprah-winfrey-26654844ddc9.