

# Neuroplasticity: Brain health, risk taking and mental health during adolescence

**Zoltán Sarnyai, M.D., Ph.D.**

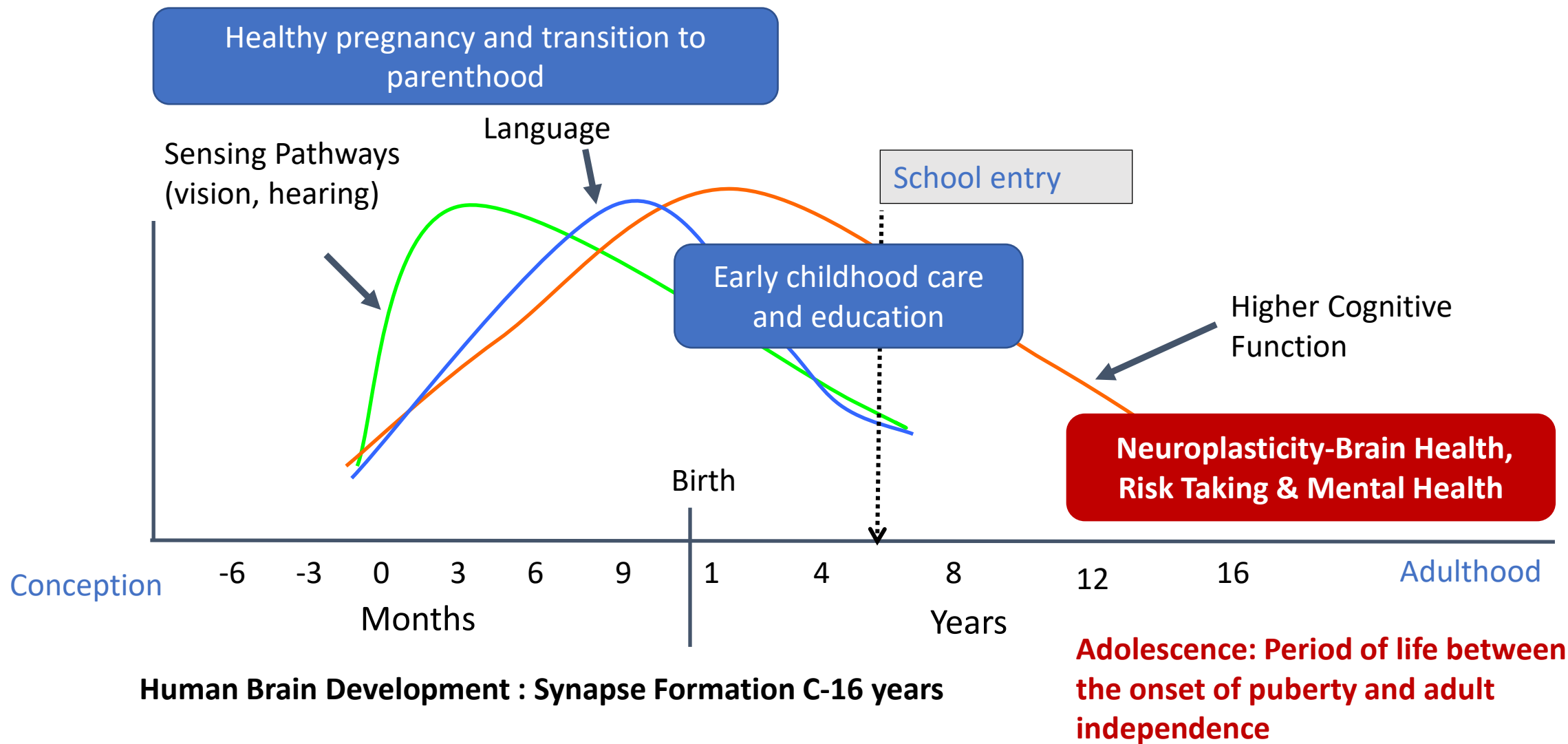
Laboratory of Psychiatric Neuroscience, AITHM, James Cook University

The Brain Place – Centre for Brain Health in the Tropics, Tropical Brain and Mind Foundation

**Brain Builders Summit**

Queensland Brain Institute; Brisbane, QLD

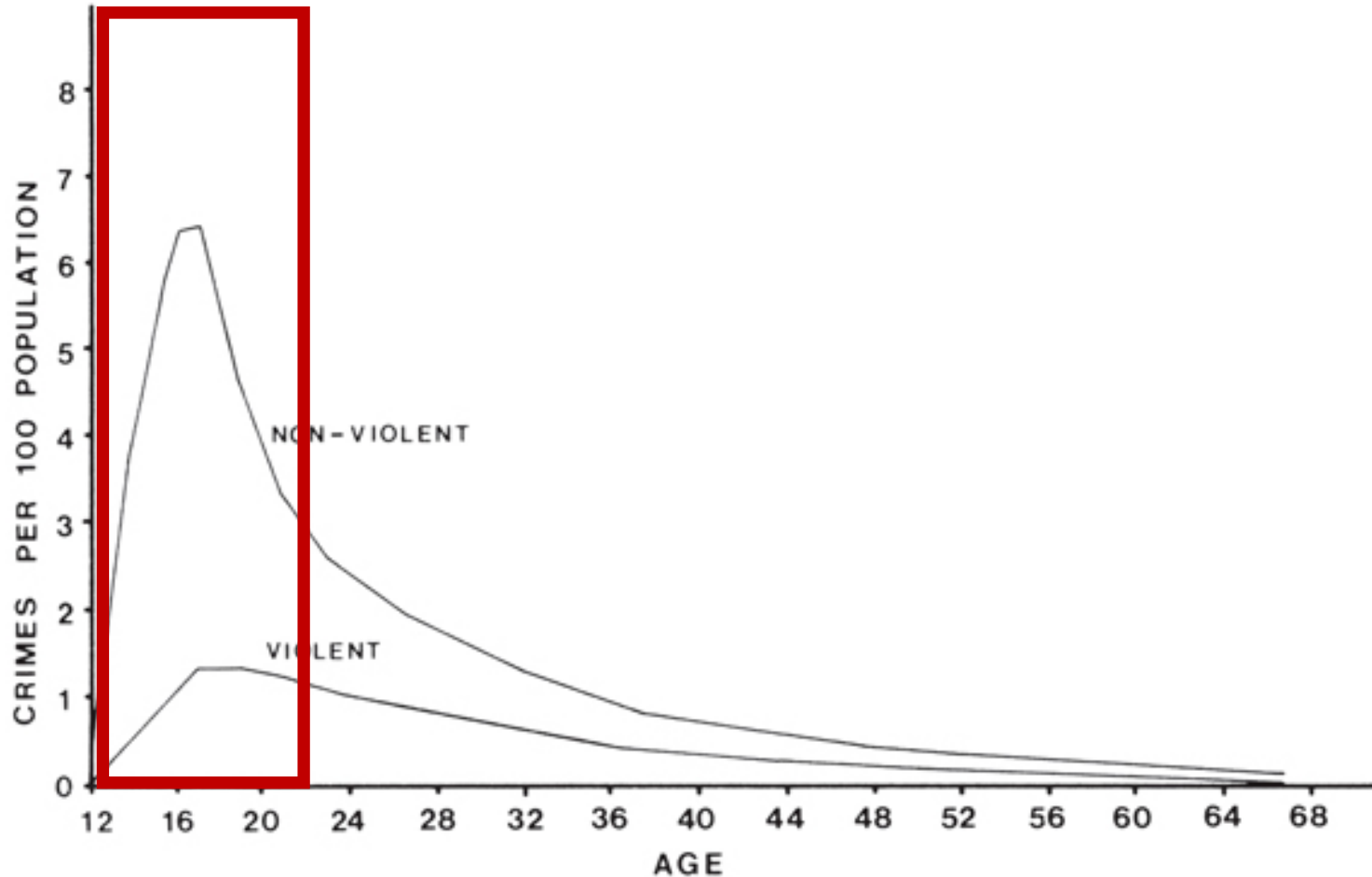
30 August 2023



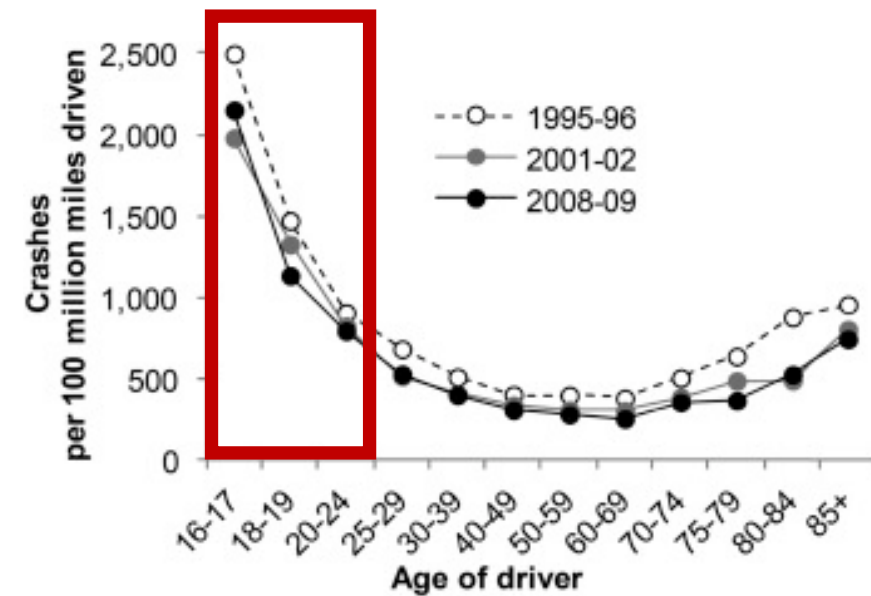
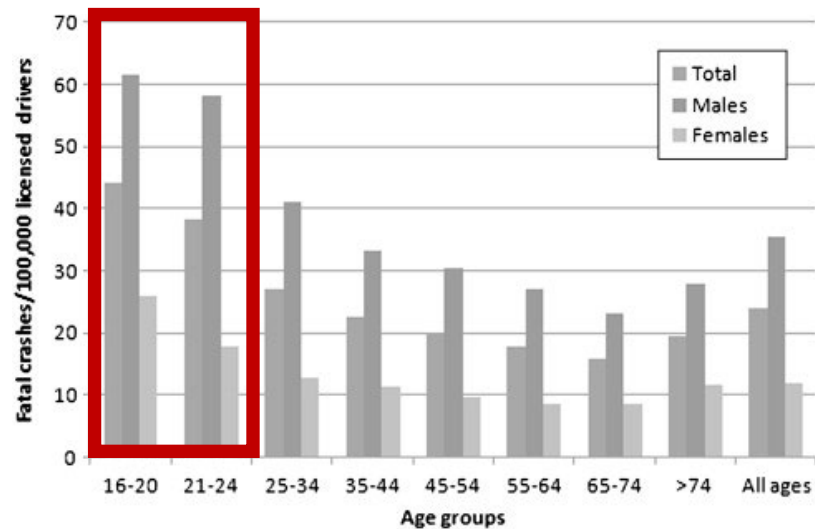
# Traditional view of adolescence

