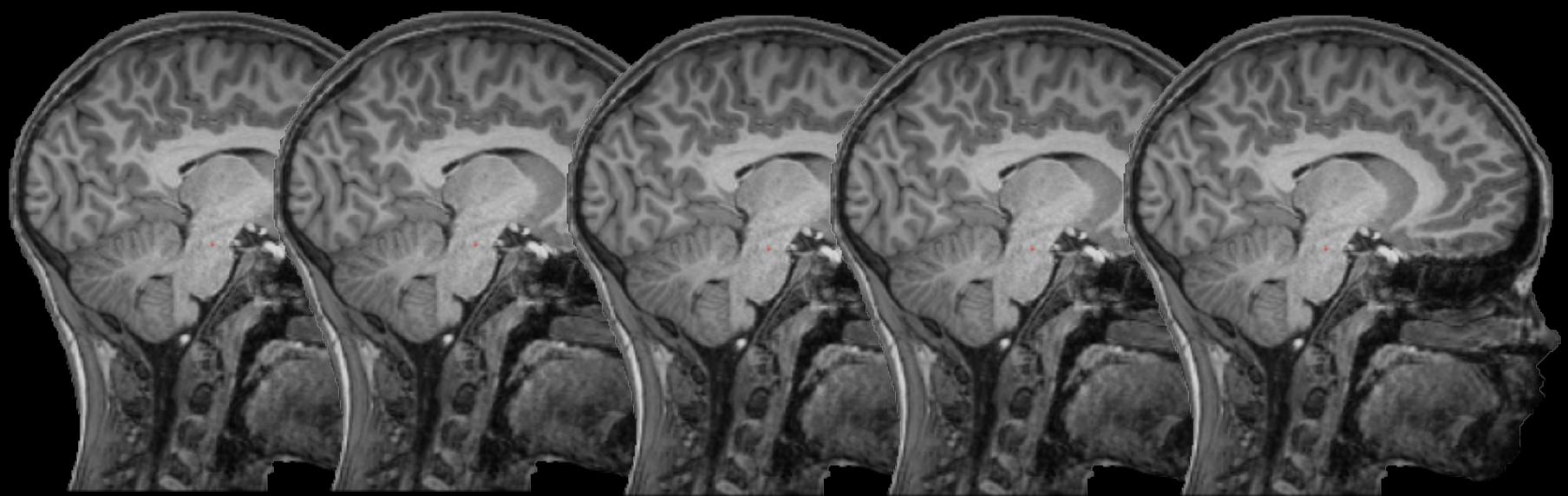


Longitudinal Developmental Structural Neuroimaging



Kate Mills

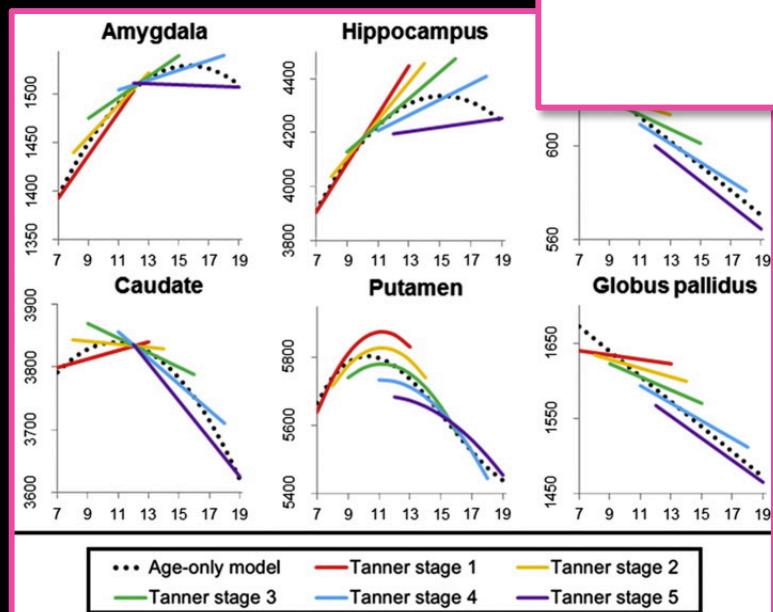




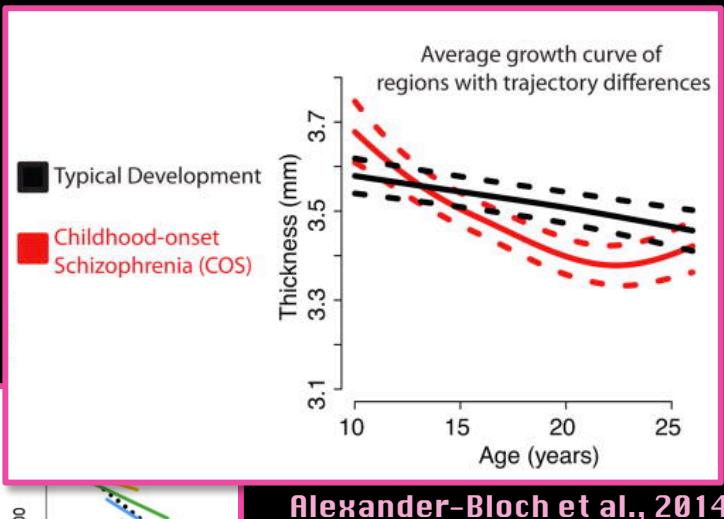
Time

