

# Brain Development Across the Lifespan

SPICE 2024

Neuroscience & Computational Psychiatry Module

Class II

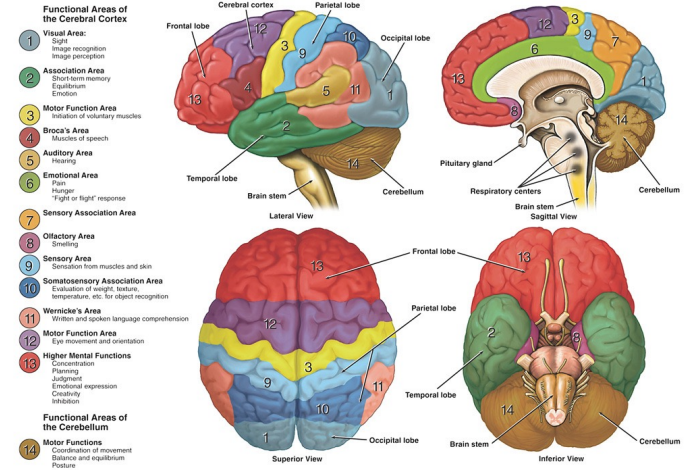
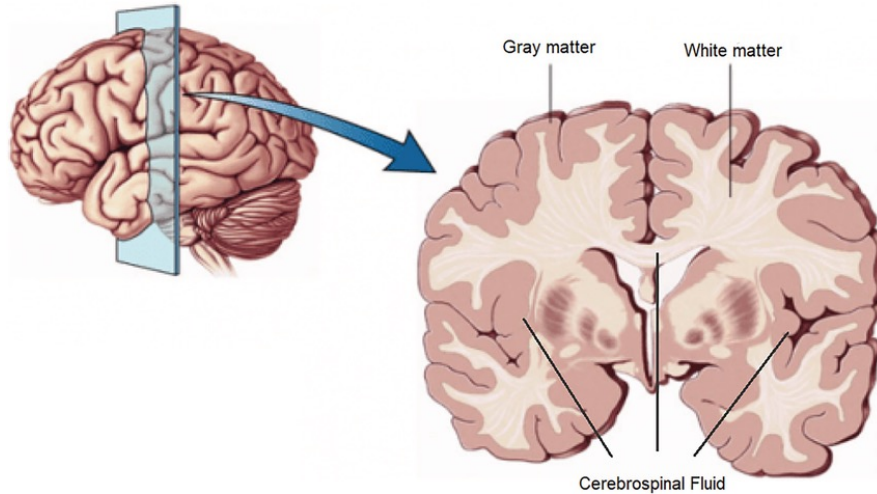


