

## When Does an Adolescent Become a Grown-up?

The transition from childhood to adulthood involves amazing changes in mind and body. During this phase of development our brain's ability to perceive and integrate stimuli, reason, react, and coordinate movement, and modulate behavior all become more sophisticated. What makes adolescence so interesting is that these functions don't all mature at the same rate. Consequently there are situations where adolescents appear quite adult-like in their reasoning and other situations where they still think and act like children. This unevenness of brain development makes it difficult to establish markers for maturity. Such markers are necessary to grant young people certain rights, such as right to vote, drive, and use intoxicants. They are also important for determining when a person should be held accountable for his or her actions. Using age as a marker assumes that all brain functions are up to speed at that age, but new research is finding that is not the case. Although 21 years old is considered the age of maturity, young people can now vote, use tobacco, and be tried as adults in court at age 18. Some courts allow adolescents as young as 16 years old to be mandated to adult court.

A recent study by researchers from various universities examined those brain regions that regulate emotion and impulse control while the participants were engaged in tasks requiring those skills. In this study 41 teens aged 13-17 years old were compared with 35 young adults aged 18-21 years old and 34 adults aged 22-25 years old. All participants were taught a Cognitive Control Under Emotion task which required them to press a key in response to one of three faces (happy, frightened or calm) flashed on a screen. The task requires concentration, quick responding, and good impulse control to press the key only when the target face appears and not when non-target faces appear (called a Go/No-Go task). The faces were presented in blocks of several faces each. During some of the blocks the participants were informed that a loud obnoxious noise would occur sometime during the task (Threat condition). During other blocks the participants were alerted to a chance to win \$100 if their scores were high enough (Reward condition). While performing this game-like task, each participant's brain was scanned by functional Magnetic Resonance Imaging (fMRI) to monitor the activity in brain regions important in emotion regulation and impulse control (mainly the prefrontal cortex).

**Results.** Teens performed worse than adults on the Go/No-Go task when cued with either frightened faces or happy faces. Just priming the younger participants with negative or positive emotion was enough to diminish their performance. Young adults performed worse than adults when cued with frightened faces only, suggesting that primes for negative emotion such as fear may be more potent for them than primes for positive emotion. Under the Threat condition (loud obnoxious noise), both teens and young adults performed worse than adults on the Go/No-Go task. Thus regardless of what kind of face was targeted, merely anticipating an aversive event such as a loud noise was enough to diminish their performance. Teens also performed worse than adults under the Reward condition (possibly winning \$100). For the younger participants either positive or negative arousal was enough to impair performance on the Go/No-Go task.

So what were the brain regions doing during these tasks? First, activity in the prefrontal cortex correlated with the amount of cognitive control exerted by all participants on the Go/No-Go task. Specifically, the more control the participants exerted to stay on task, the greater the activity in the prefrontal region of the brain. However, under the Threat condition both teens' and young adults' prefrontal regions were less active than the same regions in the adult brains.

These results add to a growing body of research revealing lags in brain development that correlate with lags in behavioral and emotional control in adolescents and even young adults. In calm settings where they can take their time to think through consequences, young people tend to make good decisions and control impulses. In situations where they are aroused either by emotional cues (happy or frightened faces) or by the prospect of reward or threat, adolescents are less likely to regulate emotion and control impulses than are adults. Together with prior findings this study suggests that under certain arousing conditions teenagers and even young adults have not reached the maturity of older adults to stay calm and control impulses. They may be "old enough to know better" but still be unable to "act their age." These results have implications for the adjudication of adolescents facing criminal charges. They also raise one big question for our judicial system: Given these lags in development, should adolescents be held to the same level of accountability as adults when they fail to control emotion and impulses?

Cohen, A.O.; Breiner, K.; Steinberg, L.; Bonnie, R.J.; Scott, E.S.; Taylor-Thompson, K.A.; Rudolph, M.D.; Chein, J.; Richeson, J.A.; Heller, A.S.; Silverman, M.R.; Dellarco, D.V.; Fair, D.A.; Galvan, A.; Casey, B.J. When is an adolescent an adult? Assessing cognitive control in emotional and nonemotional contexts. *Psychological Science*, 2016, 27, 549-562.