Developmental disorders

Developmental processes

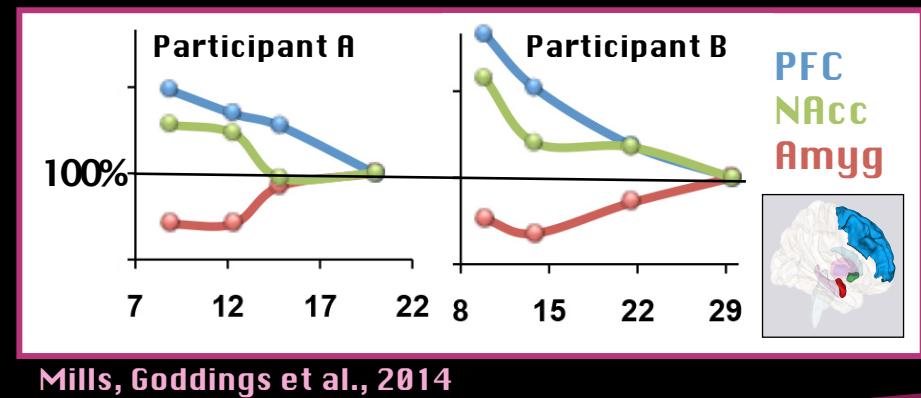


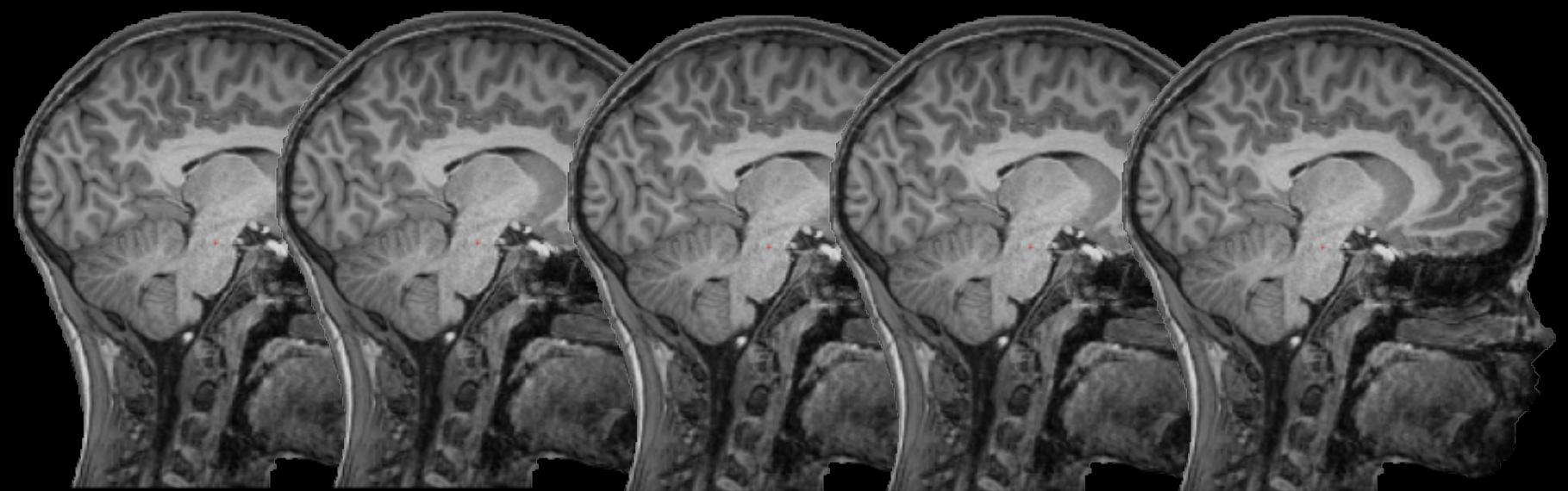
Goddings et al., 2014



Alexander-Bloch et al., 2014

Individual differences





