# Adolescent Brain Development: A brief overview

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# Throughout adolescence, teens get better at:

- Problem solving
- Multi-tasking
- Inhibition and judgment
- Cognitive/emotional control
- Accuracy and speed of responding
- Planning and understanding long-term consequences
- Social awareness and perspective taking

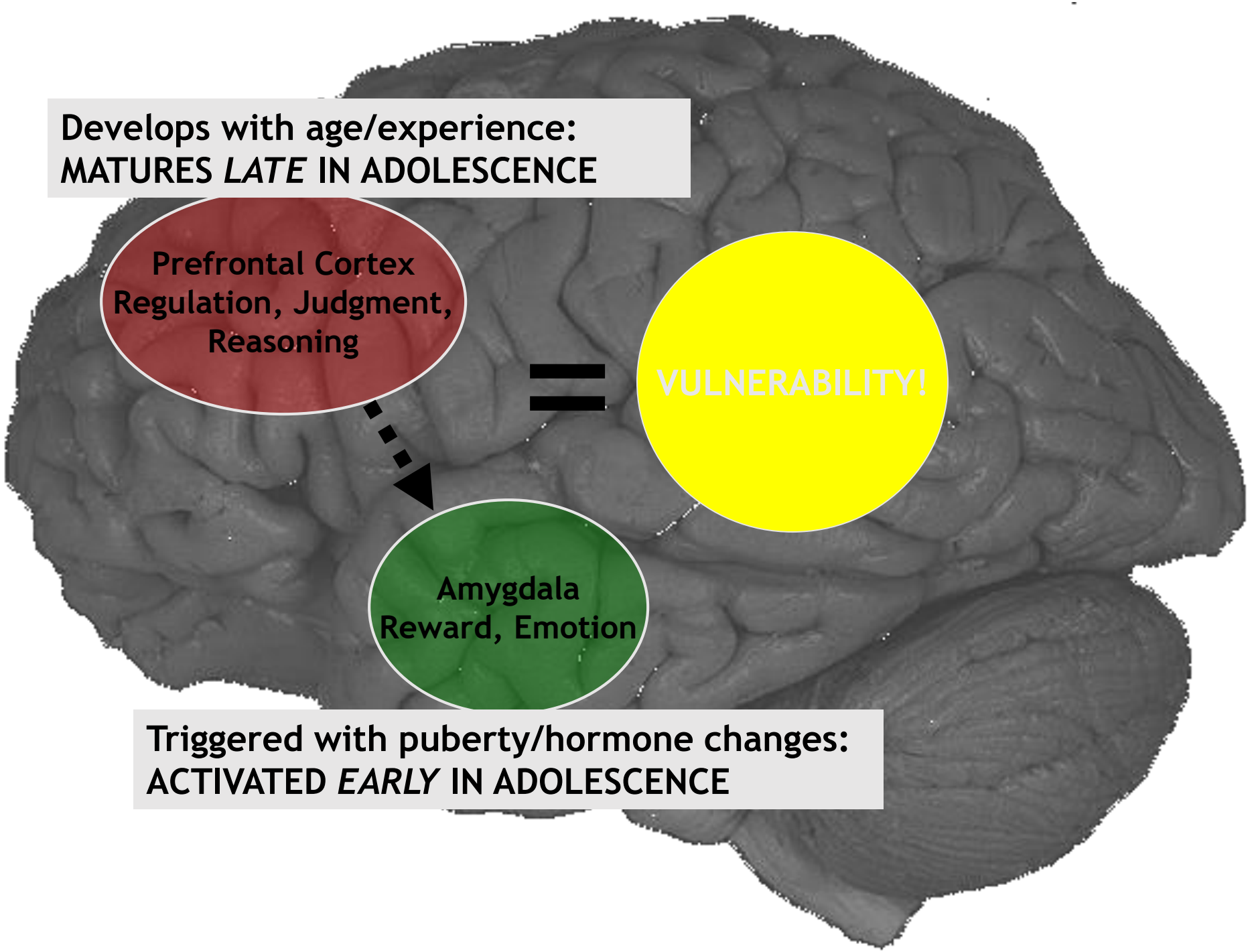
# Quotes about Adolescence

“youth are heated by Nature as drunken men by wine” (Aristotle)

“I would that there were no age between 10 and 23 for there’s nothing in between but getting wenches with child, wronging the ancientry, stealing, fighting…” (Shakespeare. The Winters Tale, Act III)

