Promoting Healthy Socioemotional Development: A Neuropsychologically Informed Approach

Erin B. Tone, Ph.D.

Conflicts of Interest and Funding Acknowlegement

- Conflicts of interest: None
- Research funding:
  - National Institute of Child Health and Development (NICHD)
  - Anxiety and Depression Association of America (ADAA)
  - Georgia State University Brains and Behavior Program

- How do emotion and emotion regulation skills develop?

- How can the dynamic interplay among intrapersonal and interpersonal characteristics lead to deviations from typical developmental trajectories?

- How can we effectively target the emotion dysregulation that can emerge in atypical emotional development?

- We begin early to experience and express emotion

http://crazytmac.deviantart.com/art/emotion-chart-140516833

- We do so in ways that others can accurately read and interpret . . .

Happy Sad Furious Terrified

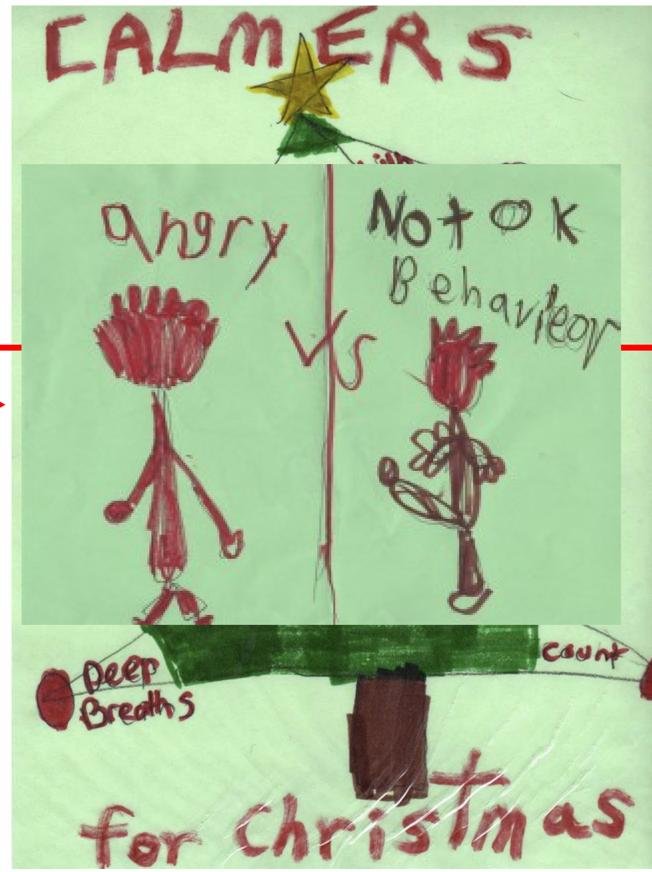
http://crazytmac.deviantart.com/art/emotion-chart-140516833

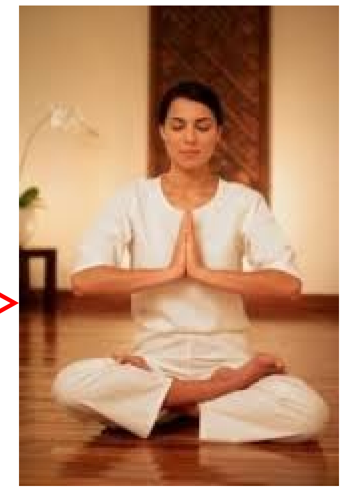
and we do so in an incredibly nuanced way . . .

http://crazytmac.deviantart.com/art/emotion-chart-140516833

We also begin early to read and respond to others' emotional cues . . .

- http://www.youtube.com/watch?v=apzXGEbZht0 and to regulate our emotions . . . initially with ample support, increasingly on our own