- **Socrates** (470-399 BC) - characterized youth as inclined to “contradict their parents” and “tyrannize their teachers”
- **Aristotle** (384-322 BC) - “youth are heated by Nature as drunken man by wine”
- **G. Stanley Hall** (1904) - a period of “storm and stress”
  - conflict with parents
  - mood disruptions
  - risky behavior

# Crime peaks during adolescence

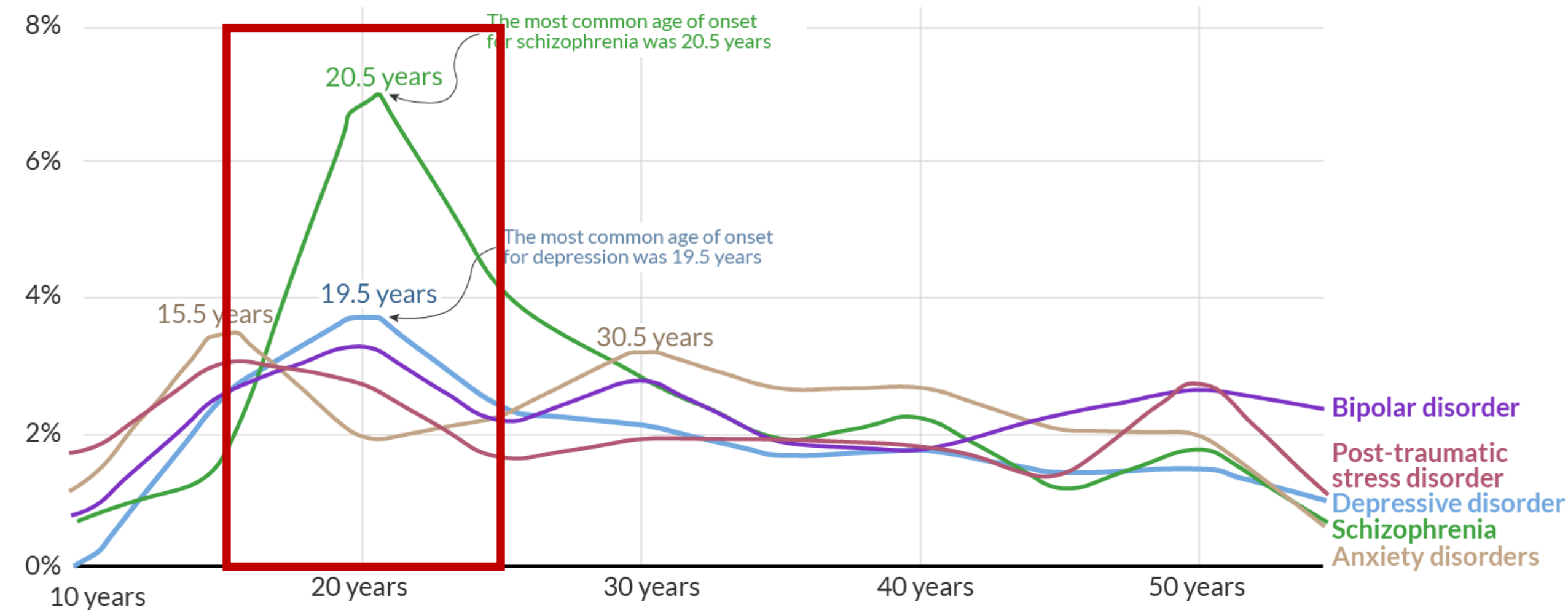


# Car accidents peak during adolescence

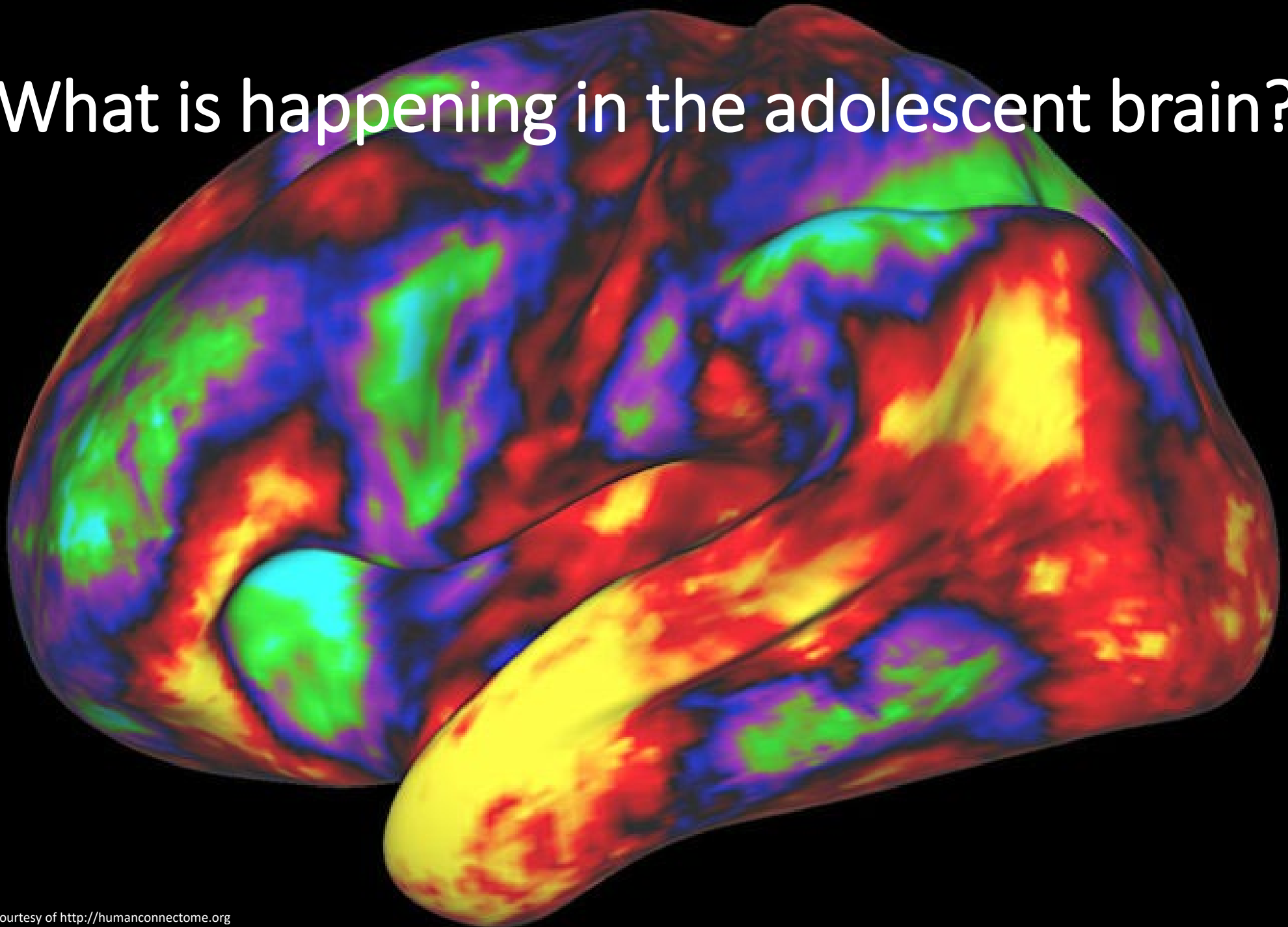


# Age of onset of mental health disorders

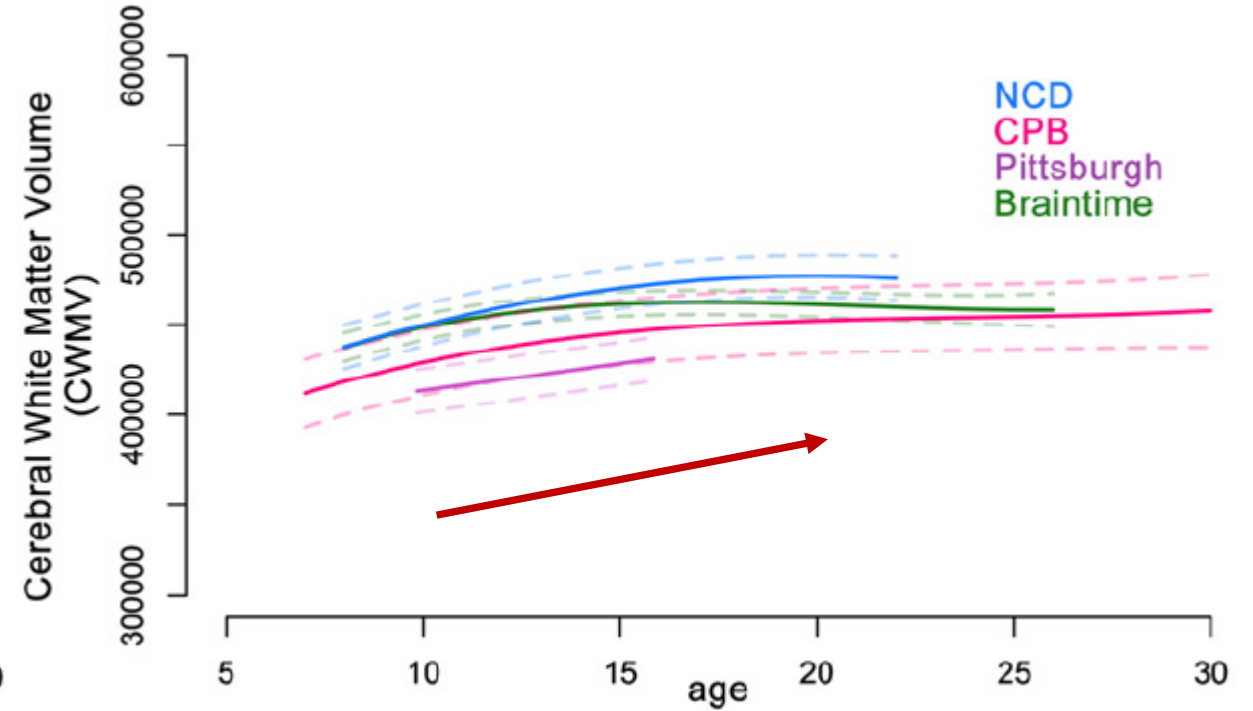
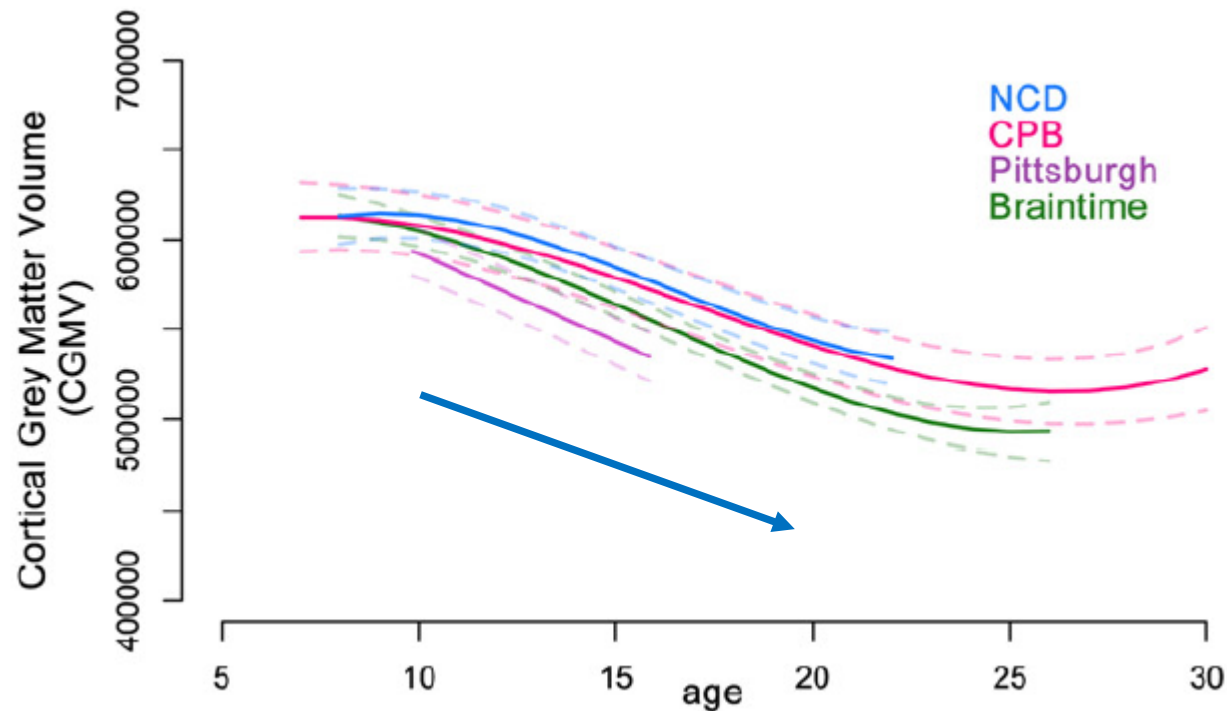
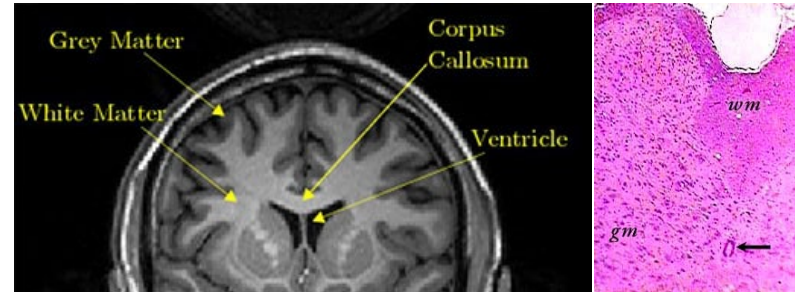
Share for whom the disorder begins at a given age