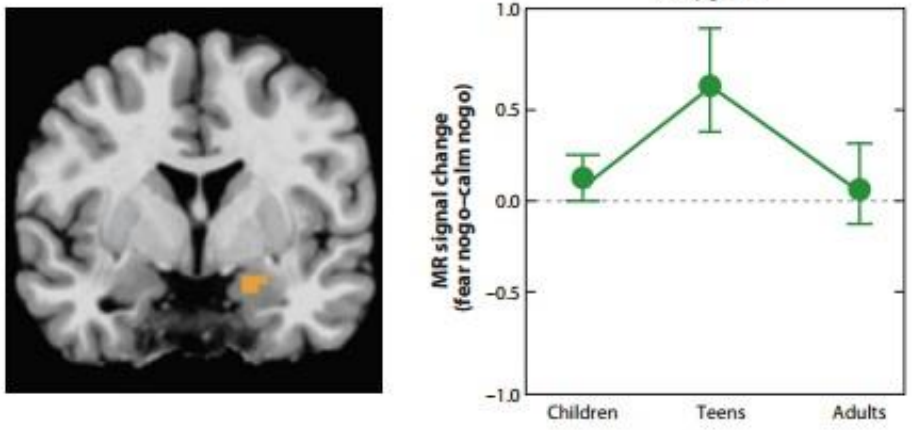
“ Adolescents are not monsters. They are just people trying to learn how to make it among the adults in the world who are probably not so sure themselves" . (Virginia Satir, The New Peoplemaking, 1988)

“ a Period of Turbo Charged Feelings with incomplete Driving Skills” (Ronald Dahl. 2003. Adapt Research Network, University of Pittsburgh)


Develops with age/experience:
MATURES *LATE* IN ADOLESCENCE
Prefrontal Cortex
Regulation, Judgment,
Reasoning
=
VULNERABILITY!
Amygdala
Reward, Emotion
Triggered with puberty/hormone changes:
ACTIVATED *EARLY* IN ADOLESCENCE

# Emotional Responsiveness

- Adolescence is a time of increased emotional responsiveness/intensity
- The amygdala is associated with the perception of emotion
- Adolescents show greater amygdalar response to social threat cues than children or adults




- Gonadal steroid levels (e.g., testosterone) have been associated with amygdala activity