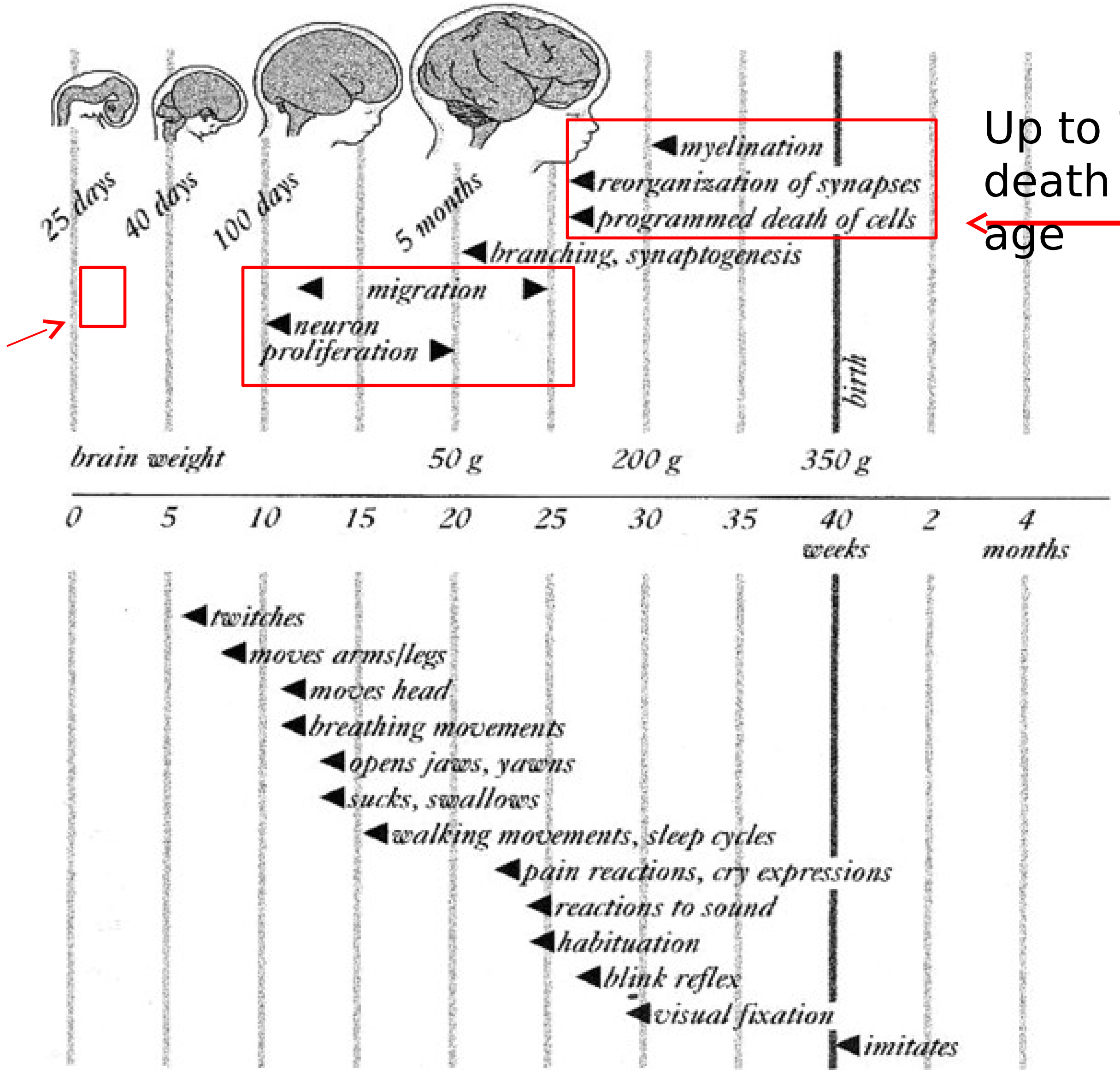


How do emotion and emotion regulation skills develop?

What happens in the brain that allows us to acquire these competencies?

Prenatal development

Predecessor neurons migrate to prospective human cortex (~30 days gestation)

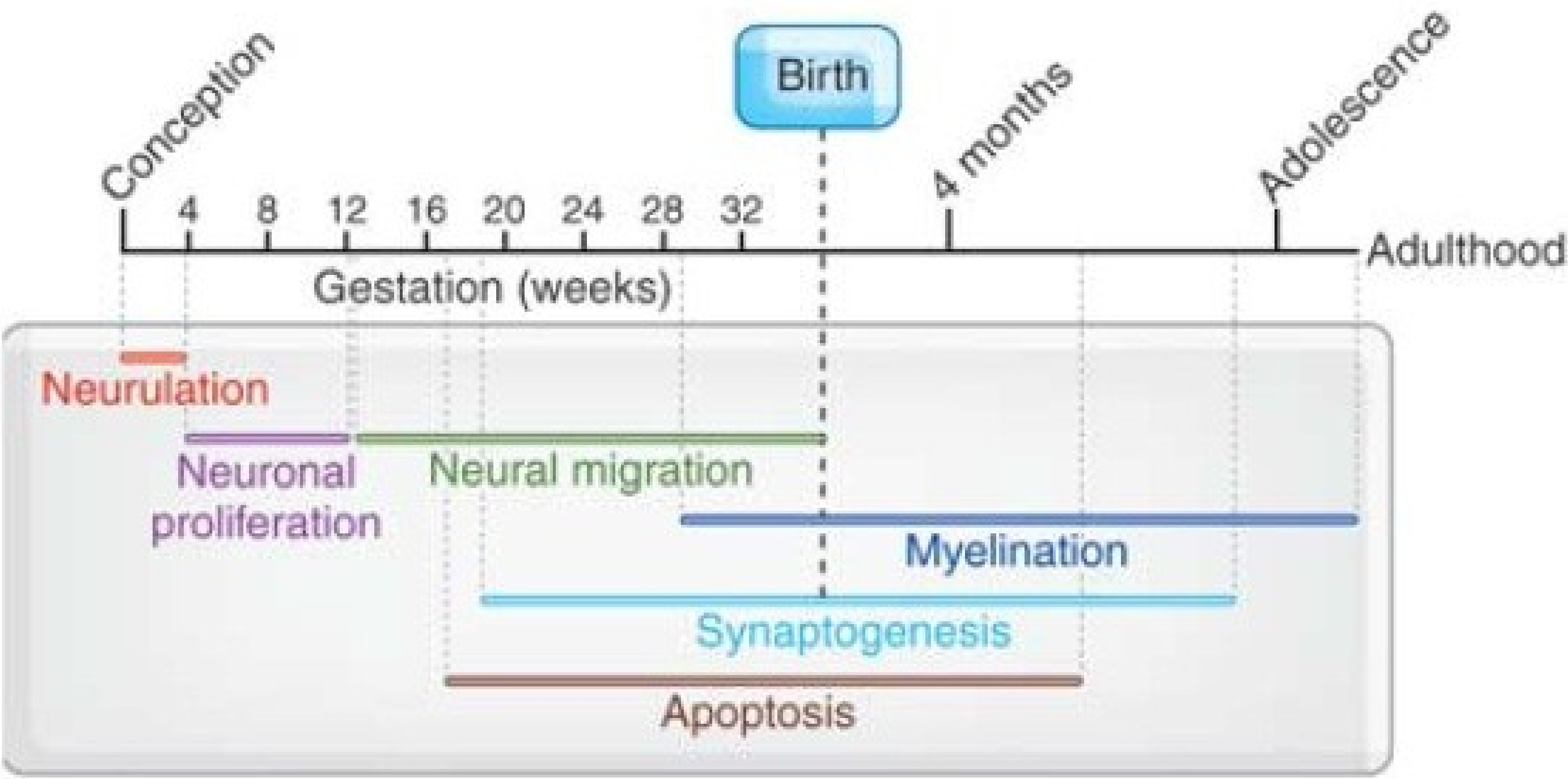


Up to 70% cell death by term age

The development of the brain displayed in a schematic form.
Source: The Newborn Brain. Edited by Lagercrantz H, Hanson M, Evrard P, Rodeck C. Cambridge University Press, Cambridge, UK. 2002, p. xii

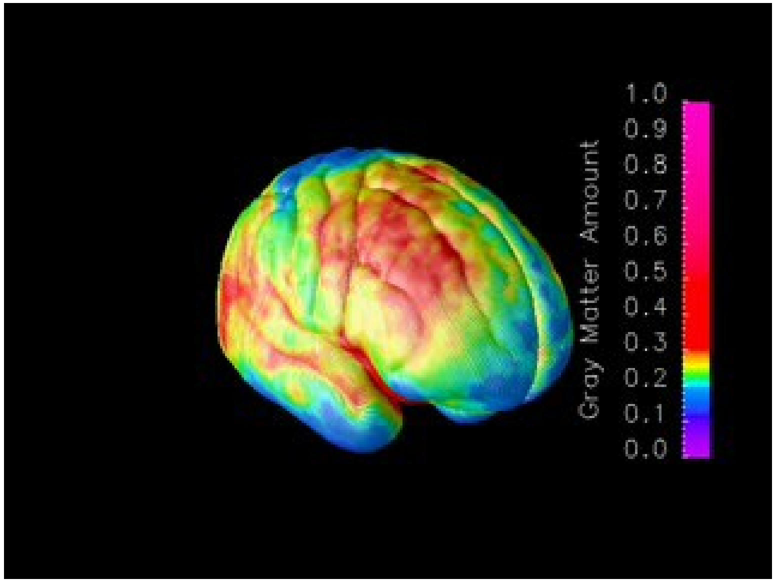
Development in Infancy, Childhood, & Adolescence

Cellular Level Development



Tau GZ, Peterson BS (2010). "Normal Development of Brain Circuits". *Neuropsychopharmacology* **35** (1): 147-168. doi:10.1038/npp.2009.115. PMC 3055433.PMID 19794405.