Time

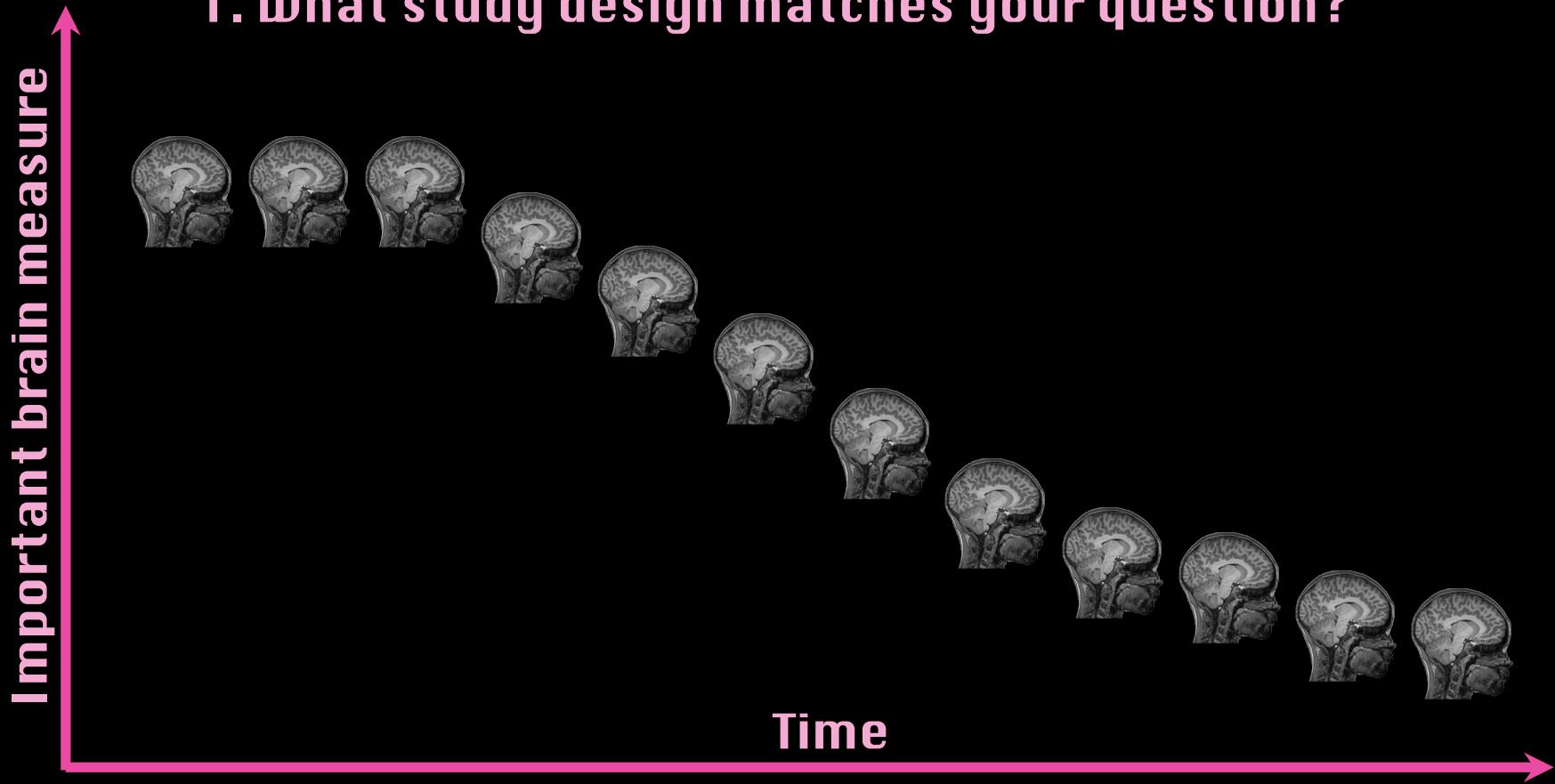


Important brain measure

Time



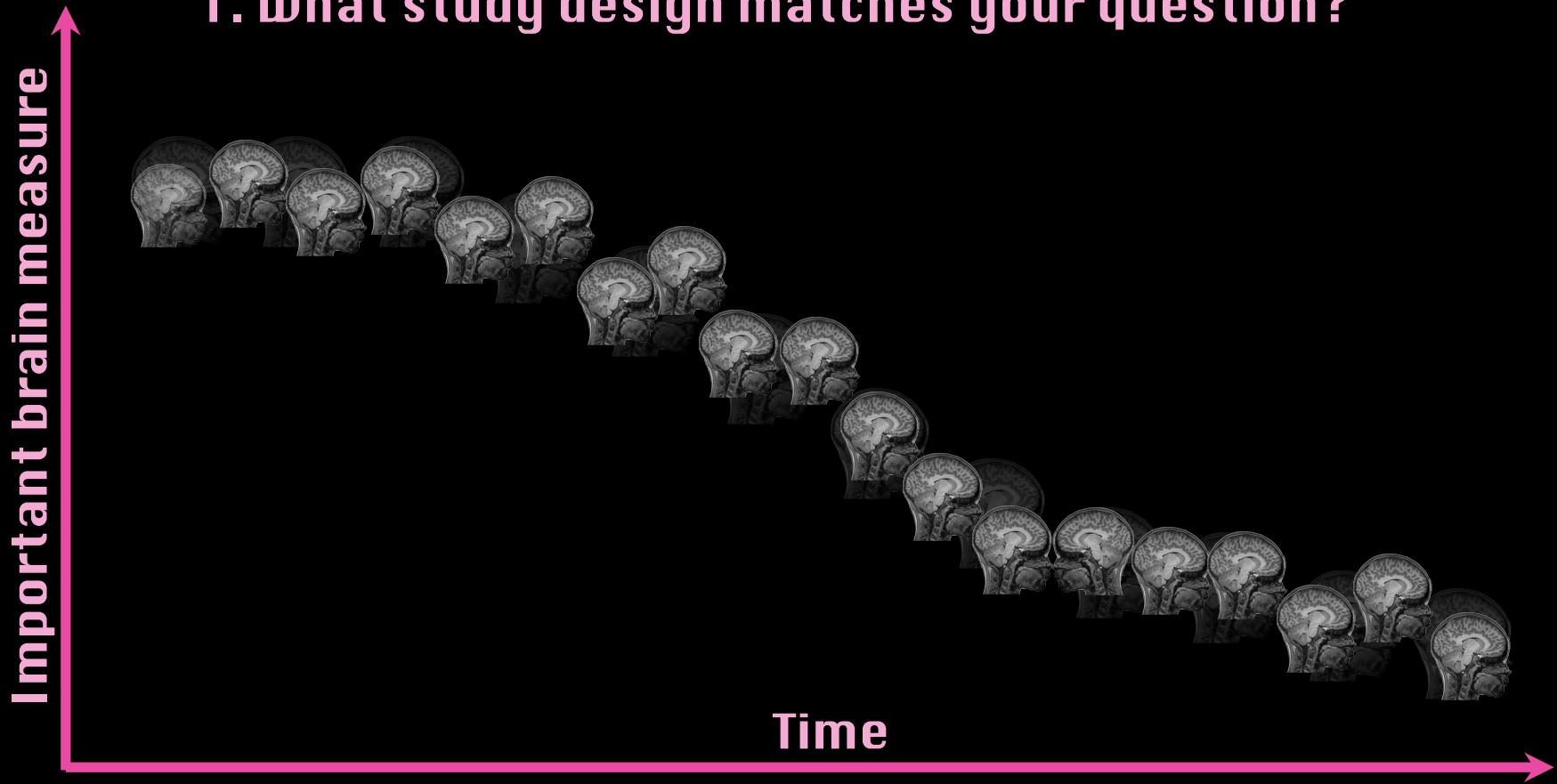
1. What study design matches your question?