**Mount  
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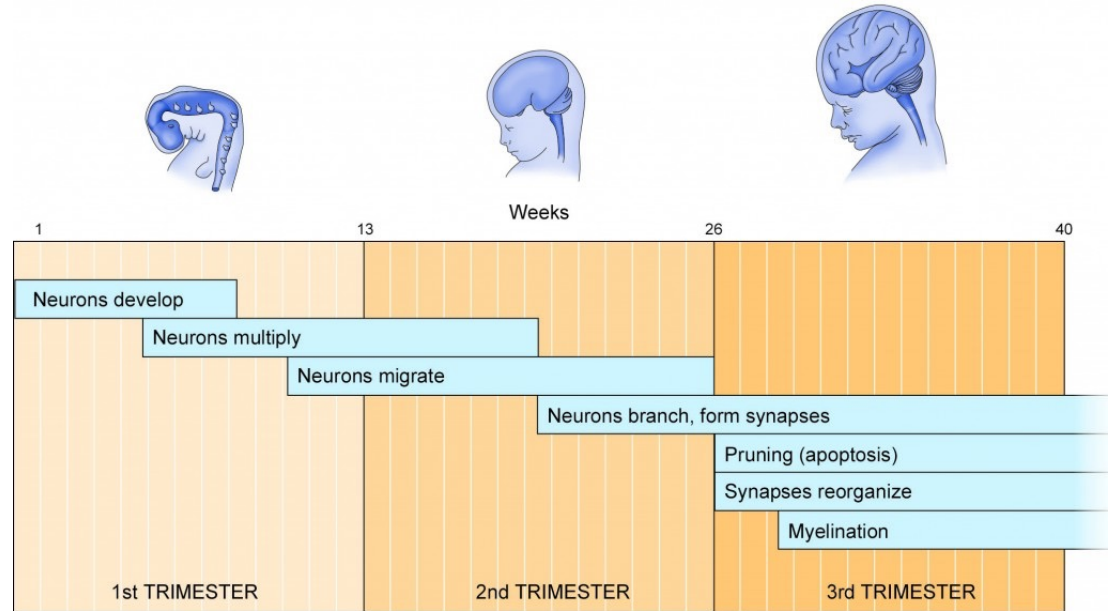
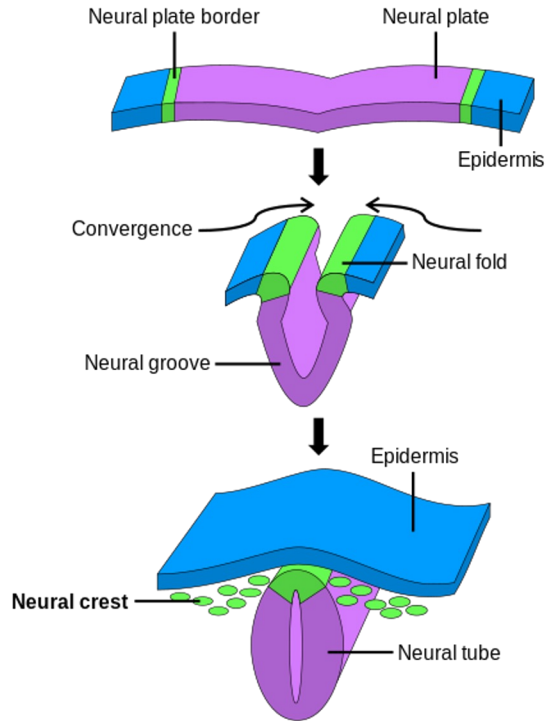
*Center for  
Computational  
Psychiatry*