# What is happening in the adolescent brain?

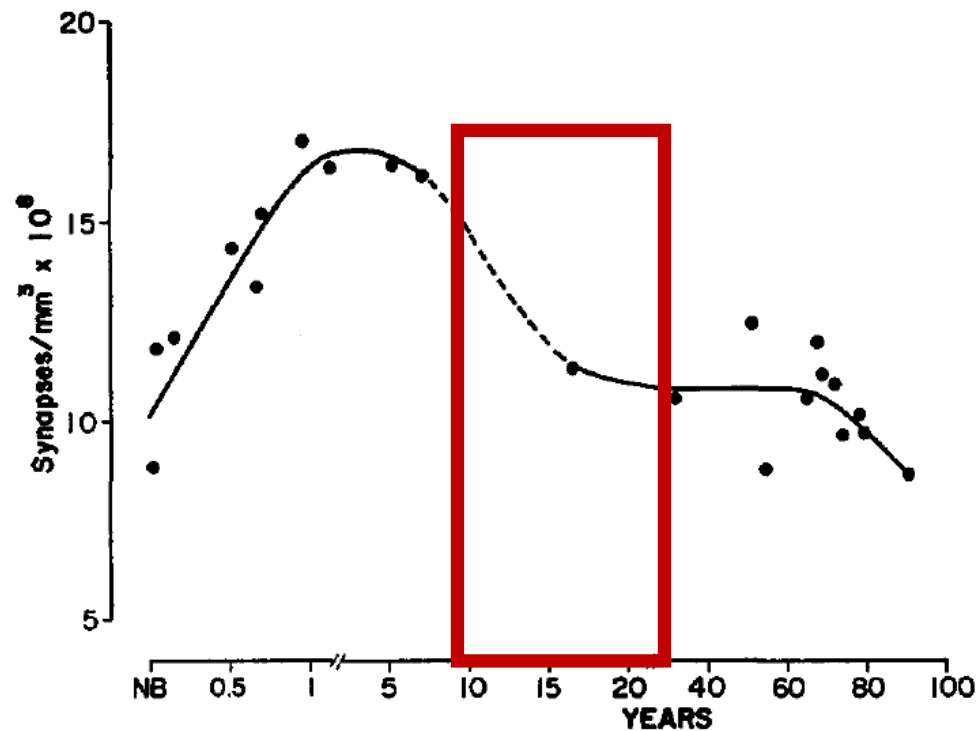


# Brain gray matter volume decreases but white matter volume increases

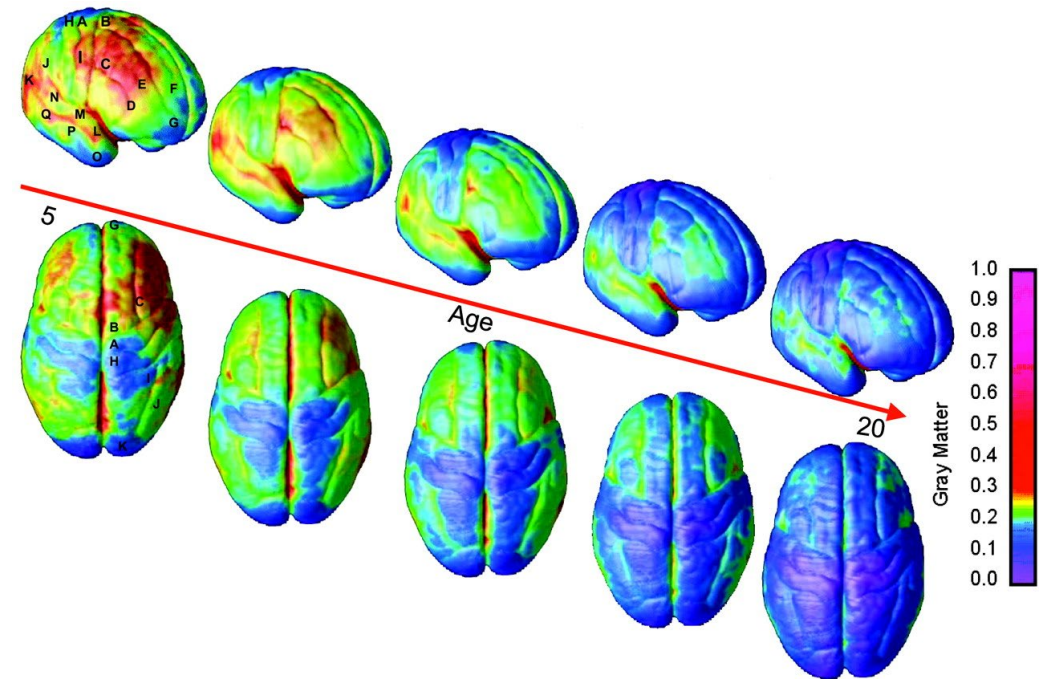




# Synaptic pruning – a key process sculpting the brain

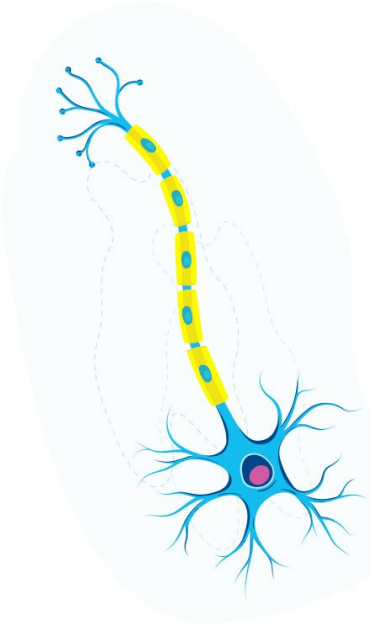


Huttenlocher PR. *Brain Res.* 1979;163(2):195-205



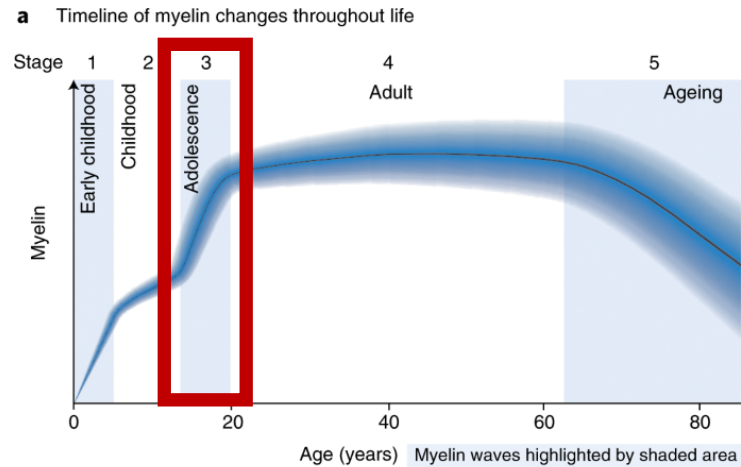
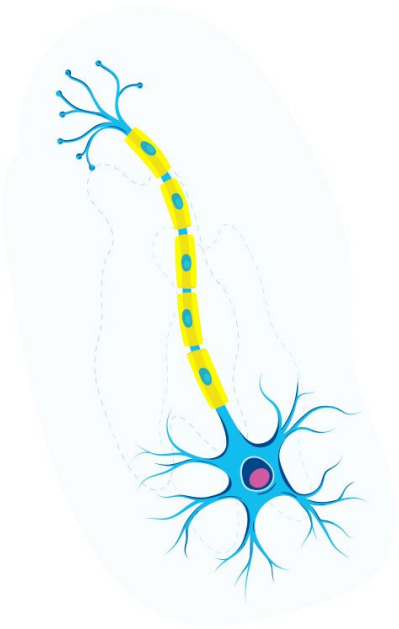
Gogtay N, et al. *Proc Natl Acad Sci U S A.* 2004;101(21):8174-9.