Figure from Casey, Annu Rev Psychol 2015

# Gogtay et al., *PNAS, 2004*

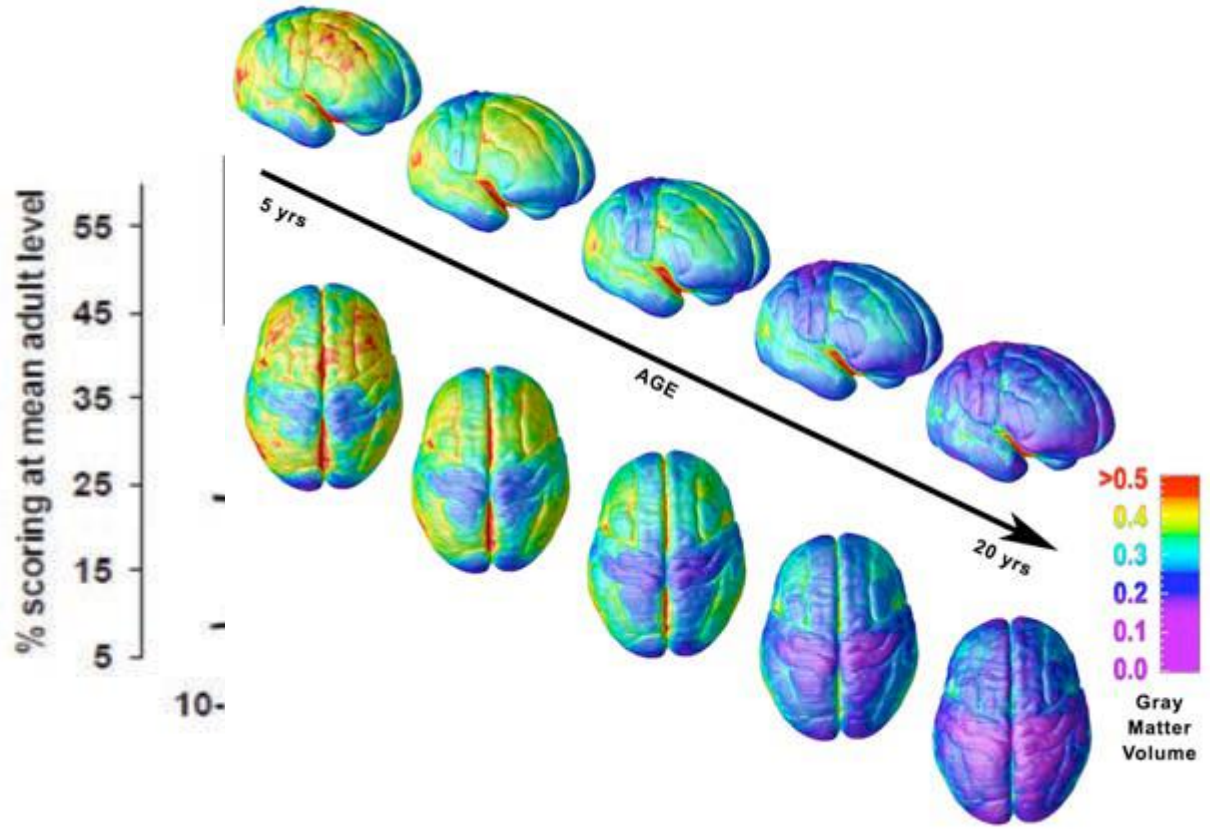
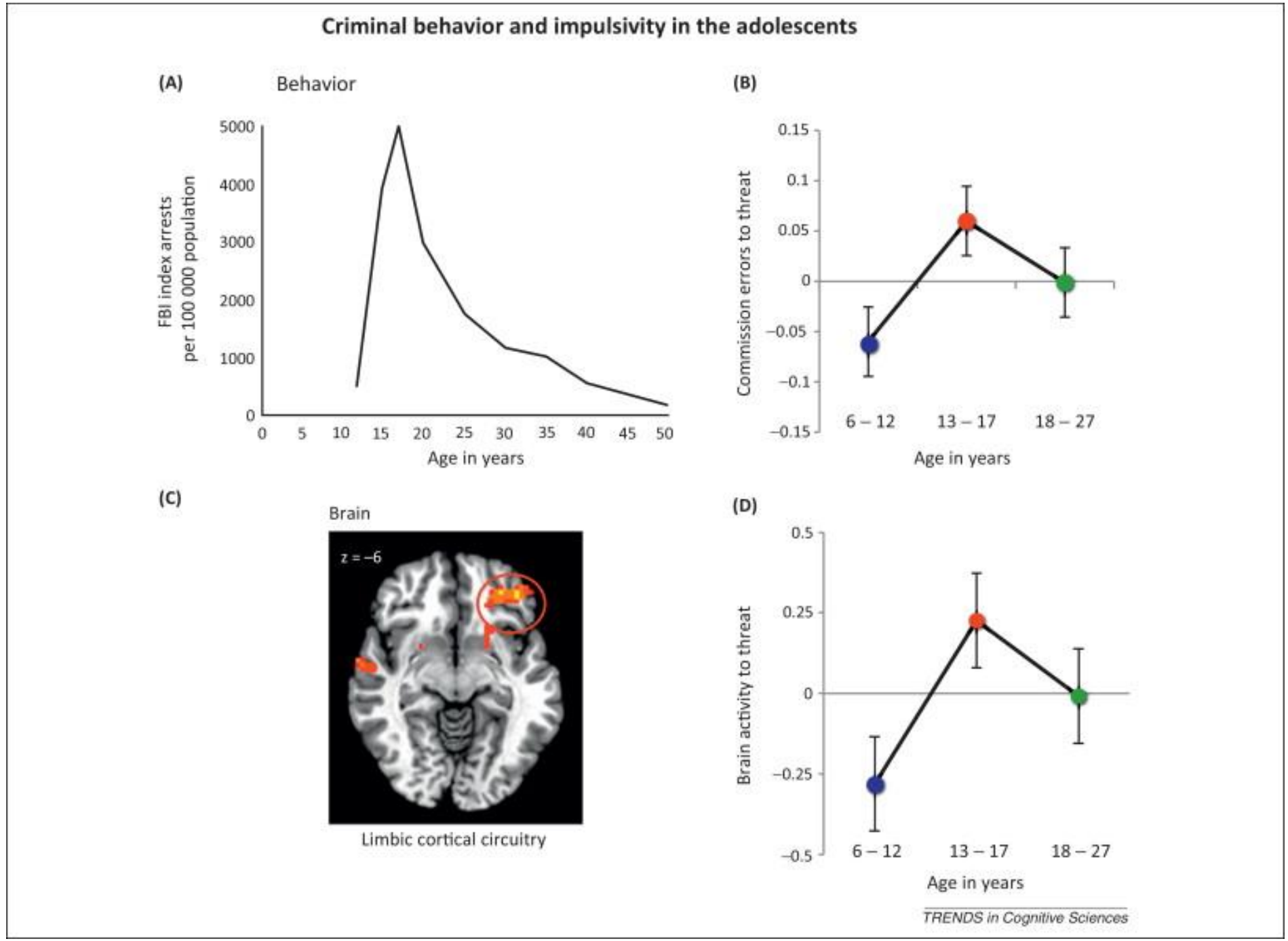