28<sup>th</sup> of June 2024

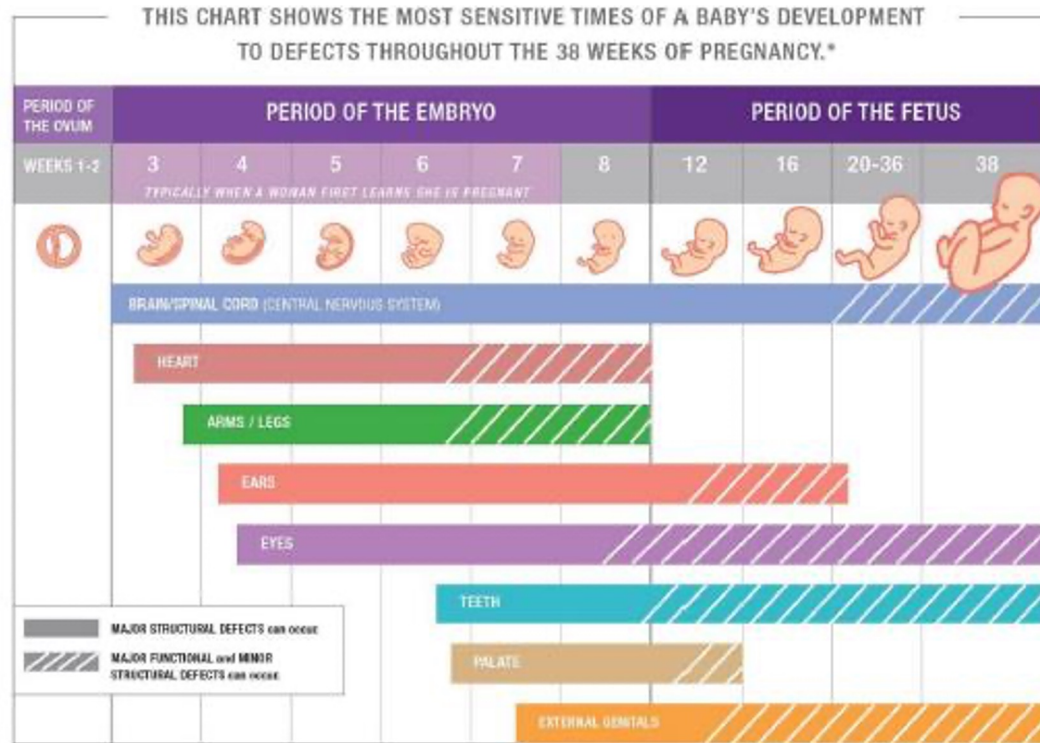
# The Brain



# Brain Development: In Utero



# Brain Development: In Utero



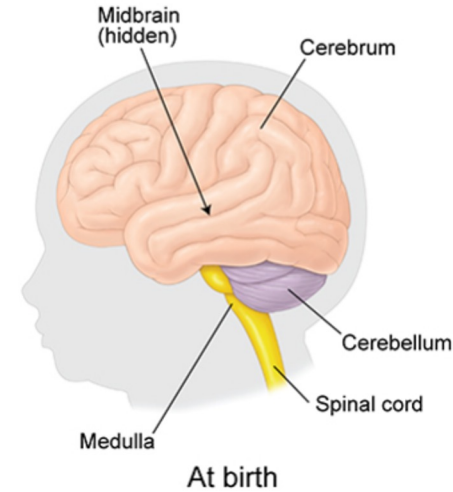
# The Brain: Early Childhood Brain Development

## Before Birth:

- Most neurons in the adult brain have been generated before birth
- Most of the long range connections are also present at birth

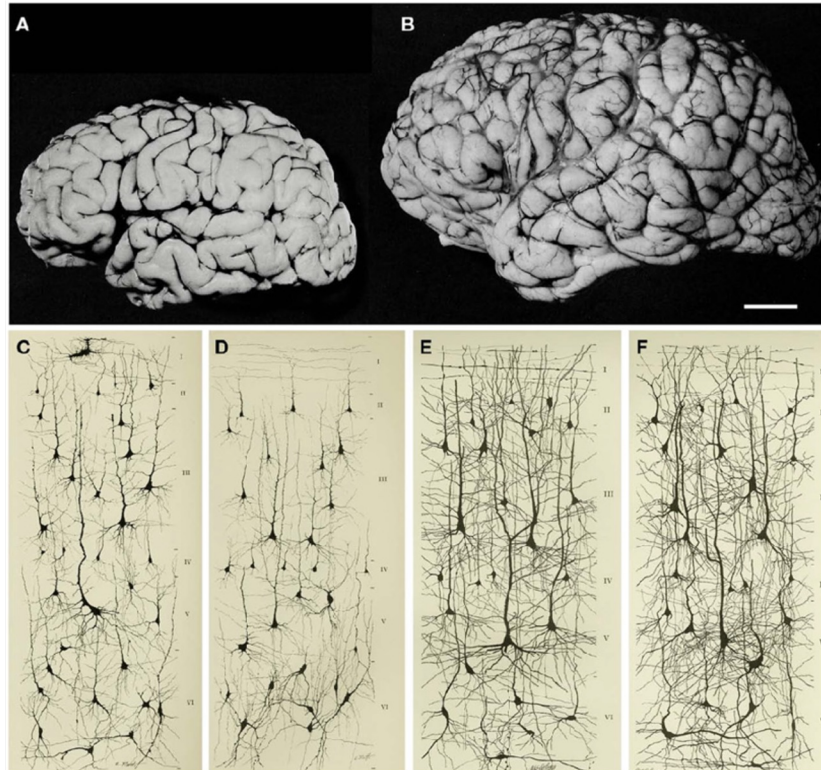
## After Birth:

- **Rapid Expansion:** The brain doubles in size during the first year, with significant growth continuing until age two.
- **Synaptic Growth:** Neurons rapidly form complex connections (synapses), crucial for learning and development (peak at approx. 2 years).
- **Myelination:** Fatty insulation (myelin) develops around neurons, speeding up brain communication and progressing from central to peripheral regions. Starts from parietal to frontal regions.



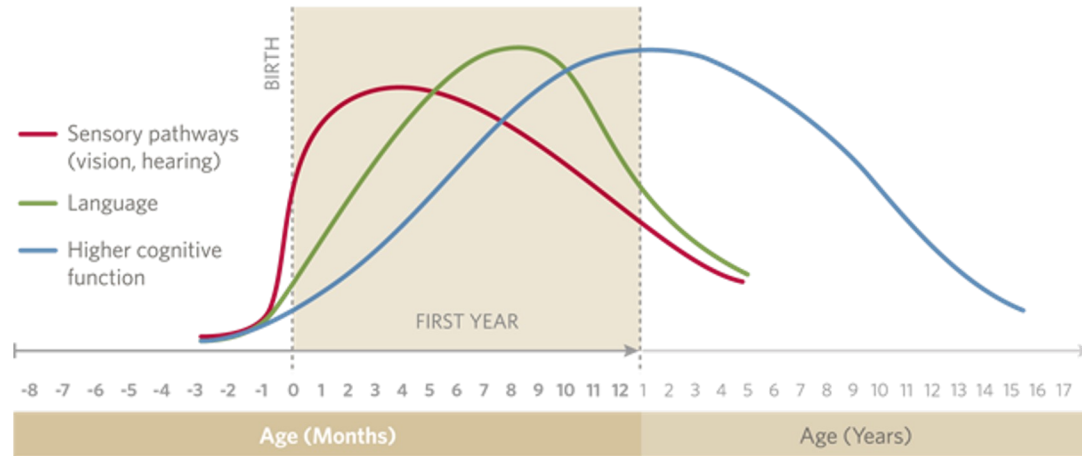
# The Brain: Early Childhood Brain Development

## 1-year-old versus 6-year-old



# Early Childhood Brain Development

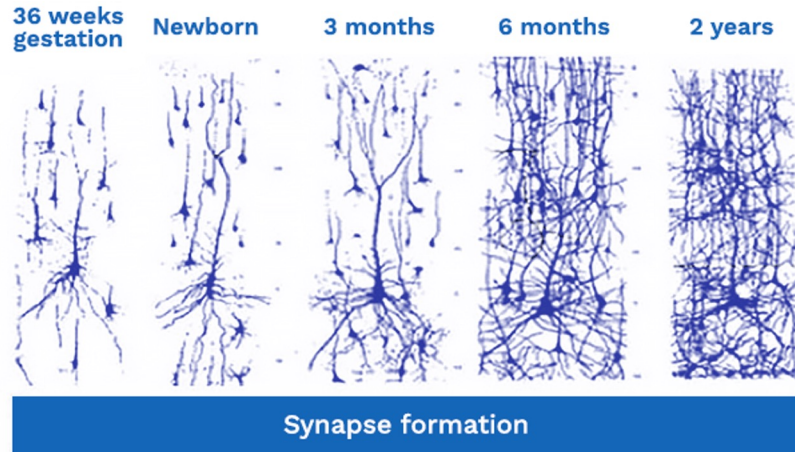
## Human Brain Development



Source: Nelson, C. (2000). *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington, DC: The National Academies Press.