# Dramatic increase in insulating axons



# Dramatic increase in insulating axons

Myelination increases

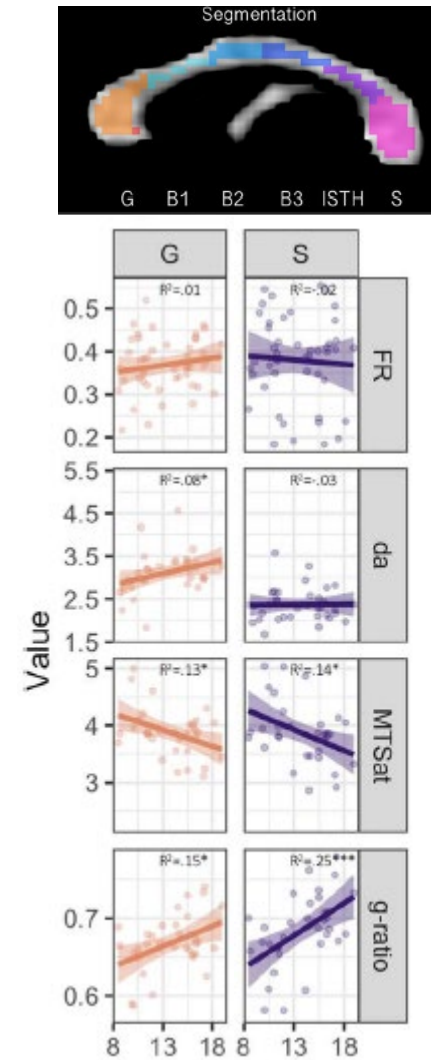
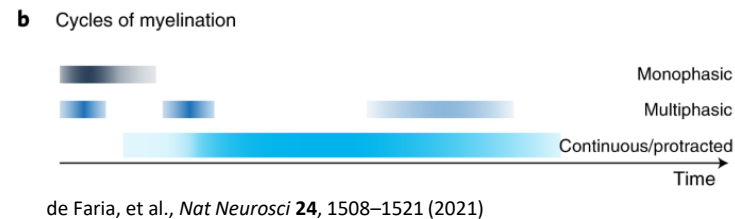
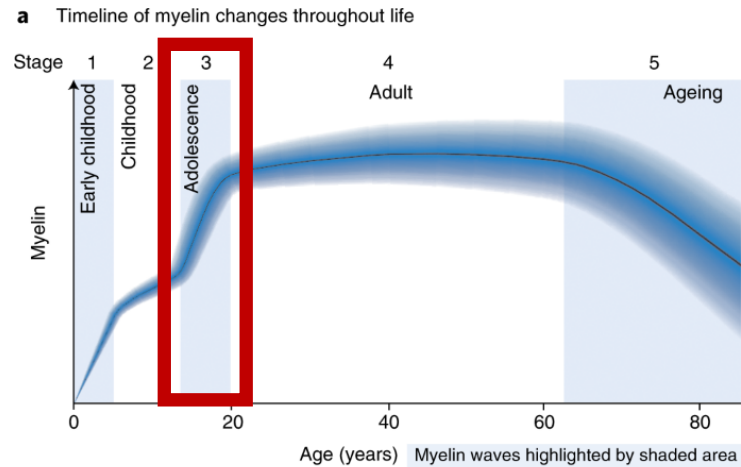
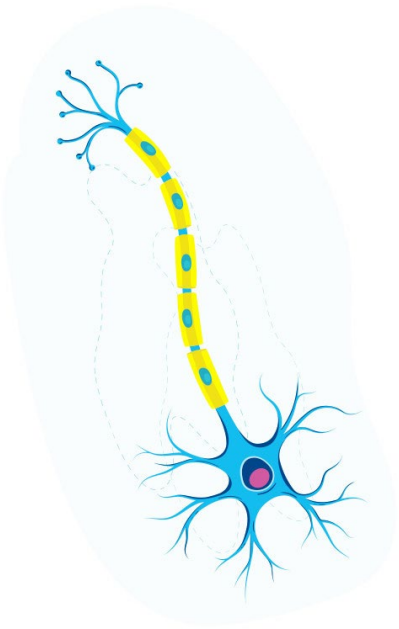


de Faria, et al., *Nat Neurosci* **24**, 1508–1521 (2021)

# Dramatic increase in insulating axons

Myelination increases

Axon diameter increases



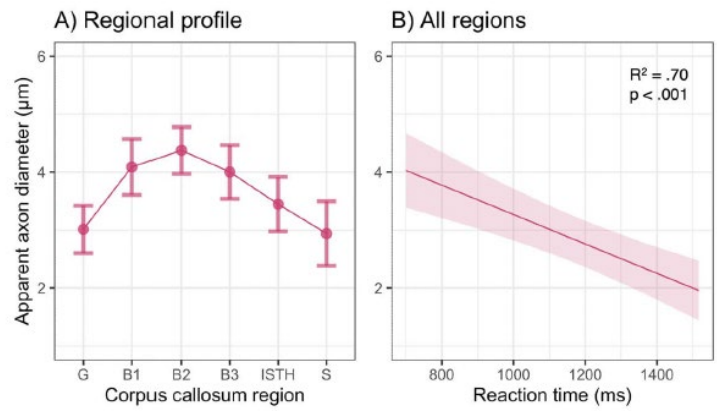
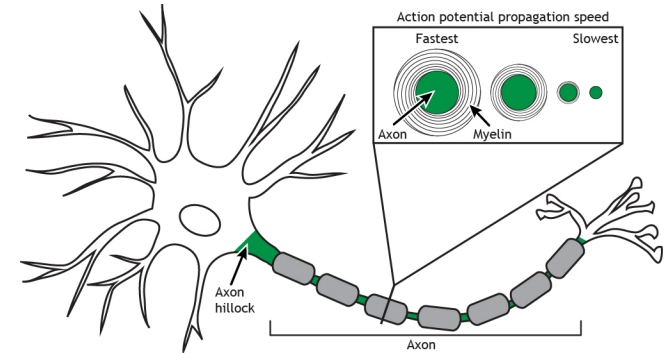
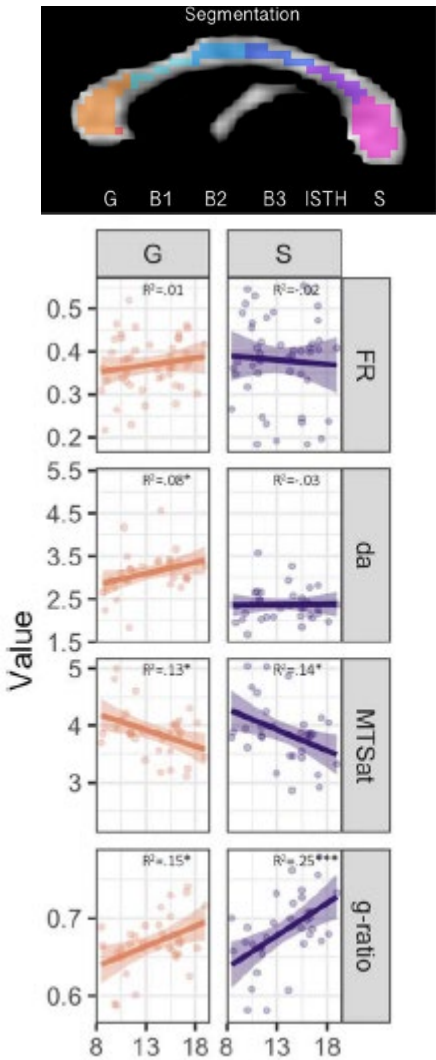
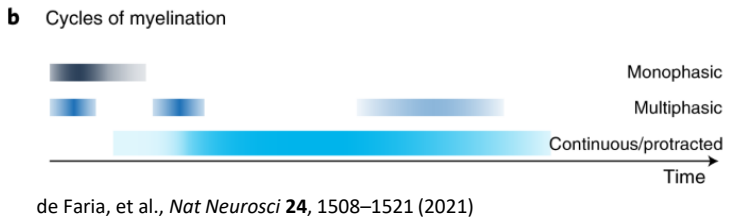
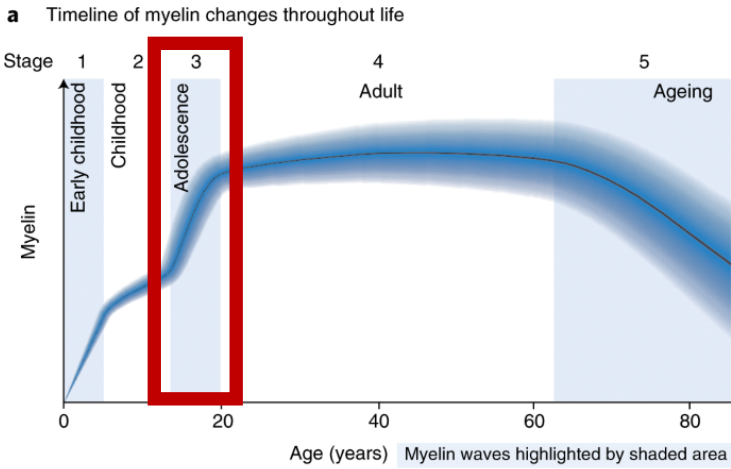
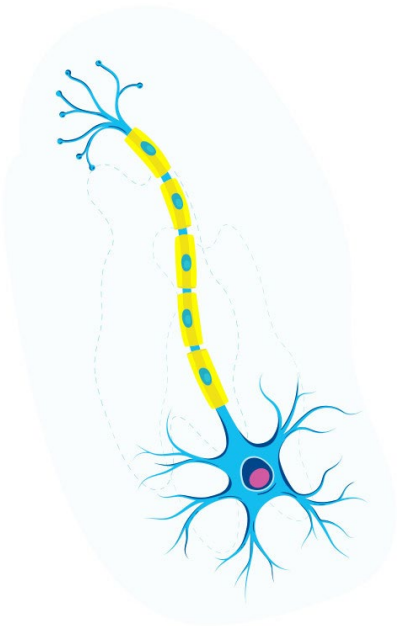
Genc S, et al. *Cereb Cortex*. 2023 33(10):6435-64