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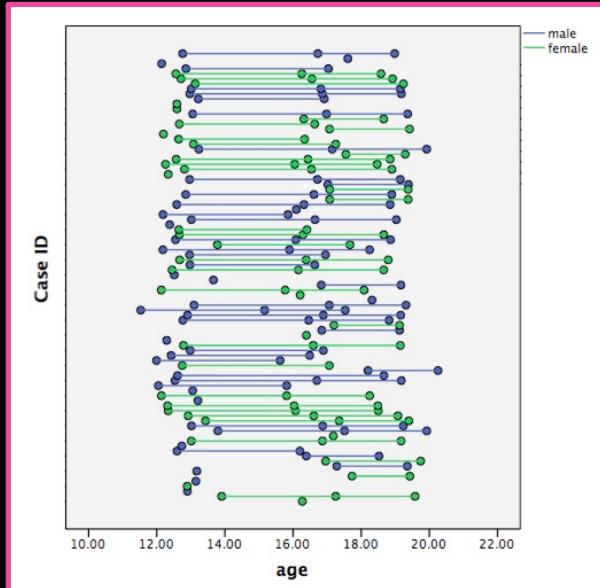


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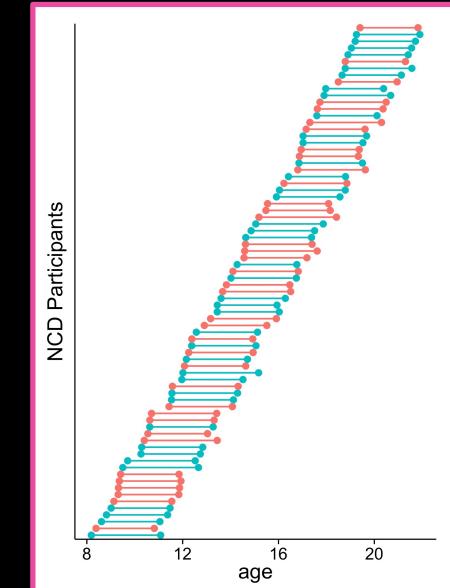
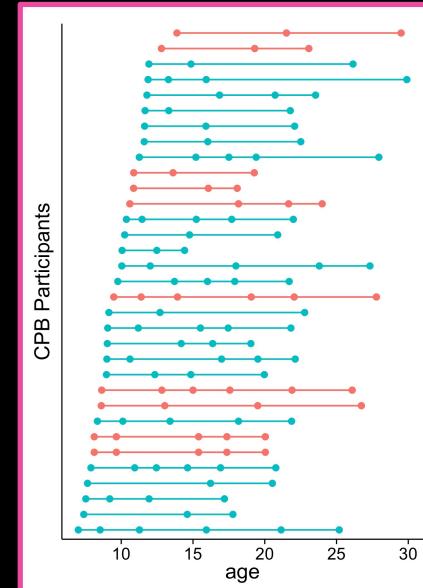