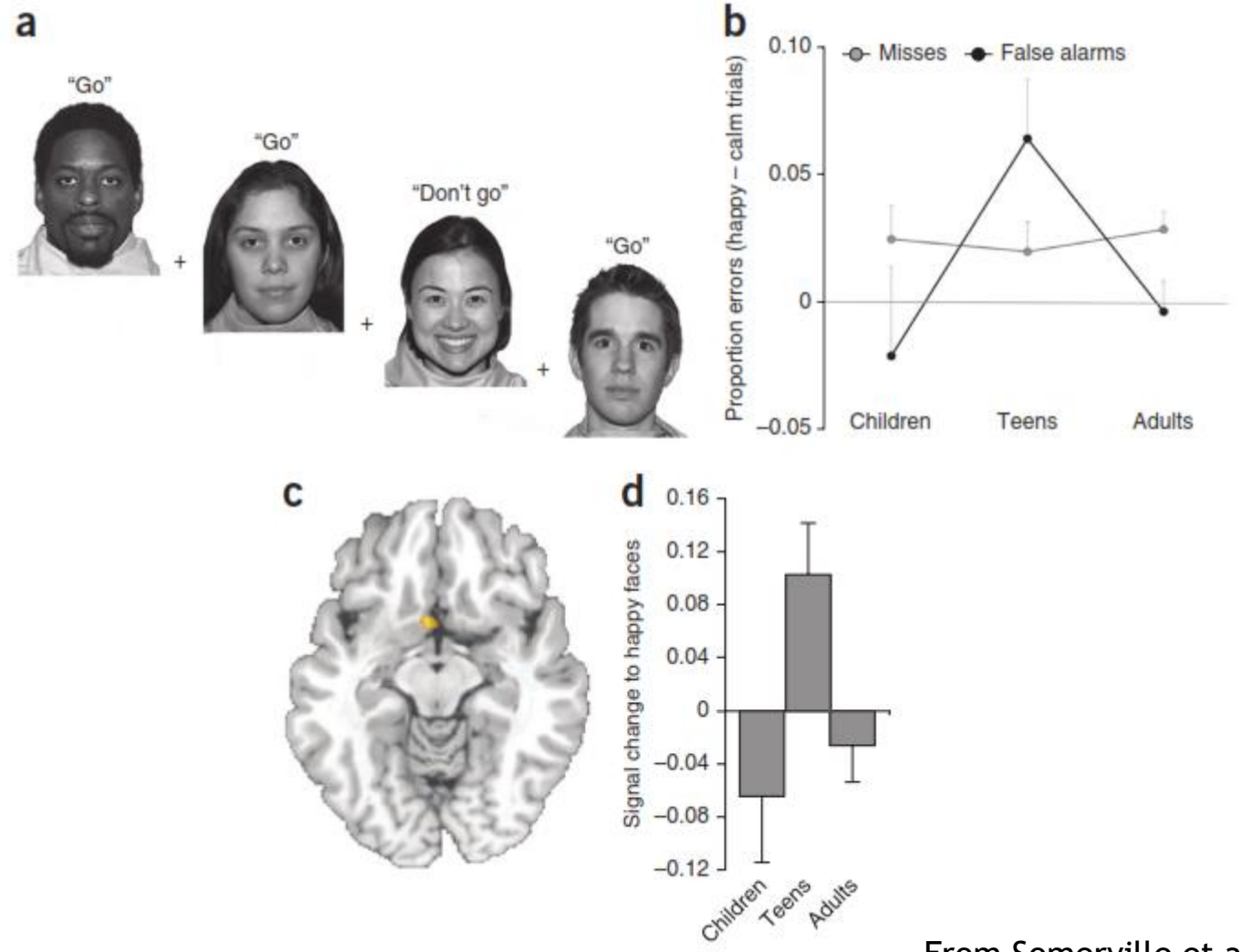

Figure 3: Proportion of individuals in each age group scoring at or above the mean for year-olds on indices of intellectual and psychosocial maturity.

Adolescents tend to use emotion and reward areas of the brain rather than reasoning areas to process information and make decisions:

- Difference between “hot” and “cold” situations
- Differences with and without peers
- Impacted by stress
- Impacted by a history of trauma in the absence of secure attachment and health sustained relationships
- Disrupted by Binge drinking
- Impaired by chronic THC use