# Dramatic increase in insulating axons

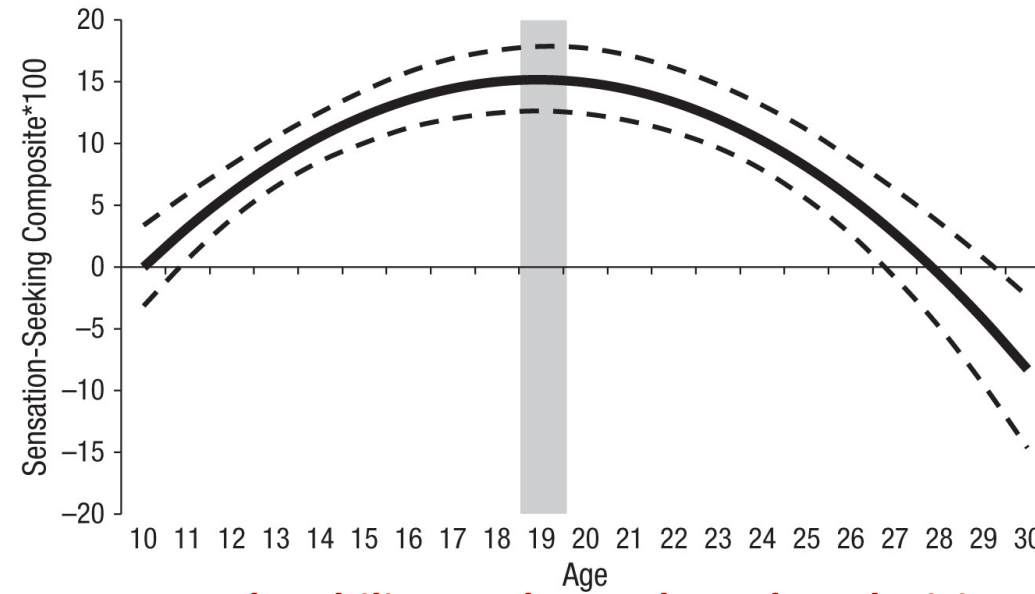
Myelination increases

Axon diameter increases

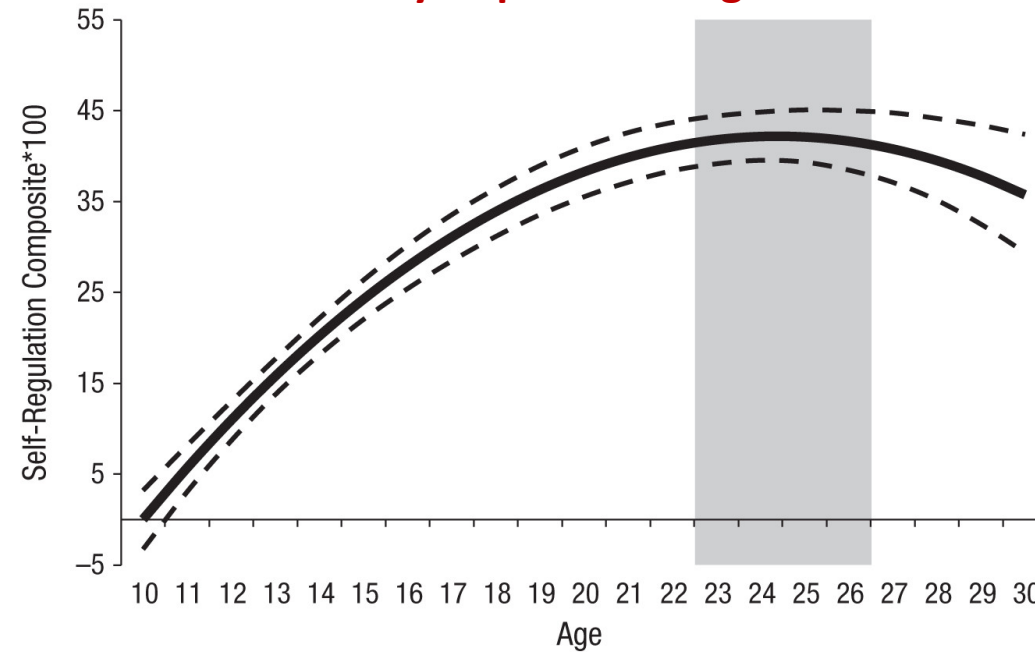
Larger axons conduct faster and result in better working memory



## SENSATION SEEKING: the desire to experience novel and rewarding stimuli

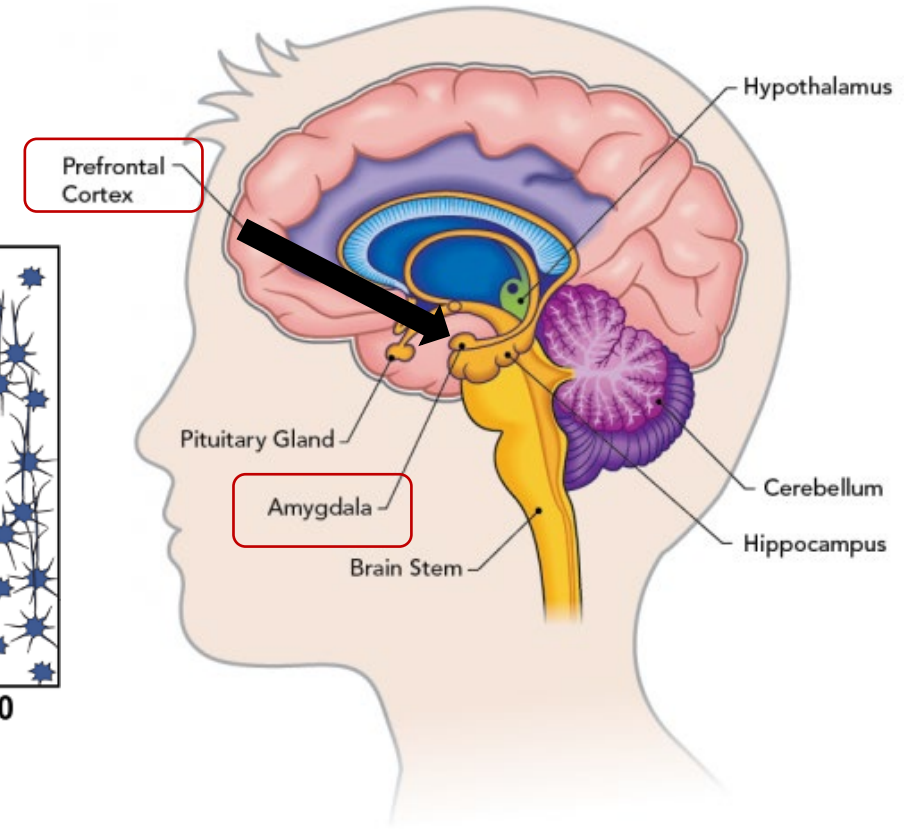
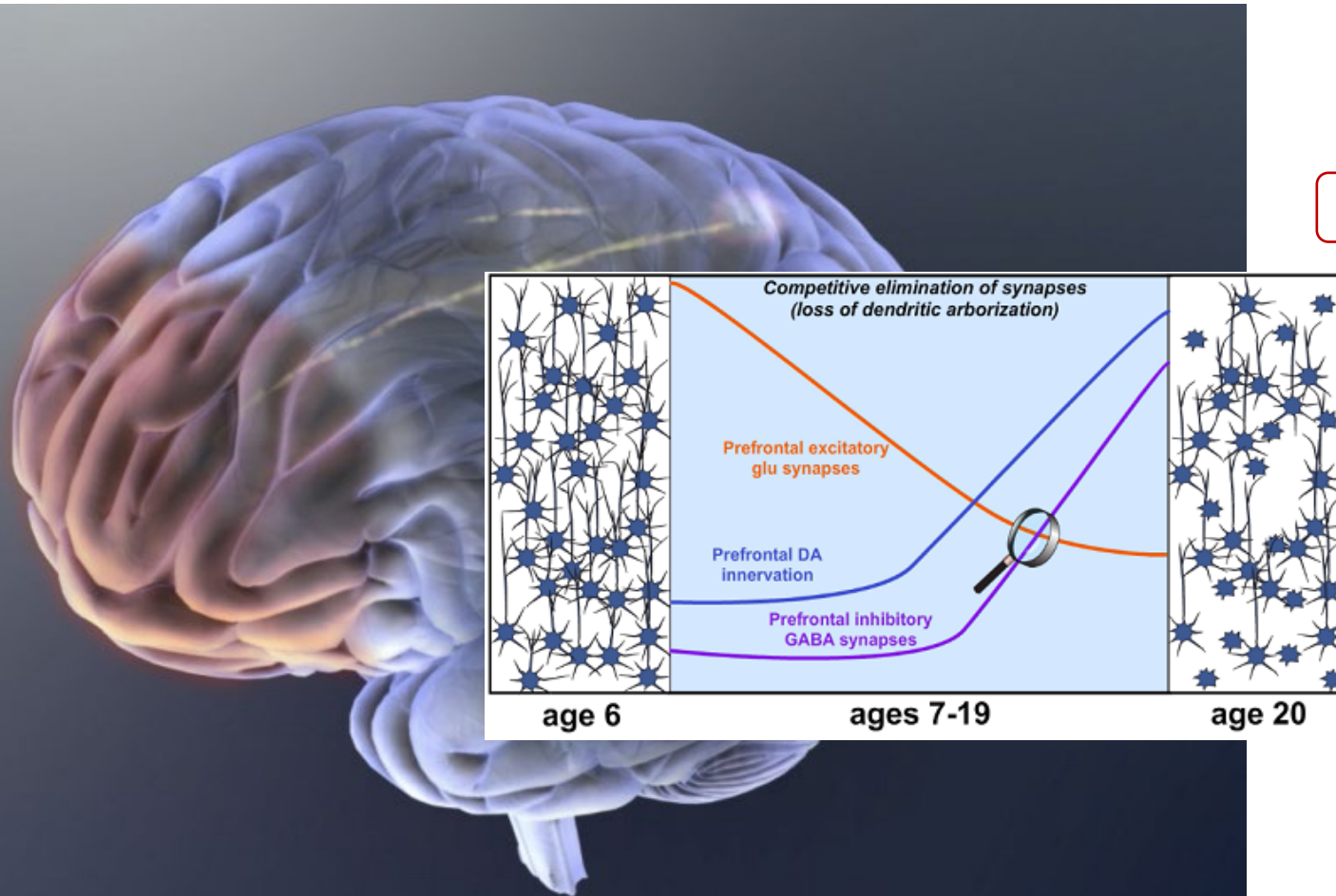