Structural Level Development: Gray matter



Big Picture:

Higher-order association cortices mature after somatosensory and visual cortices

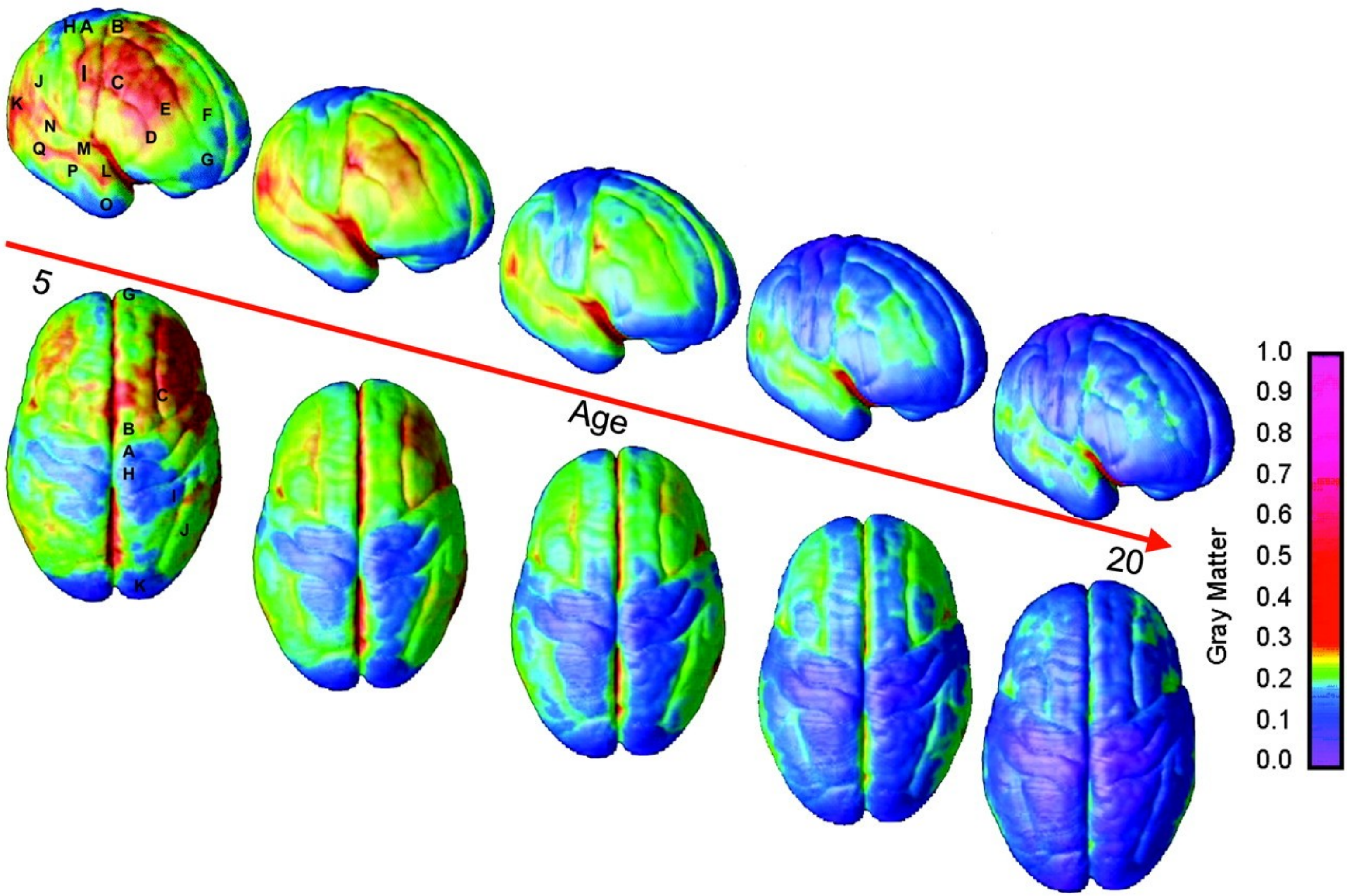
Phylogenetically older structures mature earlier than do newer ones

Around puberty, sustained GM loss begins

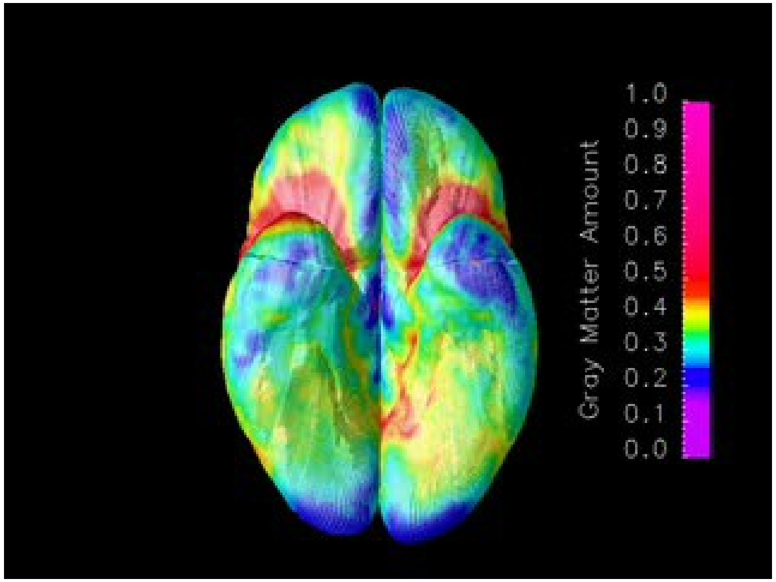
Gogtay N et al. PNAS 2004;101:8174-8179

PNAS

Right lateral and top views of GM maturation over the cortical surface (n=13; each scanned 3-4 times at 2 year intervals)