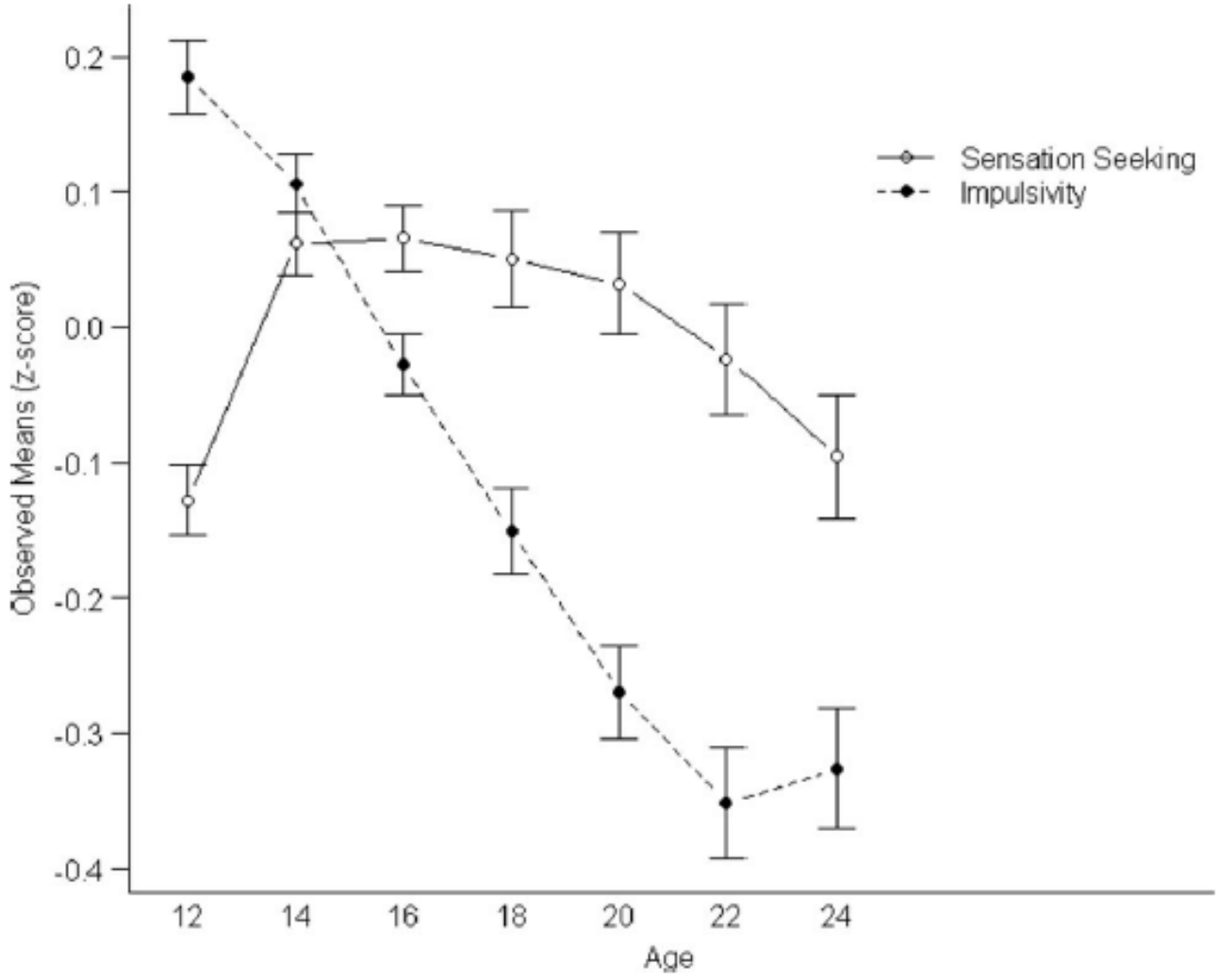

Criminal behavior and impulsivity in the adolescents
(A)
Behavior
FBI index arrests per 100 000 population
5000
4000
3000
2000
1000
0
0 5 10 15 20 25 30 35 40 45 50
Age in years
(B)
Commission errors to threat
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
6 – 12
13 – 17
18 – 27
Age in years
(C)
Brain
z = −6
Limbic cortical circuitry
(D)
Brain activity to threat
0.5
0.25
0
−0.25
−0.5
6 – 12
13 – 17
18 – 27
Age in years
TRENDS in Cognitive Sciences