## SELF-REGULATION: the ability to plan and regulate decisions and actions





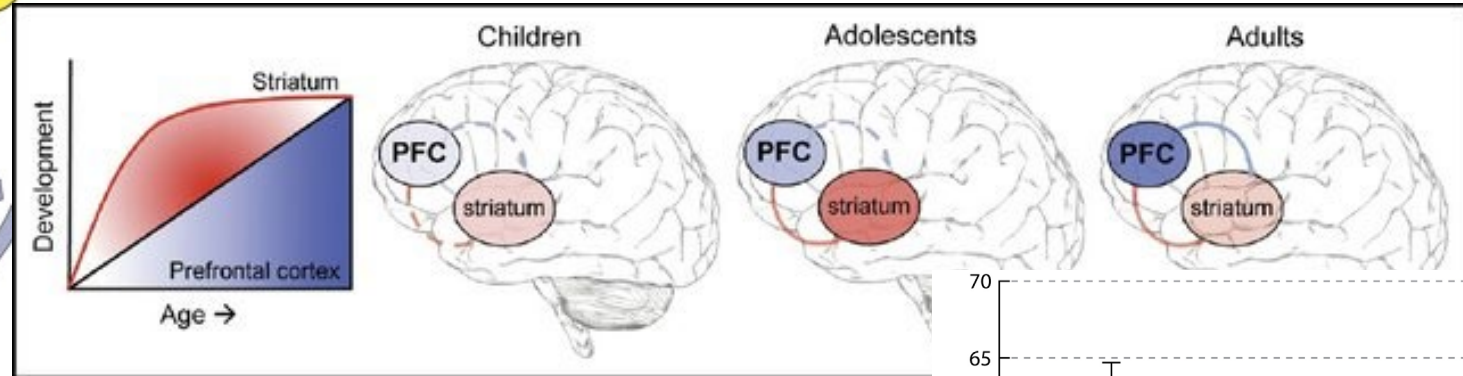
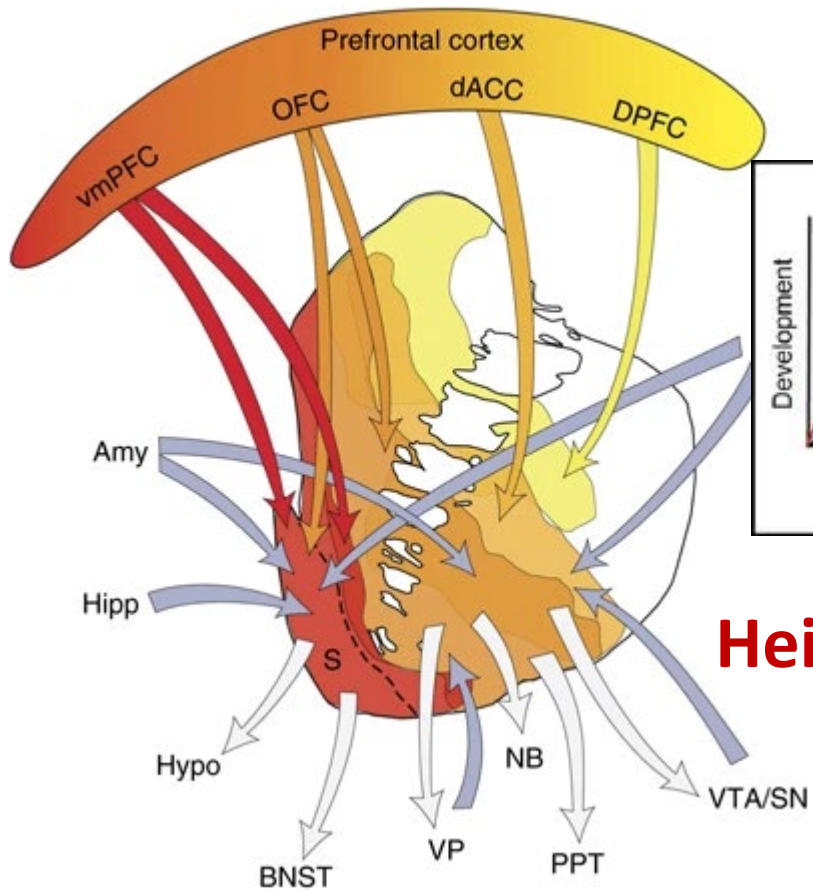
# Still maturing PFC insufficiently controls the amygdala



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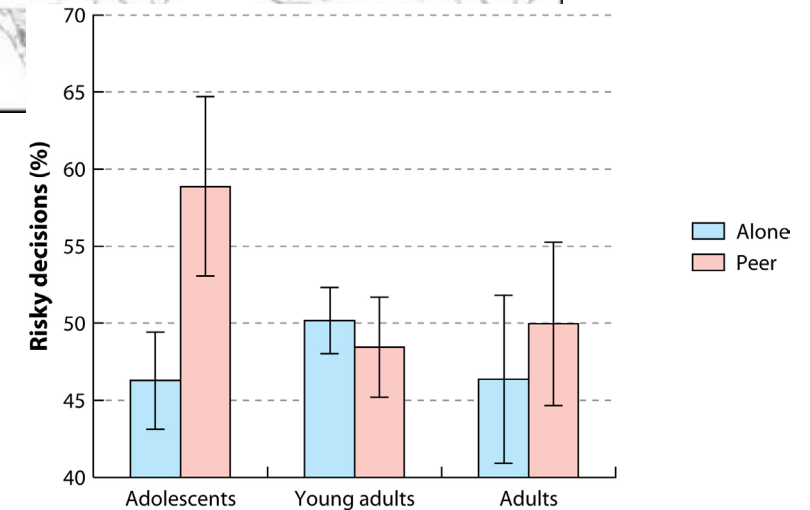
**Heightened emotional  
vulnerability**

# Still maturing PFC insufficiently controls the striatum



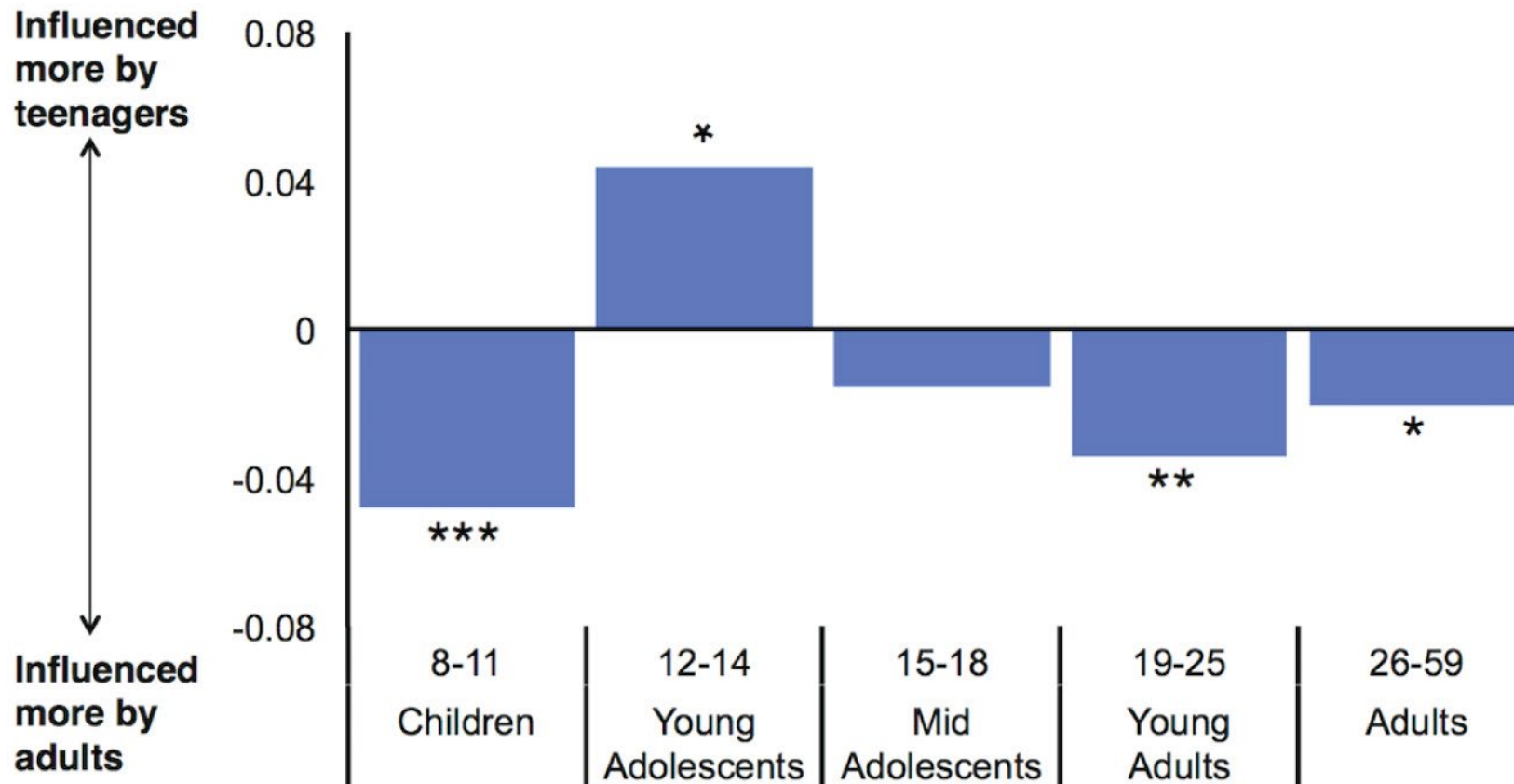
Somerville LH, Casey BJ. *Current Opinion in Neurobiology*, Vol. 20:236- 241. 2010