1. What study design matches your question?

Single Cohort Design

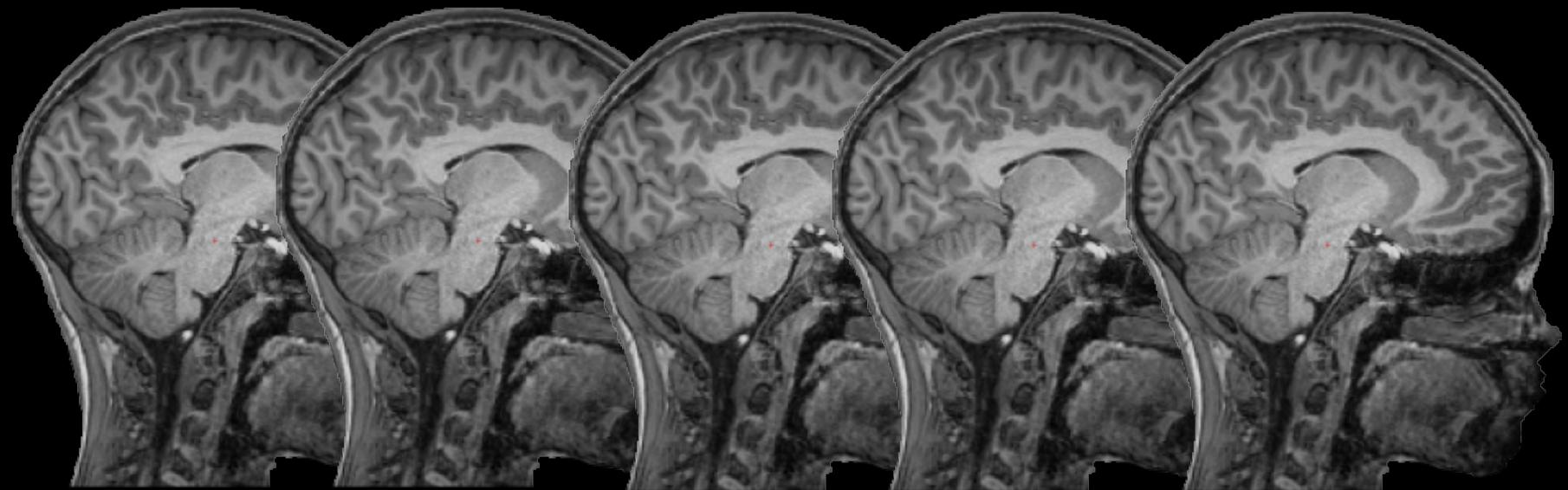


Accelerated Longitudinal Design



(plan for missingness)