# Emotional Context Influences Teen's Inhibitory Control



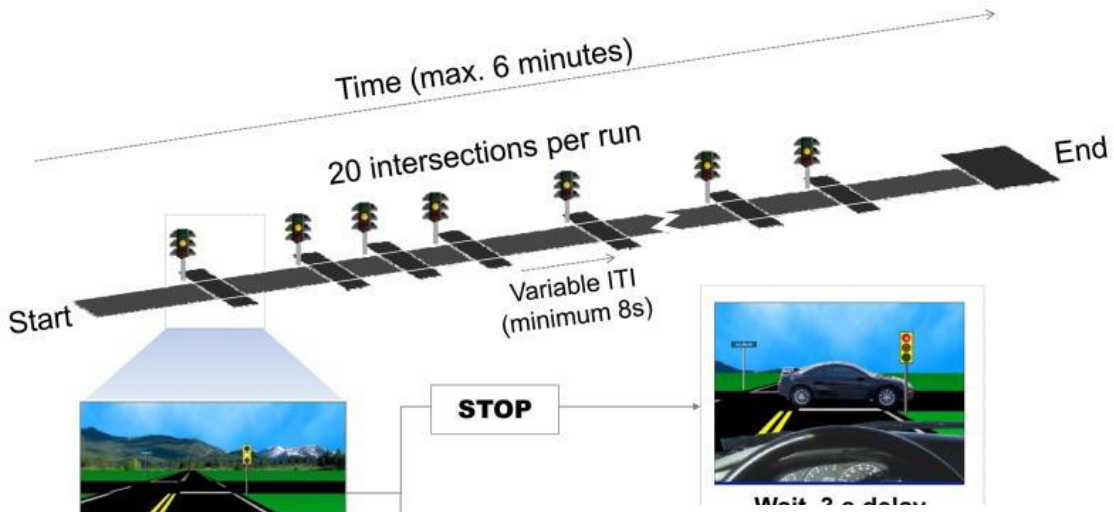

From Somerville et al., 2011, JCN

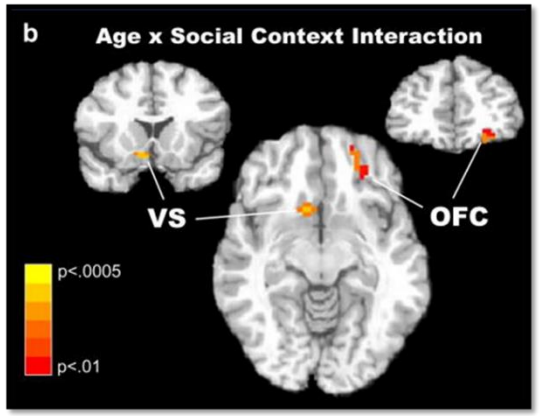
# Adolescents Are More Sensation Seeking and Impulsive



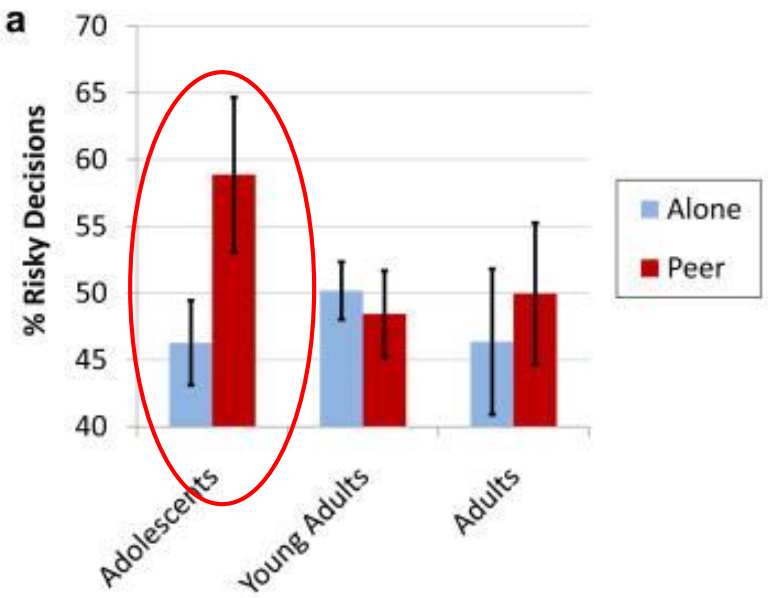

From Harden & Tucker-Drob, Dev Psychol 2011

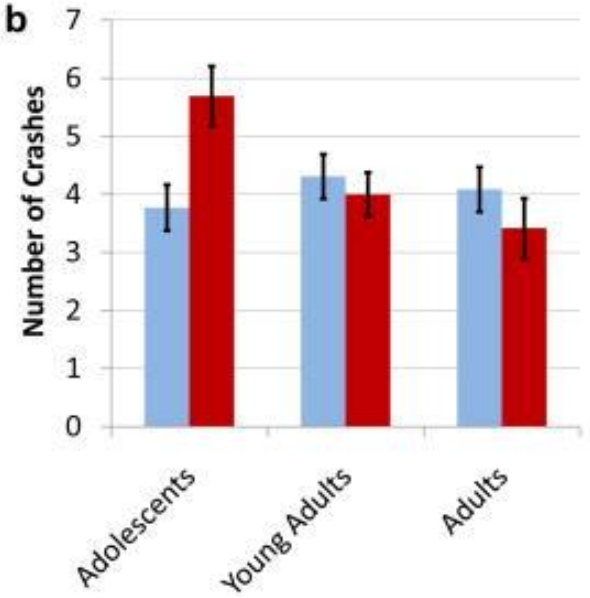
# Peers Increase Adolescent Risk Taking




Risk taking with peers is rewarding to the adolescent brain!