# Early Childhood Brain Development – Synaptic Pruning



**Synaptic Pruning:** The brain's process of eliminating weak or unused neural connections to increase efficiency and strengthen important pathways.



## Early Childhood To Adolescence – Synaptic Pruning

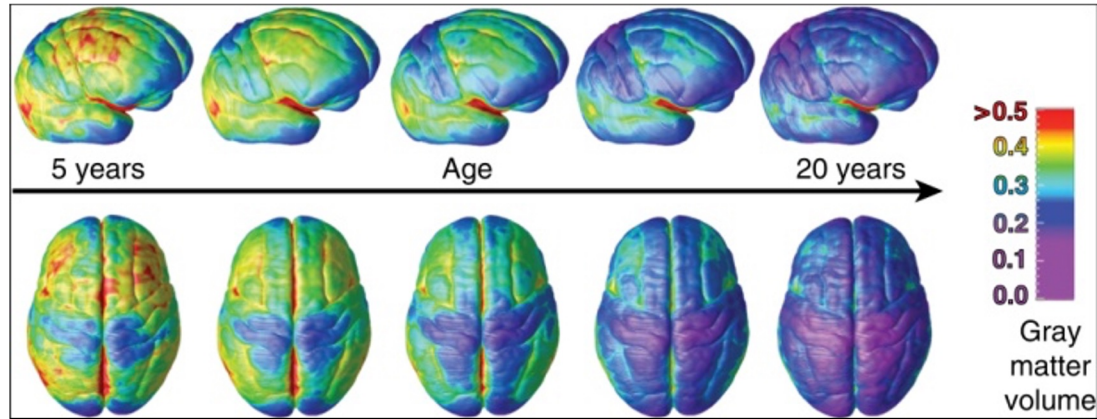
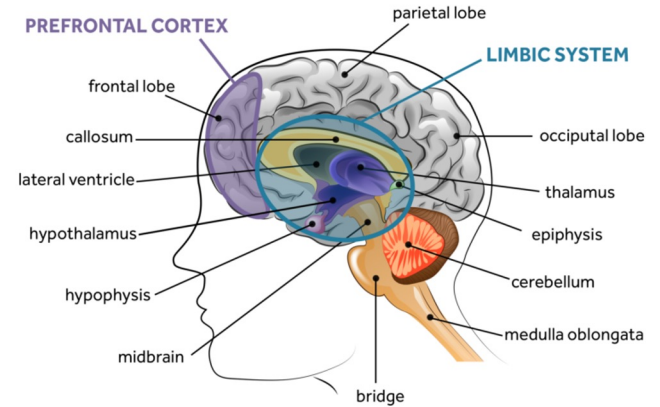
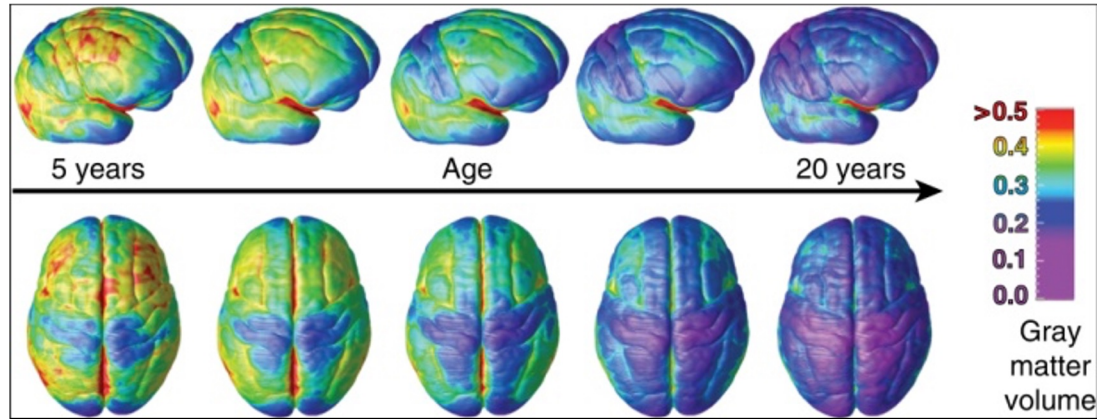