Gogtay N et al. PNAS 2004;101:8174-8179



Medial inferior temporal & caudal/medial inferior frontal regions mature early, with little change thereafter

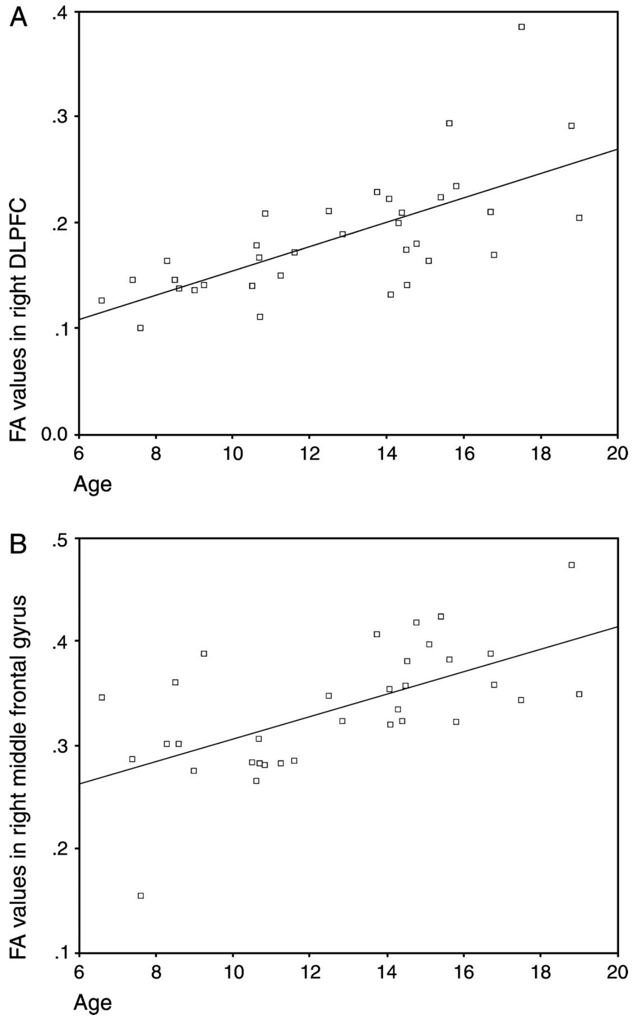
Orbitofrontal regions continue to mature throughout adolescence

Gogtay N et al. PNAS 2004;101:8174-8179

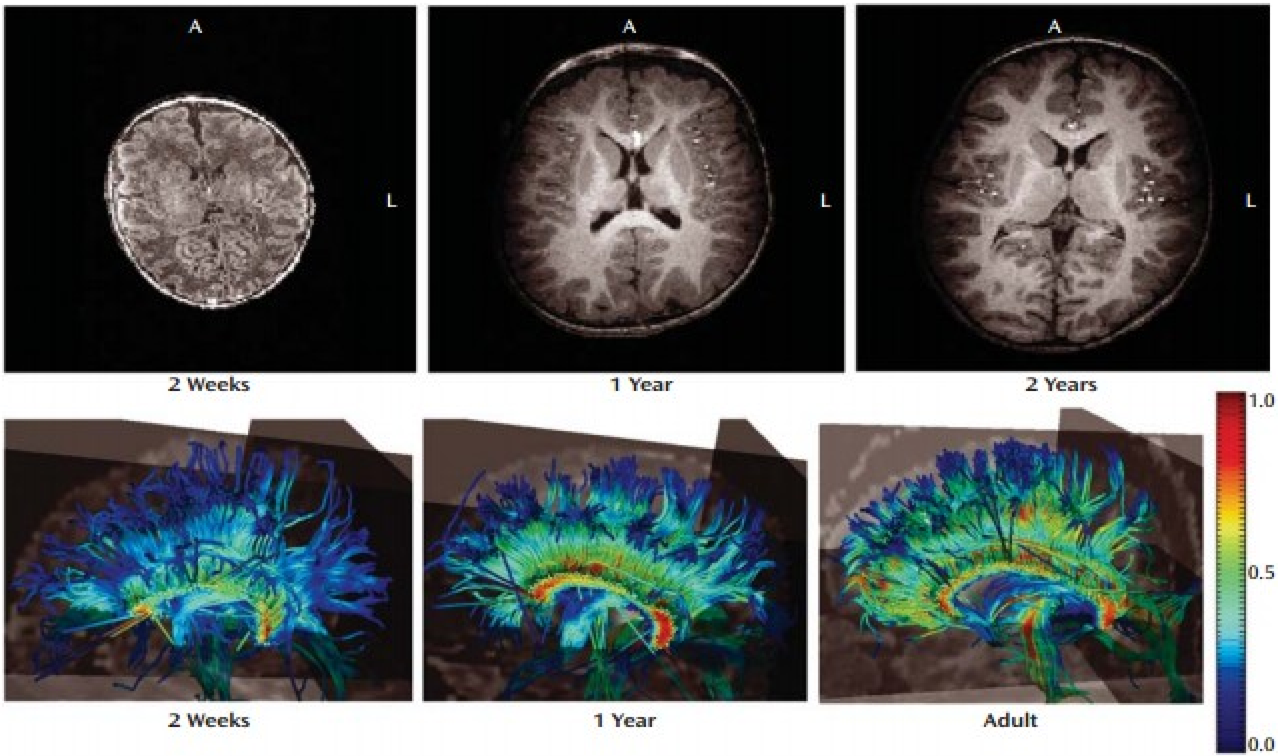
PNAS

Structural level Develoment: White Matter

Non-cortical white matter circuitry becomes more coherent, or more myelinated, with age