2. Acquire data

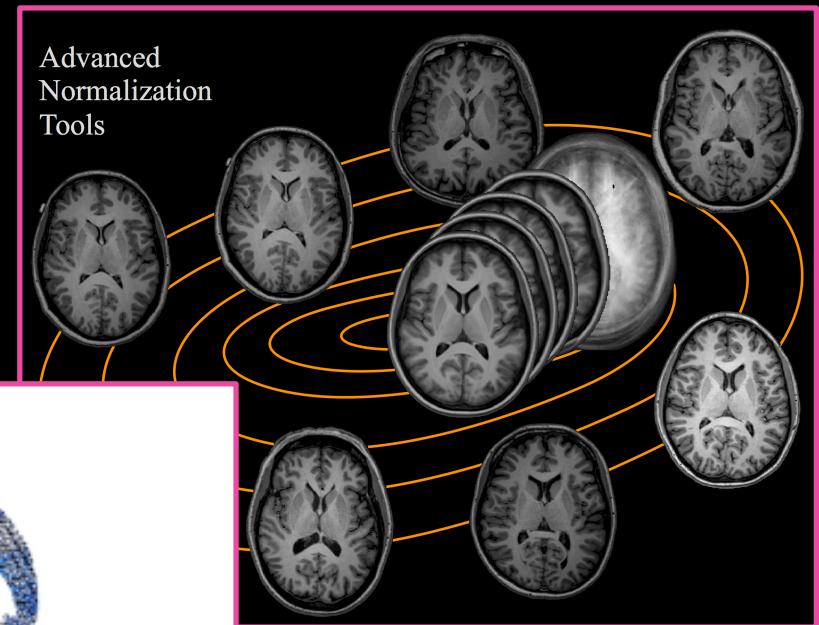
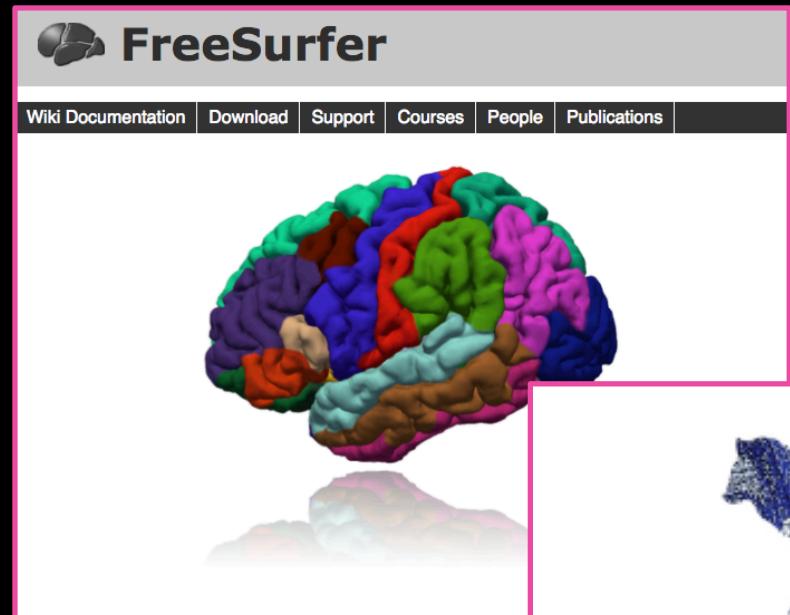