Image: Giedd et al., 2014

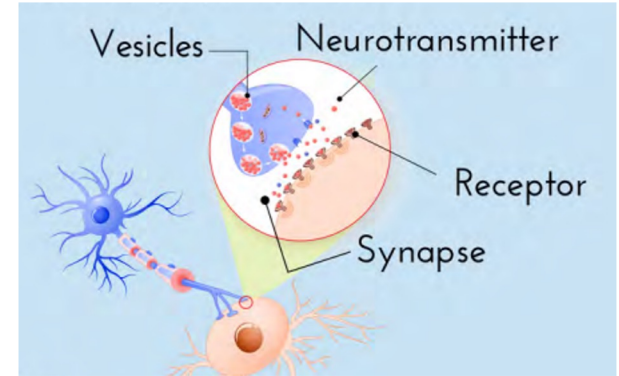
# Adolescence & Young Adulthood



Images: Giedd et al.,  
2014; Futurelearn.com

## Adolescence & Young Adulthood

- **Neuroplasticity:** The brain's ability to change and adapt through experience.
- **Long-Term Potentiation (LTP):** A process where repeated activation of a neural pathway strengthens the connections between neurons, making it easier for them to fire together in the future.



- **Learning:** LTP is a key mechanism underlying learning and memory formation.

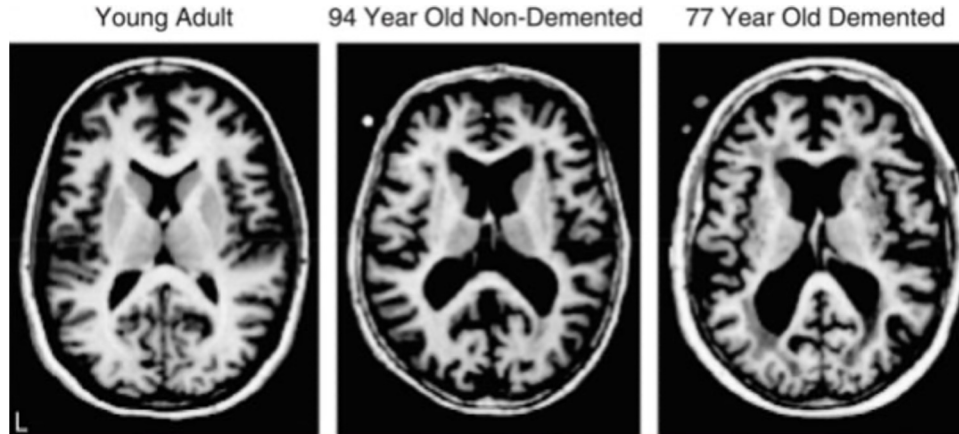
# Adolescence & Young Adulthood

- **Sensitive Period:** Adolescence is a sensitive period for learning, with the brain primed to acquire new skills and knowledge.
- Our environment and experiences matter!