Barnea-Goraly N et al. Cereb. Cortex 2005;15:1848-1854

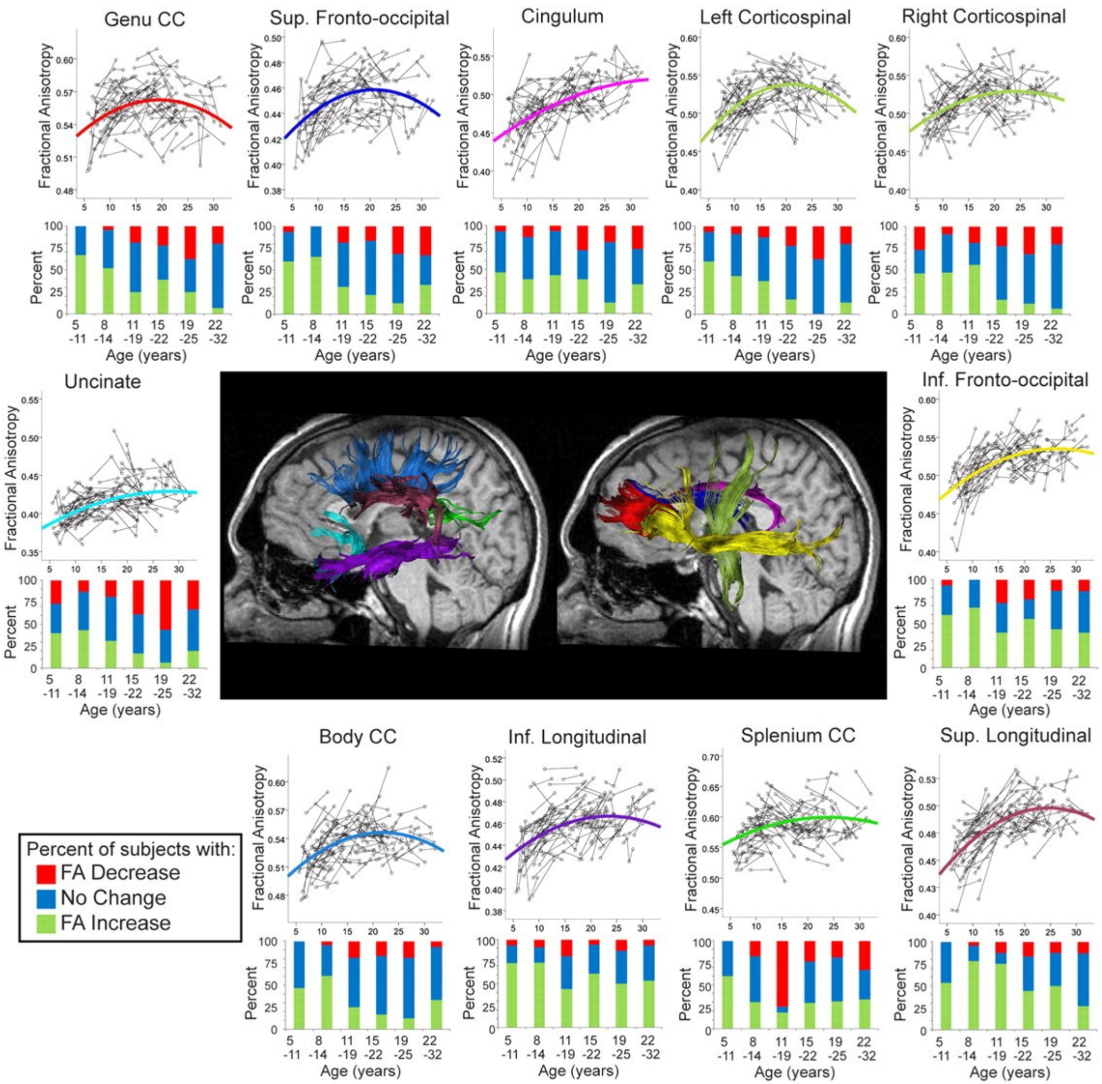


Brain myelination across development. Top panels: Images show age-related increase in brain size and white matter intensity acquired longitudinally from 1 child.

Bottom panels: Age-related differences in the organization of corpus callosum white matter (higher values =greater organization of fiber tracts).

Gilmore JH, Lin W, Gerig G. Fetal and neonatal brain development. *Am J Psychiatry*. 2006;163:2046.

Longitudinal age-related changes of fractional anisotropy.