**Heightened reward sensitivity**

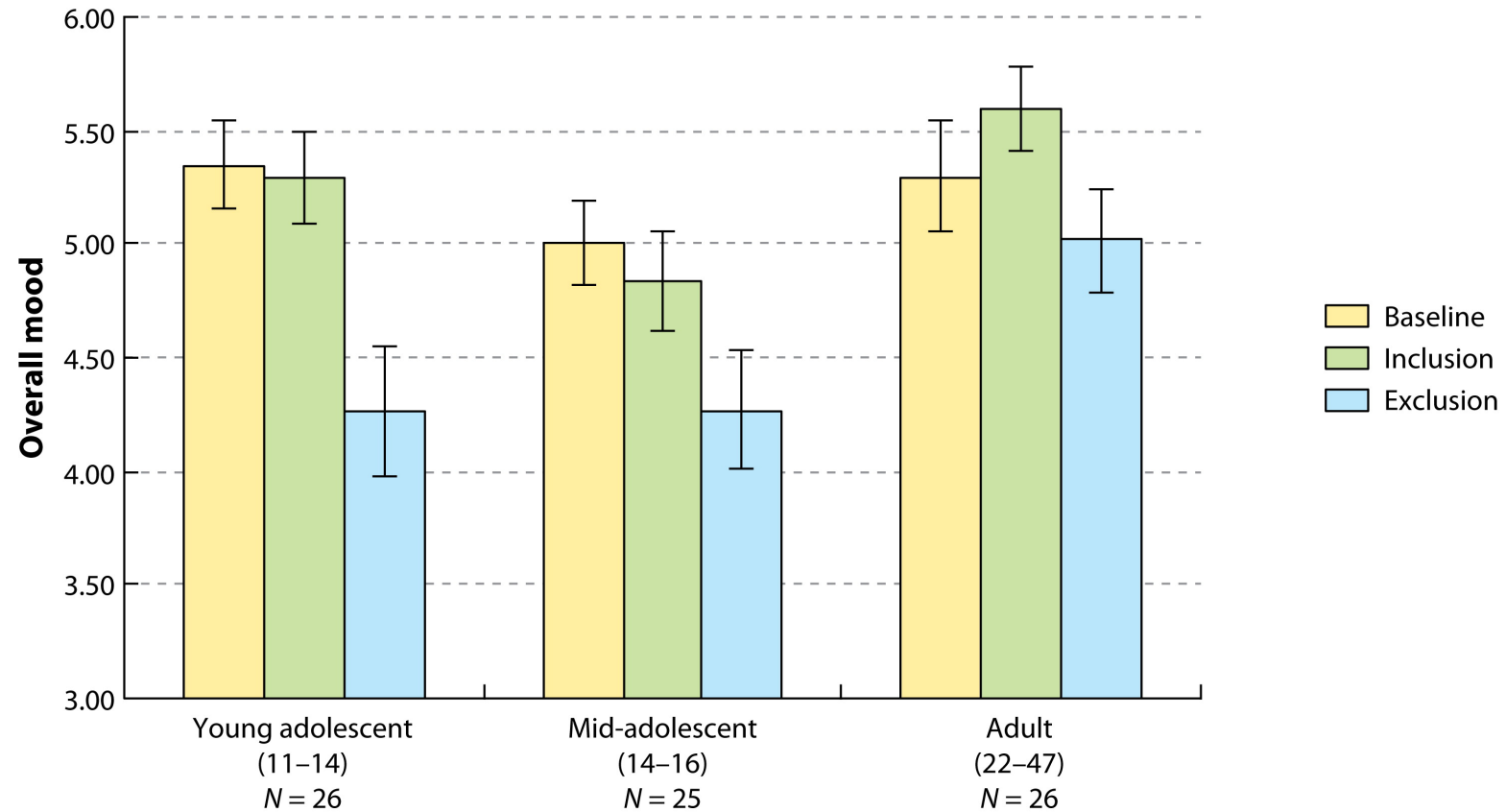




# Young adolescents are more influenced by peers

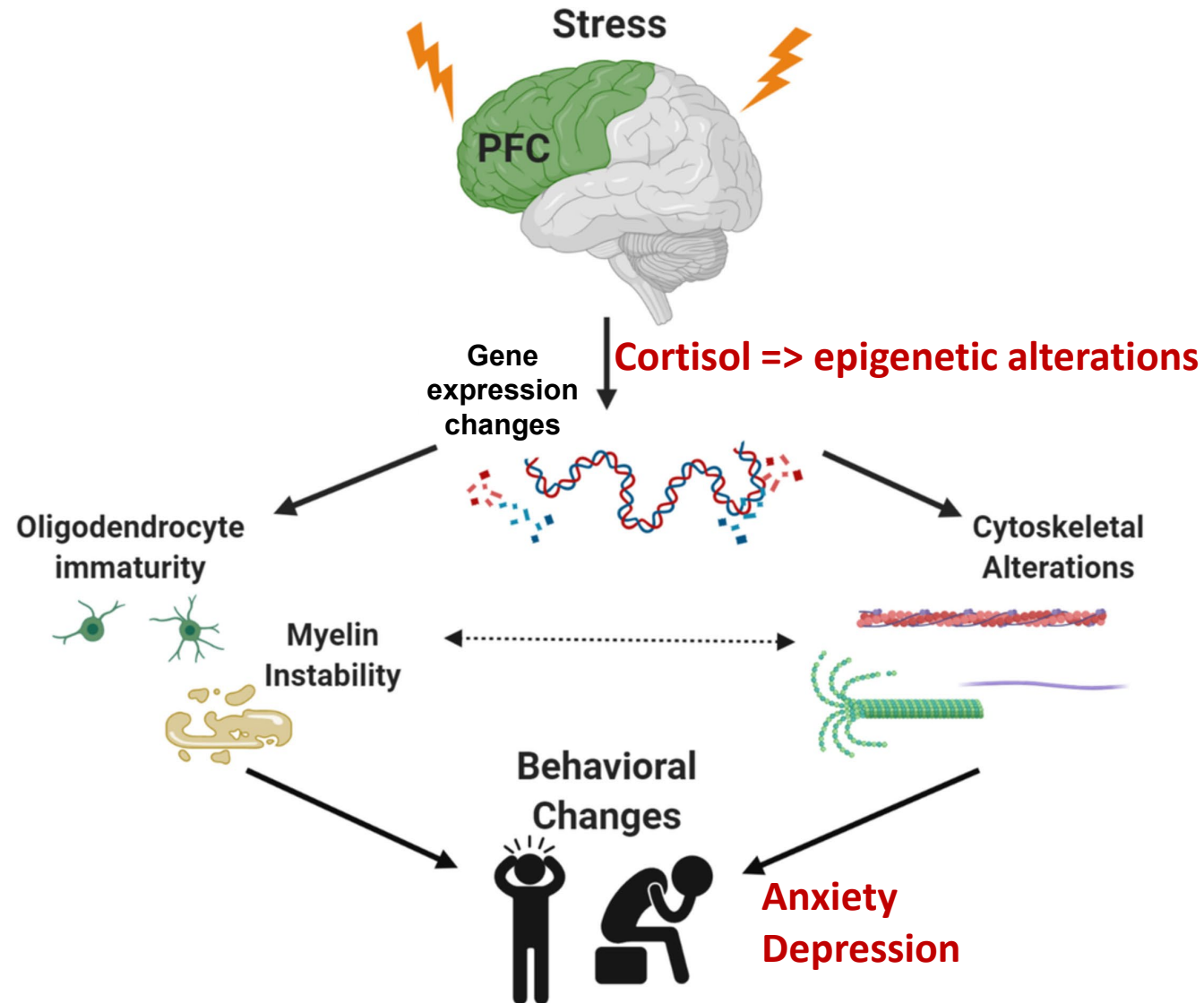


# Adolescents are hypersensitive to the negative consequences of social exclusion



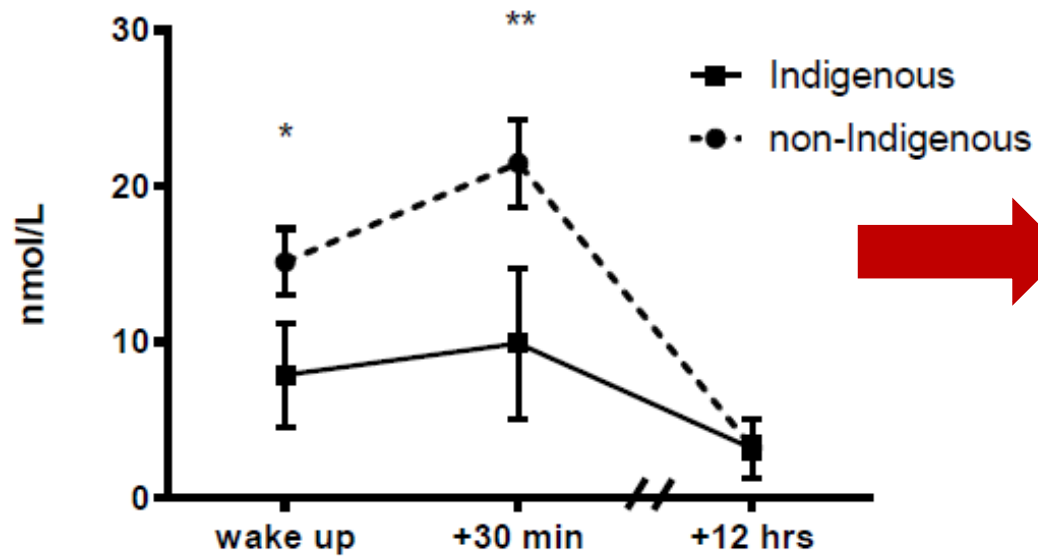
AR Blakemore S-J, Mills KL. 2014.  
Annu. Rev. Psychol. 65:187–207

# Psychosocial stress vulnerability during adolescence



# Inappropriate stress response in Indigenous youths

## Blunted CAR



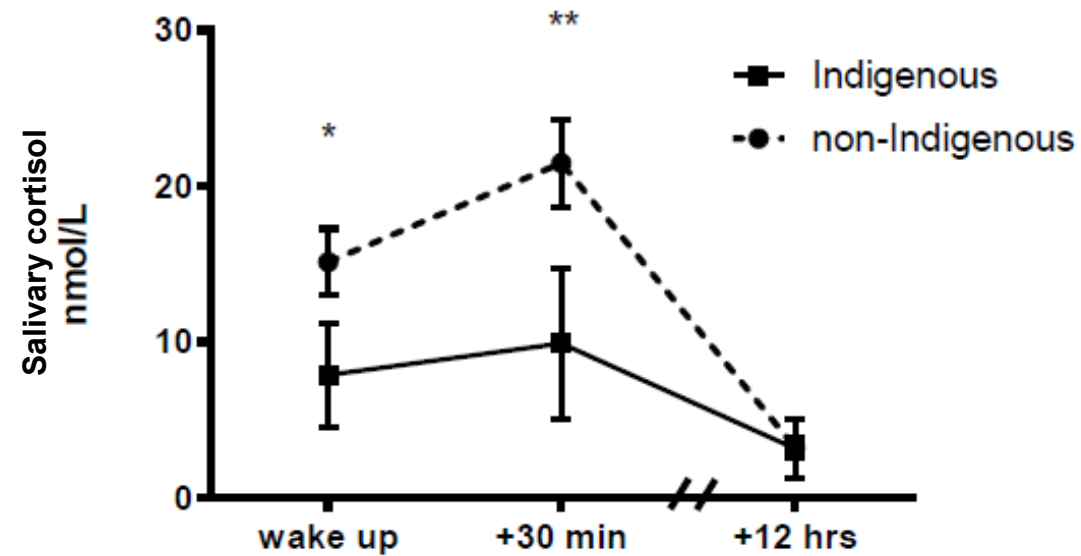
Abnormal  
Stress  
Response

## Mental illness

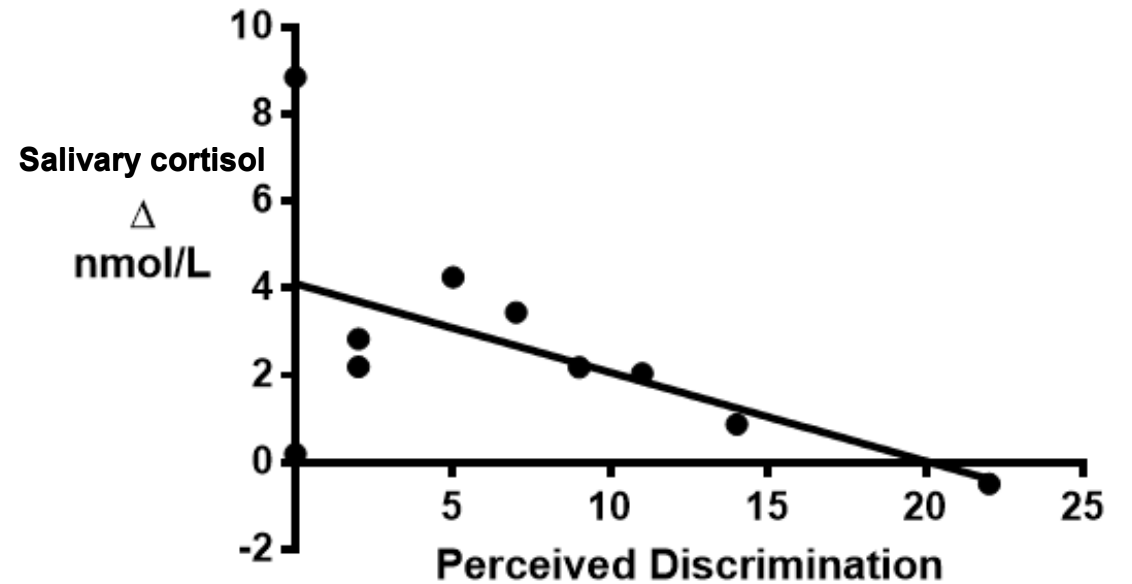
Anxiety  
Depression  
PTSD  
Psychosis  
Drug Addiction