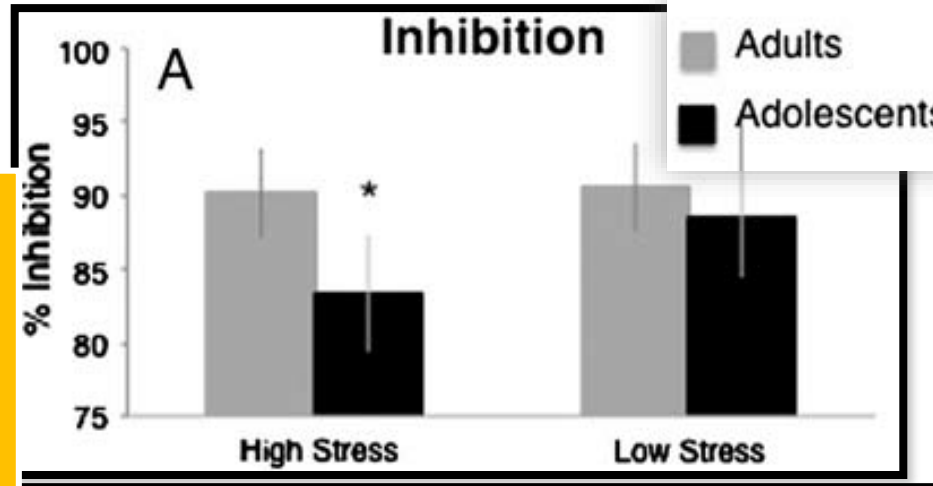


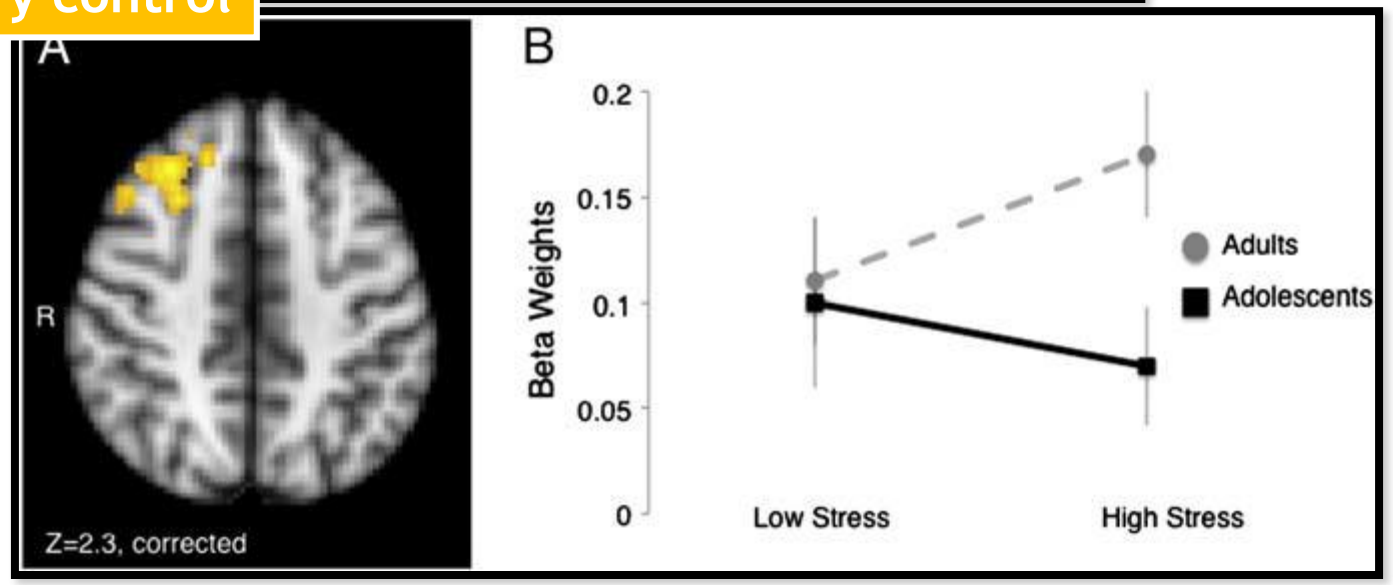




From Chein et al., 2011 Dev. Sci.