Lebel C , and Beaulieu C J. Neurosci. 2011;31:10937-10947

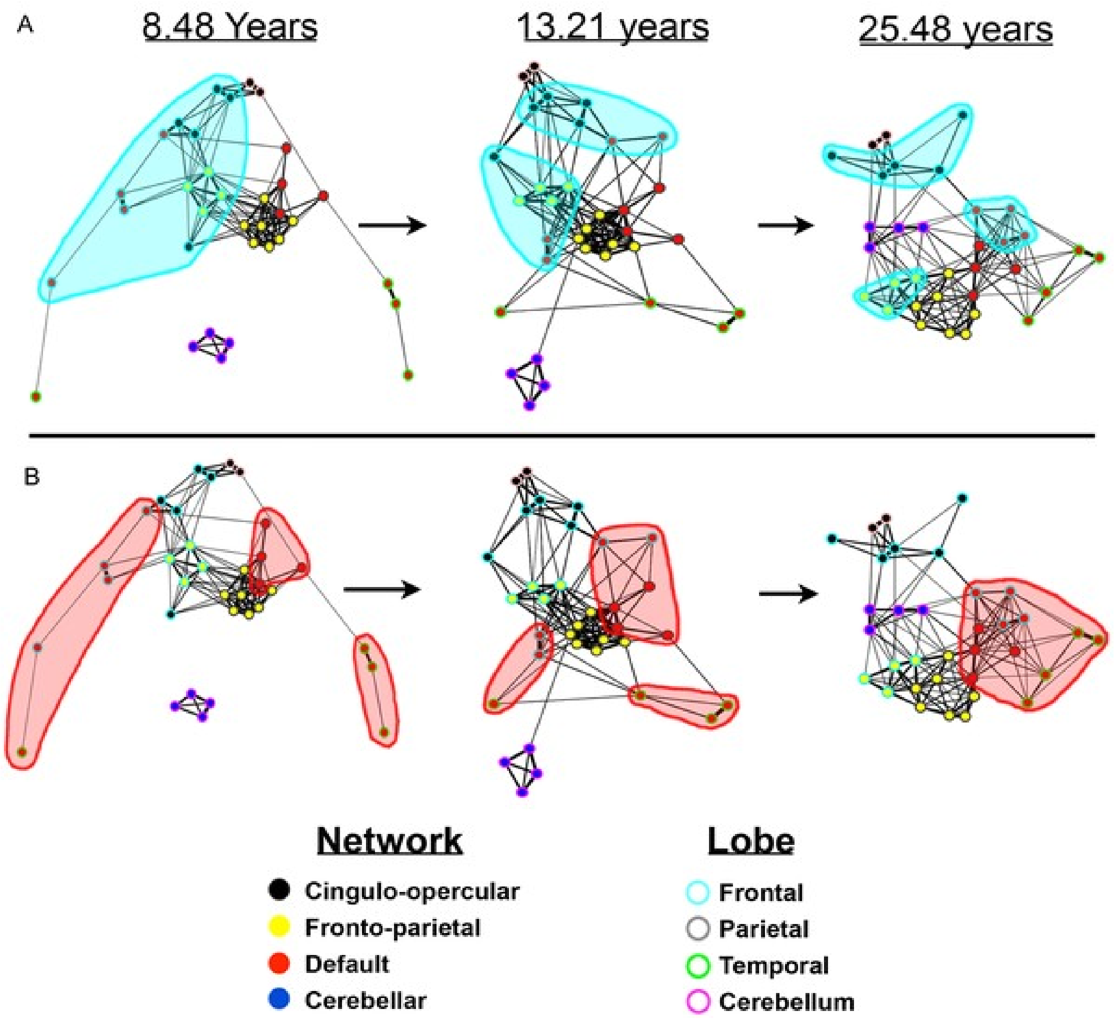
n=103

The Journal of Neuroscience

Figure 2. Over age the graph architecture matures from a “local” organization to a “distributed” organization.

A: Anatomically-clustered regions segregate with age.

B. Functionally clustered networks become more integrated with age.



Fair DA, Cohen AL, Power JD, Dosenbach NUF, et al. (2009) Functional Brain Networks Develop from a “Local to Distributed” Organization. PLoS Comput Biol 5(5): e1000381. doi:10.1371/journal.pcbi.1000381

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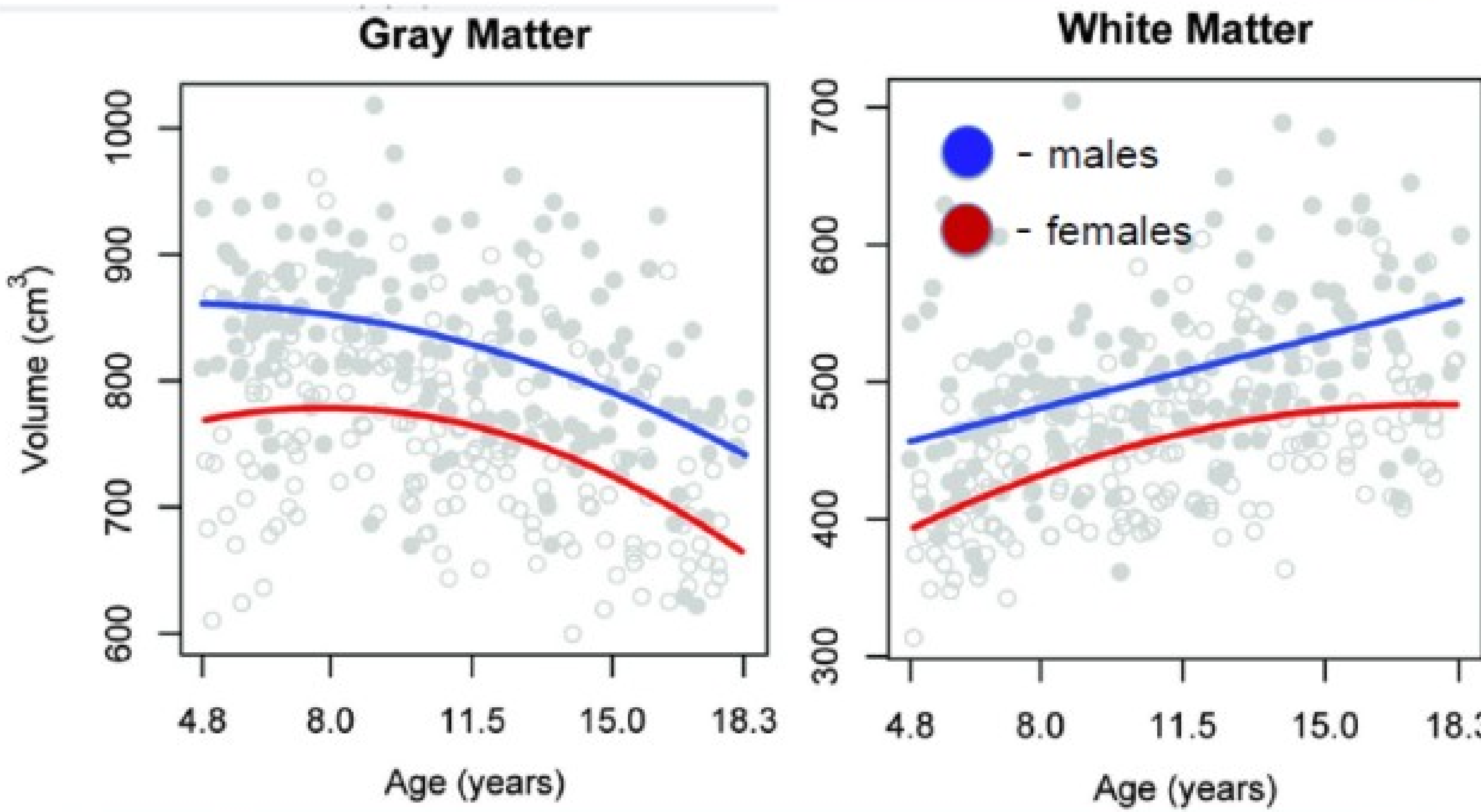
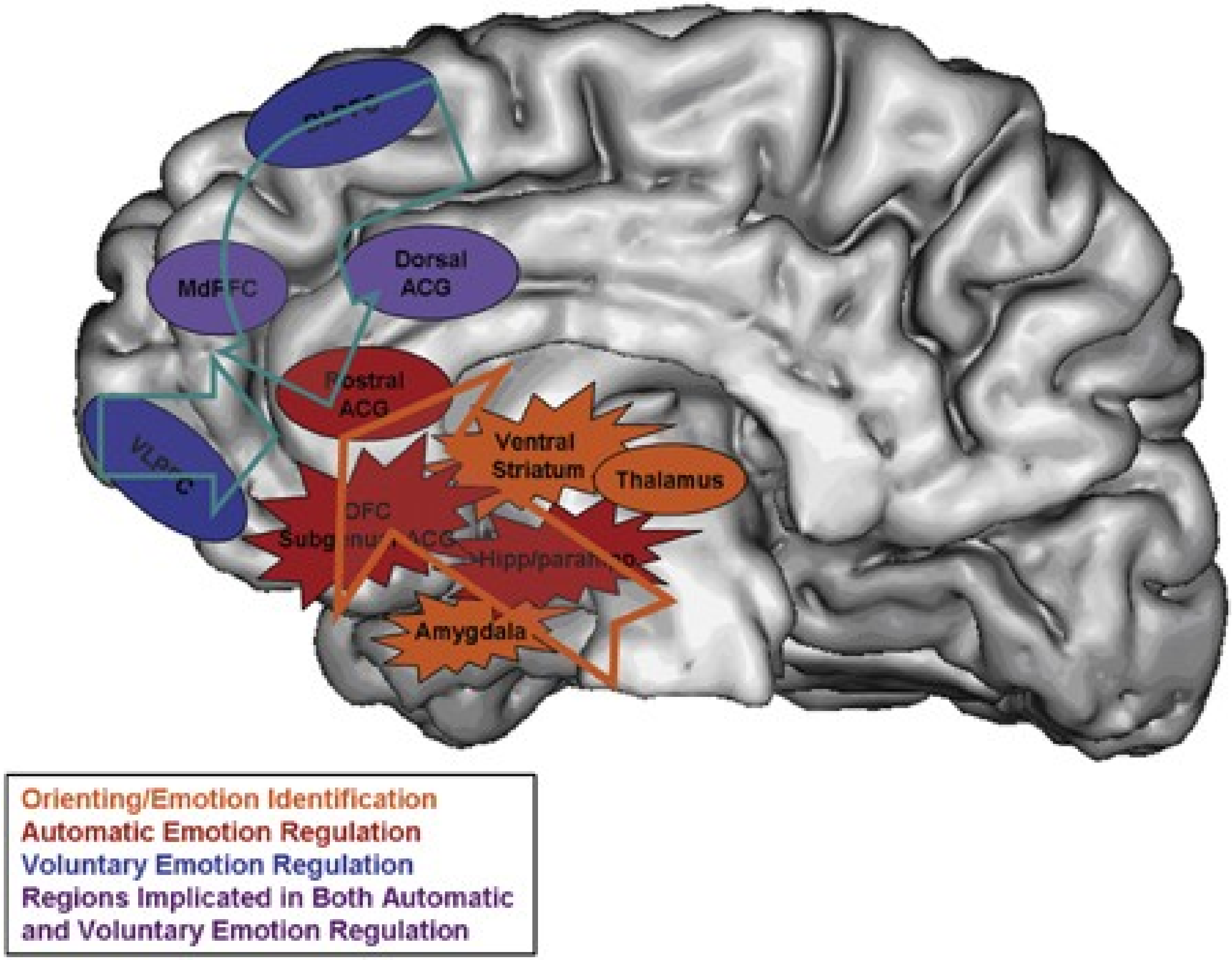
Changes Occur Within and Between Circuits