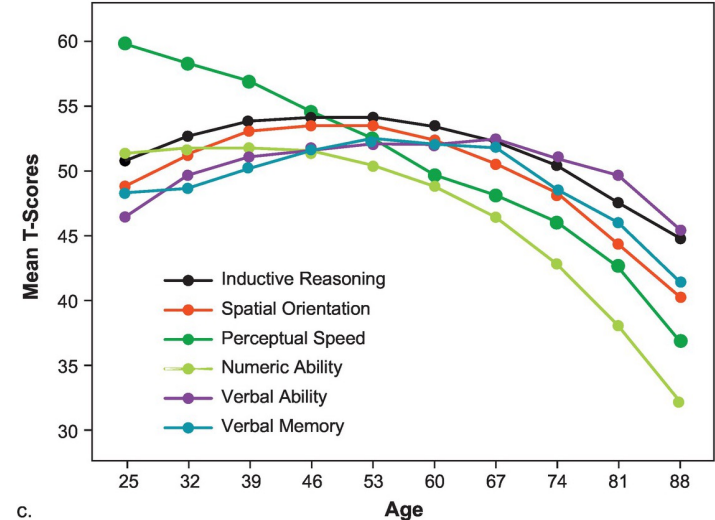


- Many **psychiatric disorders** arise during adolescence and before (e.g., obsessive-compulsive disorder, ADHD)
- Neuroplasticity also supports therapeutic interventions

# The Ageing Brain



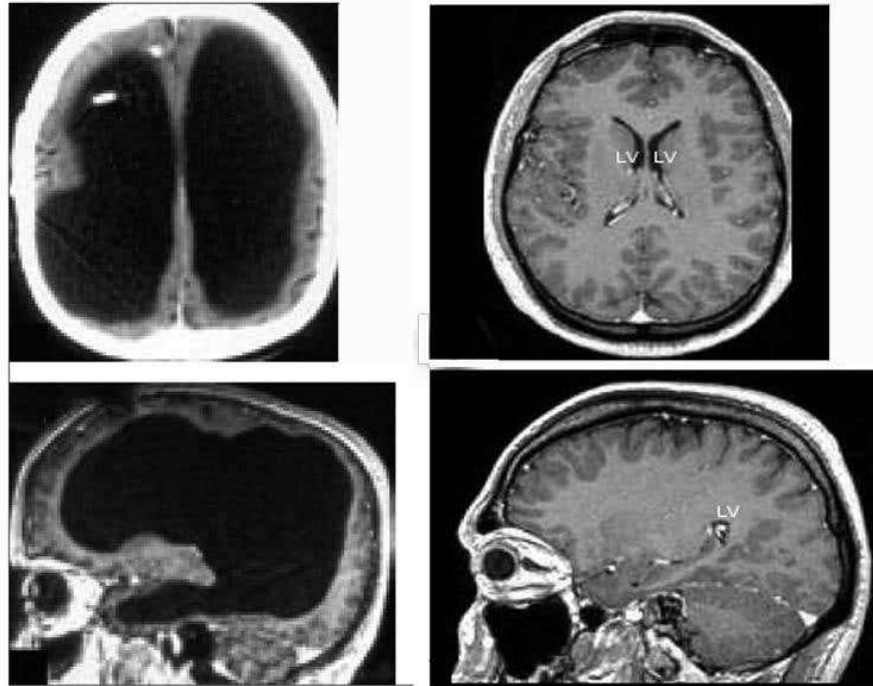
*Longitudinal Estimates of Mean Factor Scores for the Latent Ability Constructs*



c.

Note. From 7-year within-subject data.

## Volume is not Everything



Buckley, 2017

## Summary

- **Lifelong Journey:** The brain continuously develops and adapts.
- **Prenatal:** The brain's foundation is formed.
- **Early Childhood:** Rapid brain growth and connection formation, shaped by experiences.
- **Synaptic Pruning:** Refines neural connections for efficiency.
- **Adolescence:** Emotional brain matures, high learning potential, risk-taking tendencies.
- **Young Adulthood:** Peak cognitive function, continued adaptation.
- **Older Adulthood:** Changes in structure and function, but cognitive reserve can be built through healthy habits.





**Thank you!**

**Any Questions?**

# Thank you!

# Any Questions?

Next Class:

Monday 1<sup>st</sup> of July

10am-11am

Review

Cell  
PRESS

*Special Issue: Cognition in Neuropsychiatric Disorders*

## Computational psychiatry

**P. Read Montague<sup>1,2</sup>, Raymond J. Dolan<sup>2</sup>, Karl J. Friston<sup>2</sup> and Peter Dayan<sup>3</sup>**

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