Time

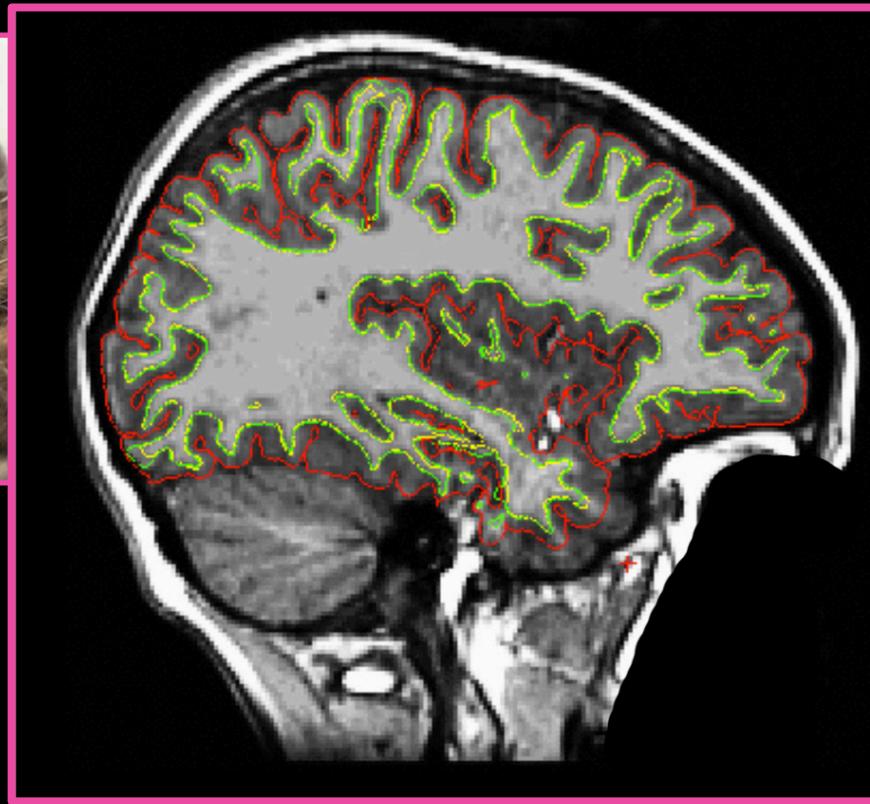
3. Quality Control Data



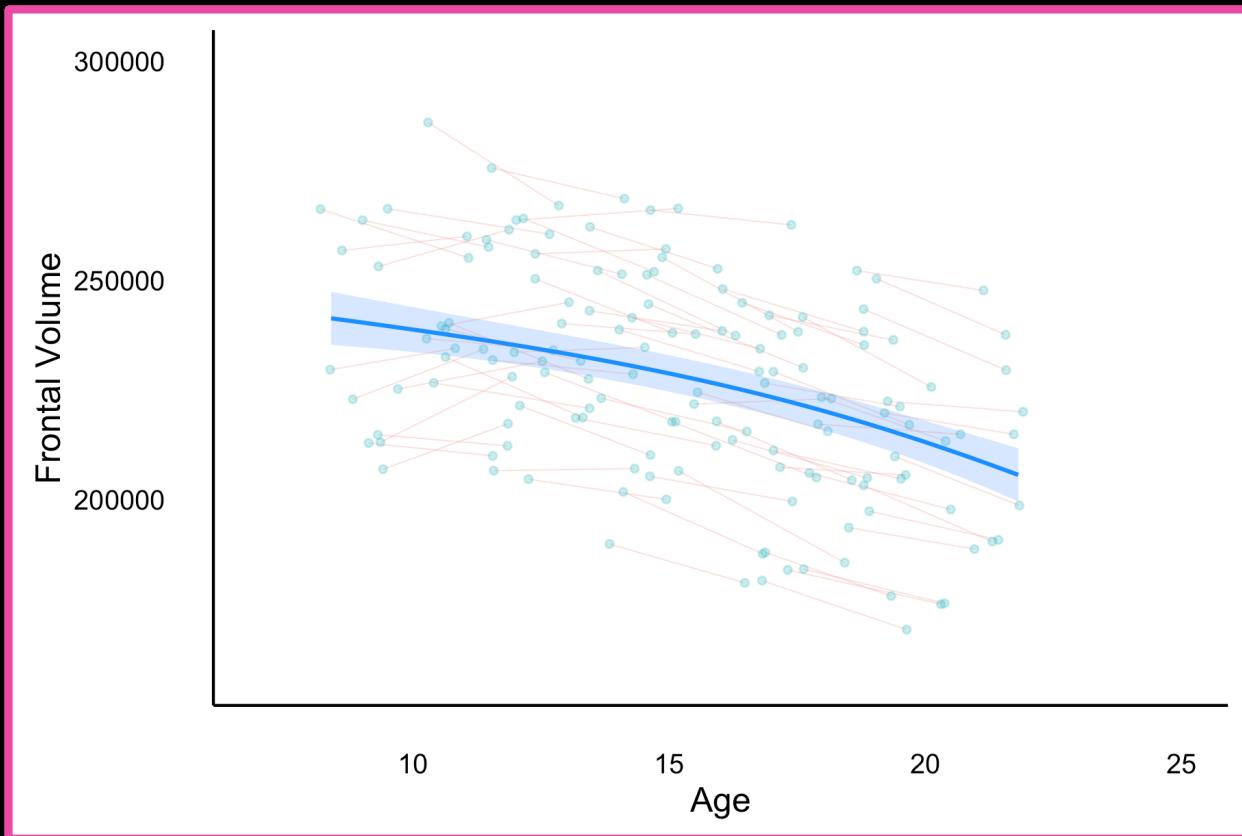
4. Process data



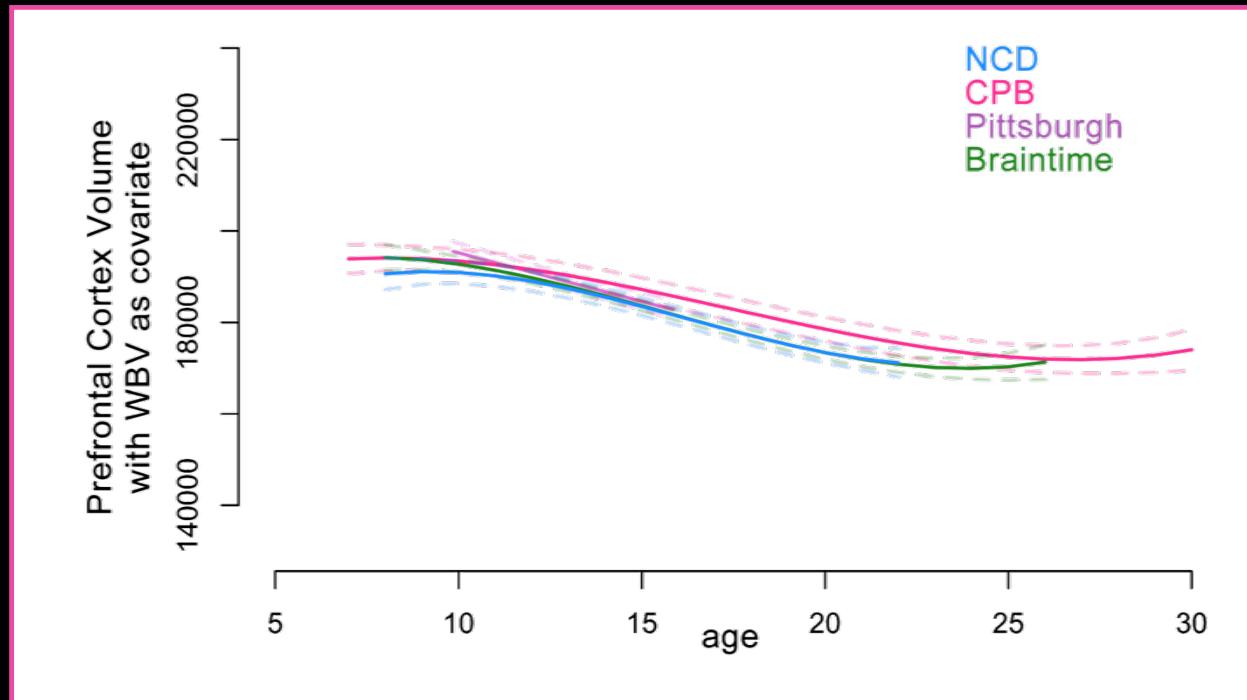
5. Quality Control Data



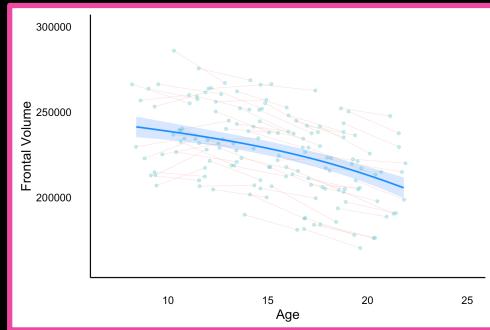
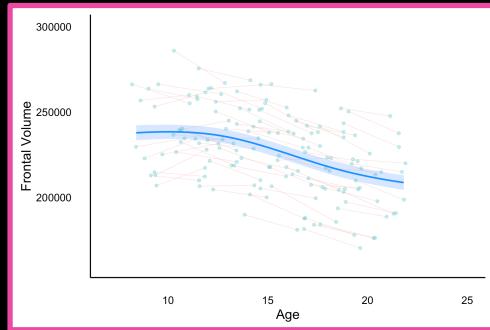
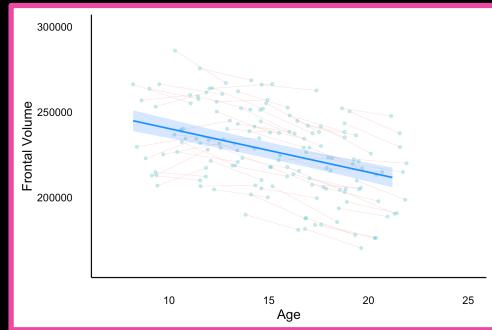
6. Model Data



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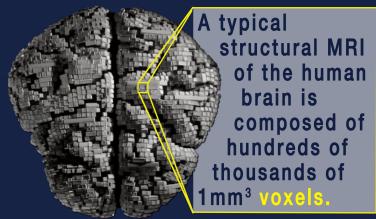
7. Model Selection



8. What does it all mean?

What are we measuring in developmental structural MRI?

Kate Mills^{1,2}, Anne-Lise Goddings^{1,3}, Jay Giedd², Sarah-Jayne Blakemore¹



However, human brains and mouse brains differ!

The occipital cortex contains more neurons per mm^2 of surface area than the rest of the cerebral cortex.

Prefrontal cortex has less neuronal density, but more neuropil, possibly reflecting greater local connectivity.

What is contained in 1mm^3 ?

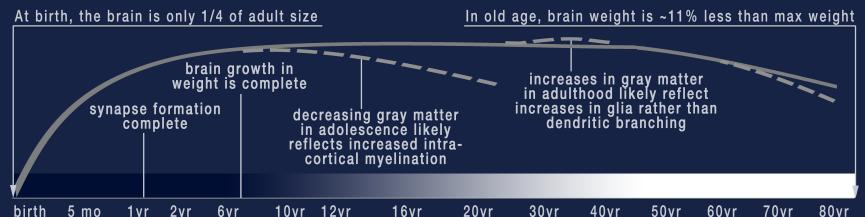
A 1mm^3 cube of gray matter in the mouse brain contains:

extracellular space	5%
cell bodies & blood vessels	14%
dendritic spines	12%
glial cells	9.5%
axons	30%
dendrites	30%

(Braitenberg, 2001)

There is great variability across the human cerebral cortex, where 1mm^3 could contain between:
13,000 (MFG) – 40,000 neurons (V1)
Up to four times as many glial cells
100,000,000 – 600,000,000 synapses

What do changes in brain structure possibly reflect across the lifespan?



Synaptic pruning

Synaptic density in the mature brain is 60% of the maximum.

Dendritic growth

Dendritic development follows inside-out pattern of cortical development.

Myelination

The formation of new synapses in adulthood is likely to be balanced by loss of other synaptic connections.
-Huttenlocher, 2002

Evidence for post-adolescence synaptic pruning is limited

Huttenlocher & Dabholkar, 1997

Synaptic pruning stabilizes around age 16 years.

Middle frontal gyrus

Petanjek et al., 2011

Brodman Area 9

Synaptic pruning stabilizes in late twenties.

How variable is the length of synaptic elimination?

"Changes in the density of synapses affect very little either the volume or the surface of the cortex because the total volume of synaptic boutons is only a very small fraction of the cortical volume."
-Bourgeois & Rakic, 1993