National Institute on Alcohol Abuse and Alcoholism



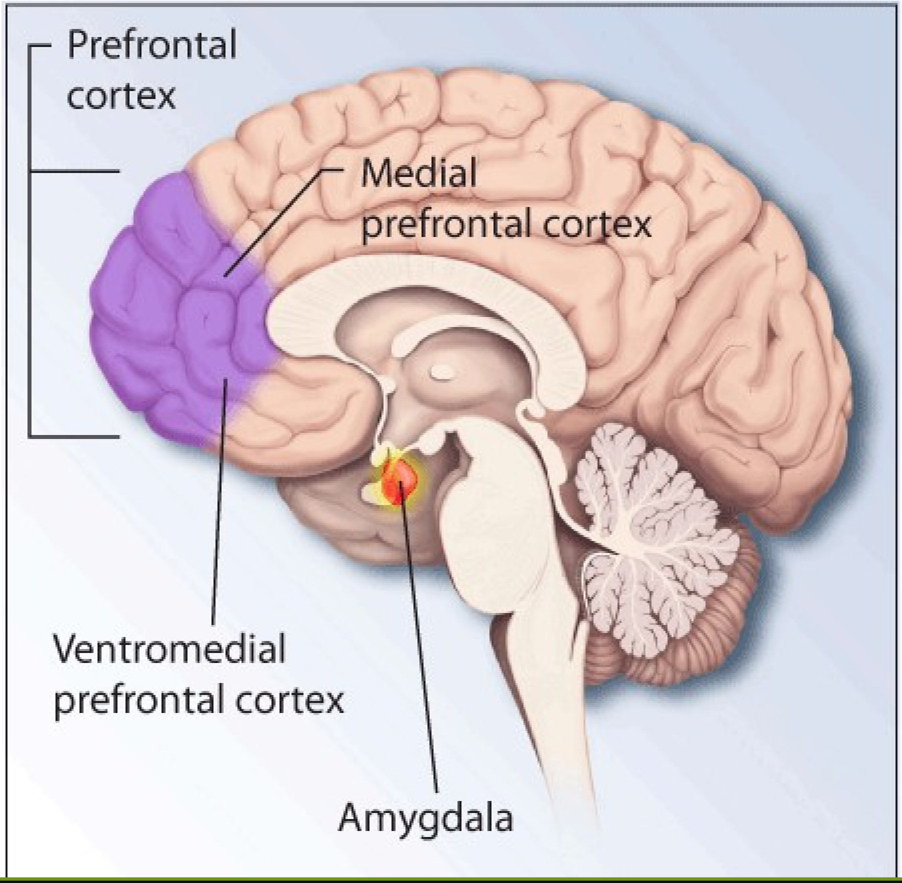
National Institutes of Health magnetic resonance imaging study of normal brain development (*Cerebral Cortex*, 2012).

What does development look like in neural regions that support emotional experience and regulation?



Phillips, M. L., Ladouceur, C. D., & Drevets13, W. C. (2008). Neural systems underlying voluntary and automatic emotion regulation: Toward a neural model of bipolar disorder. *Molecular Psychiatry*, *13*(9), doi:10.1038/mp.2008.82