# Stress Impacts Inhibitory Control and Brain Functioning In Adolescents

**High stress impairs adolescents' ability to practice inhibitory control**

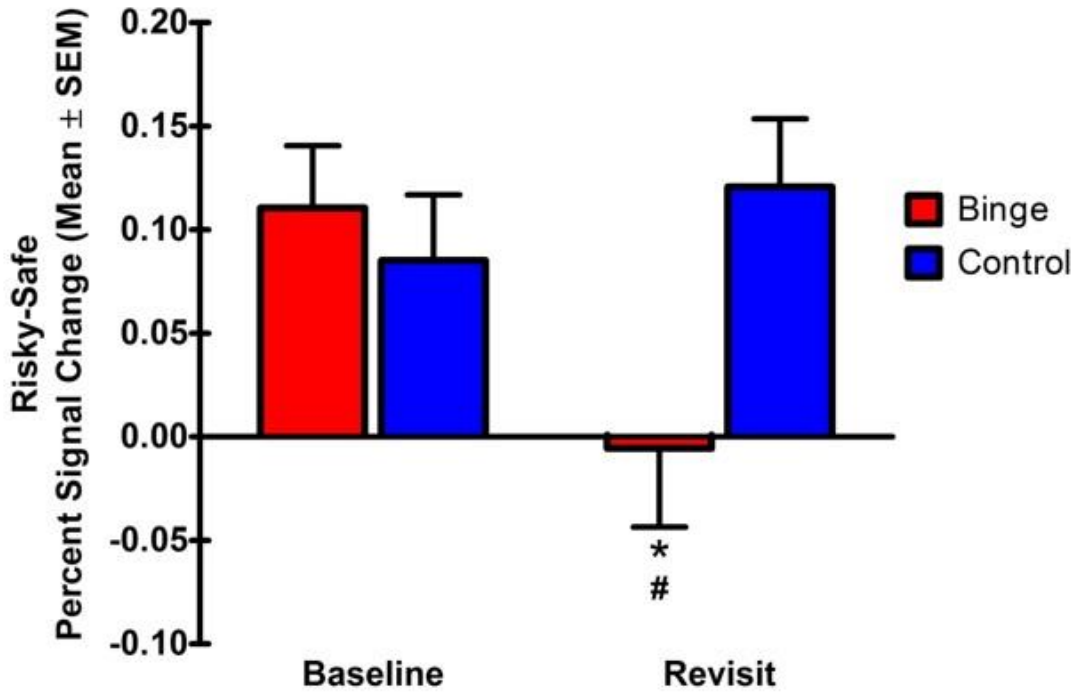


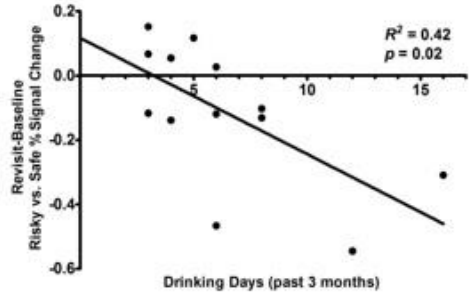



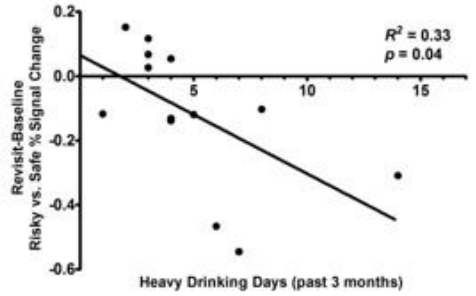

From Rahdar & Galvan, NeuroImage 2014

Traumatic (Toxic) stressors throughout childhood, particularly in the absence of secure attachments and relationships disrupt development of inhibitory centers, impairs learning and activates threat mechanisms that disrupt emotion regulation.

# Binge Drinking Reduces Brain Response During Risky Decision Making




Jones, Cservenka, & Nagel, *NeuroImage*, 2016

# Marijuana Use Impacts Cognition

- Even after 28 days of abstinence, marijuana abusing teens show impairments in:
  - Attention
  - Verbal Memory
  - Executive functioning

From Medina et al., 2007

# Summary: Compared to Children and Adults, Adolescents:

1. Have diminished judgment (prefrontal cortex) when their reward and threat cue systems (amygdala/limbic system) are activated.
2. Are stimulus seeking which leads to risk taking behaviors.
3. Are neurologically activated by having peers around at the expense of good judgment.
4. Are made more vulnerable by typical and chronic or toxic stress.
5. When binge drinking have demonstrably diminished judgment.
6. When Chronically using THC have persistent deficits in judgment and memory functions.

**Adolescents are not big kids or small adults, their neuropsychological functions are unique and we should consider this deeply when implementing clinical, educational and judicial policy.**

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