# Inappropriate stress response in Indigenous youths

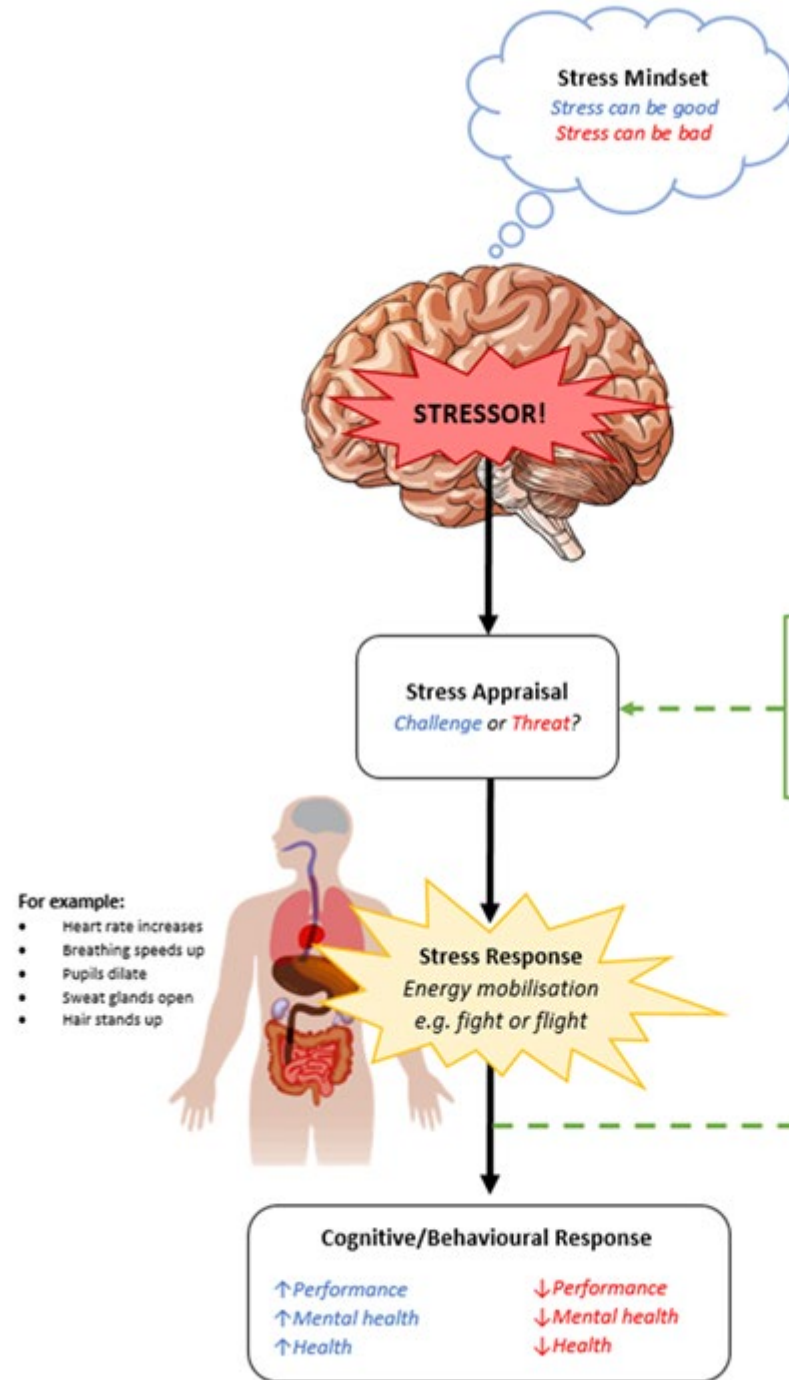
## Blunted CAR



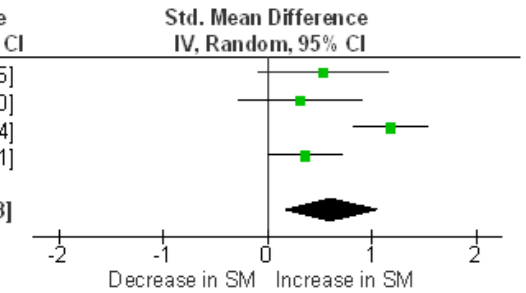
## Higher perceived discrimination => more blunted CAR



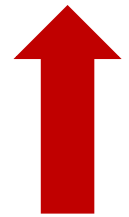
# Positive stress mindset



Study or Subgroup	Experimental			Control			Weight	Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Crane et al. (2020) (Community)	3.32	0.43	34	3.11	0.27	15	21.3%	0.53 [-0.09, 1.15]
Crane et al. (2020) (Corporate)	3.24	0.46	38	3.11	0.27	16	22.0%	0.31 [-0.28, 0.90]
Keech et al. (2021)	4.27	0.83	69	3.28	0.84	70	28.3%	1.18 [0.82, 1.54]
Wols et al. (2020)	1.68	0.61	77	1.45	0.67	52	28.4%	0.36 [0.01, 0.71]
<b>Total (95% CI)</b>			<b>218</b>			<b>153</b>	<b>100.0%</b>	<b>0.62 [0.15, 1.08]</b>
Heterogeneity: $\tau^2 = 0.16$ ; $\chi^2 = 12.22$ , $df = 3$ ( $P = 0.007$ ); $I^2 = 75\%$								
Test for overall effect: $Z = 2.61$ ( $P = 0.009$ )								



Marie et al., unpublished

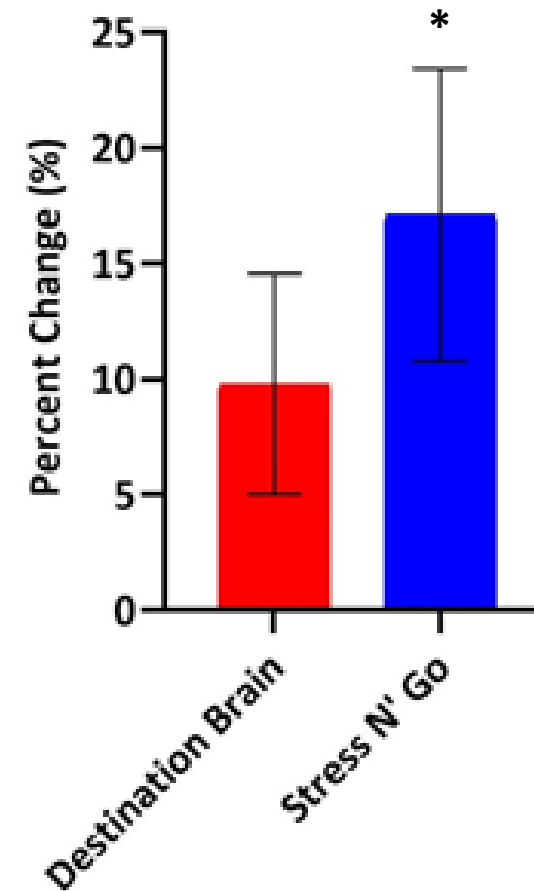
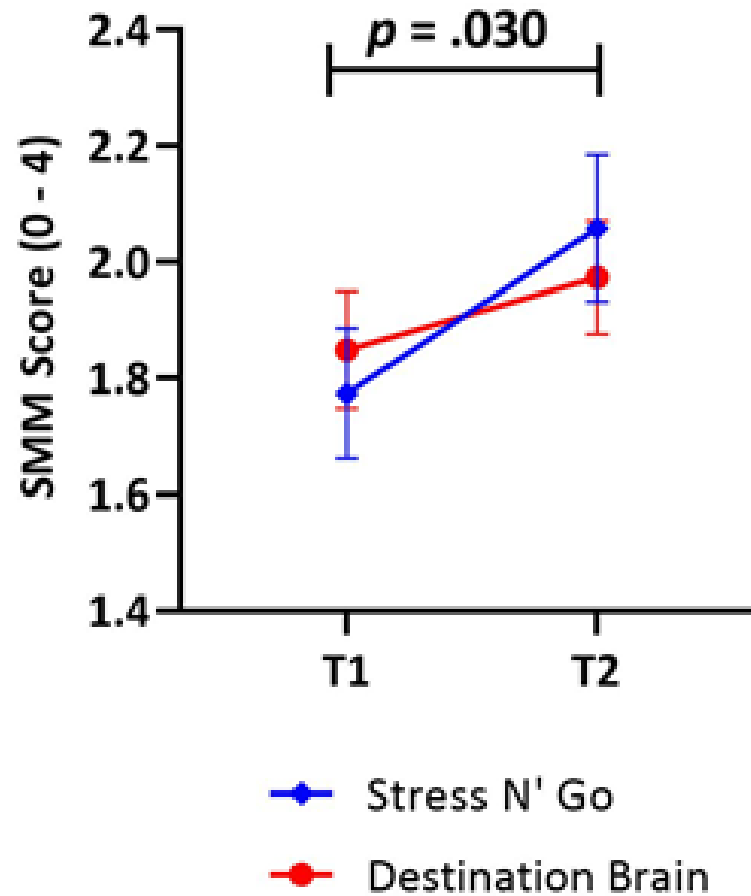


# Positive stress mindset



- Learn to recognize a physiological stress response
- Understand the usefulness of the physiological stress response in life
- Modify negative stress preconceptions to make them more positive.
- Learn that it is possible to use the physiological stress response to one's advantage during stressful experiences such as school examinations.

# Positive stress mindset





# Key messages about the adolescent brain

1. **Still developing** - susceptibility to psychosocial stressors
2. **Has a predilection to risky behaviours**
3. **Hypersensitive to social influence by peers**



1. Youth crime cannot be reduced by more psychosocial stress, deprivation and abuse
2. Focusing on social norms and peer expectations have positive impact on adolescent behavior
3. Effects of psychosocial stress to be managed and mitigated