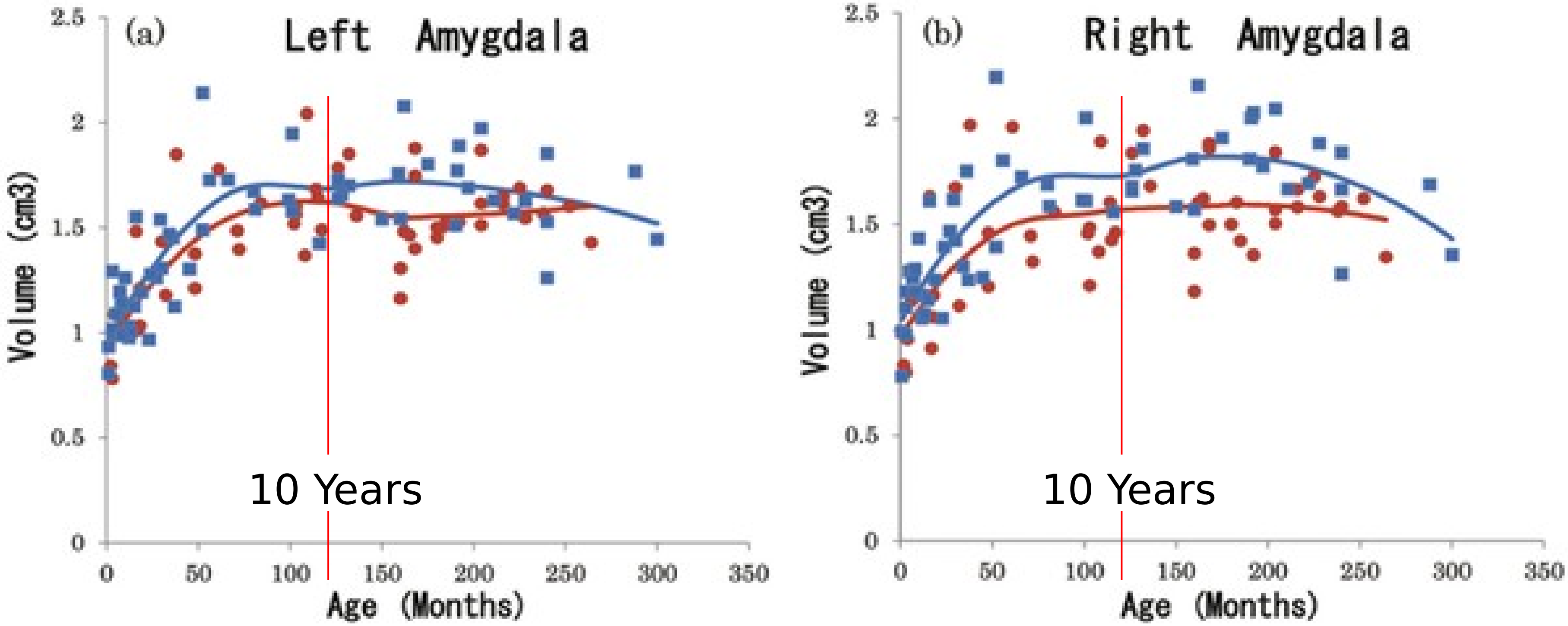
Voluntary Regulation



Emotion

Emotions and Emotion Regulation

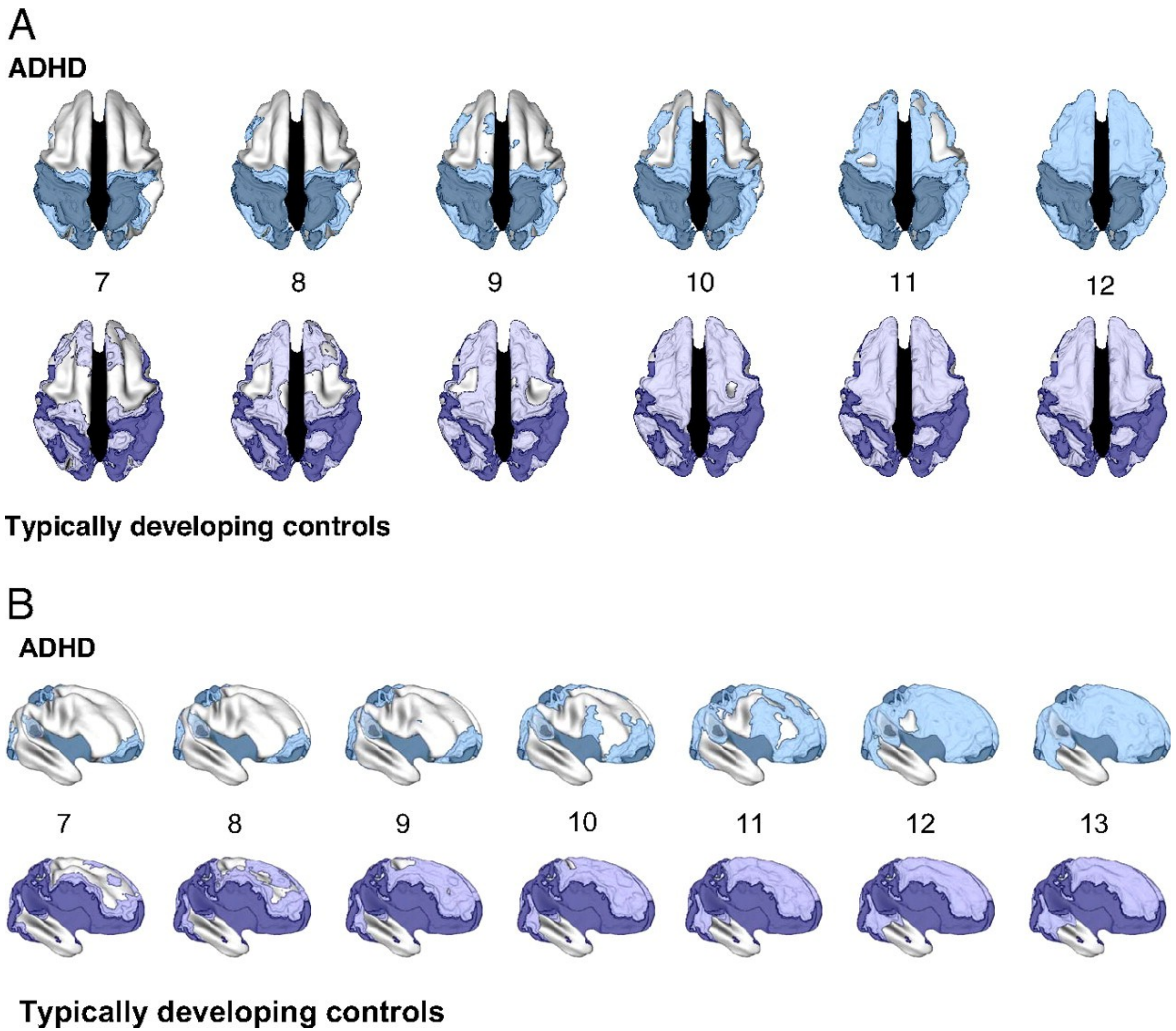
Amygdala Volume Peaks Between Ages 9-11 Years



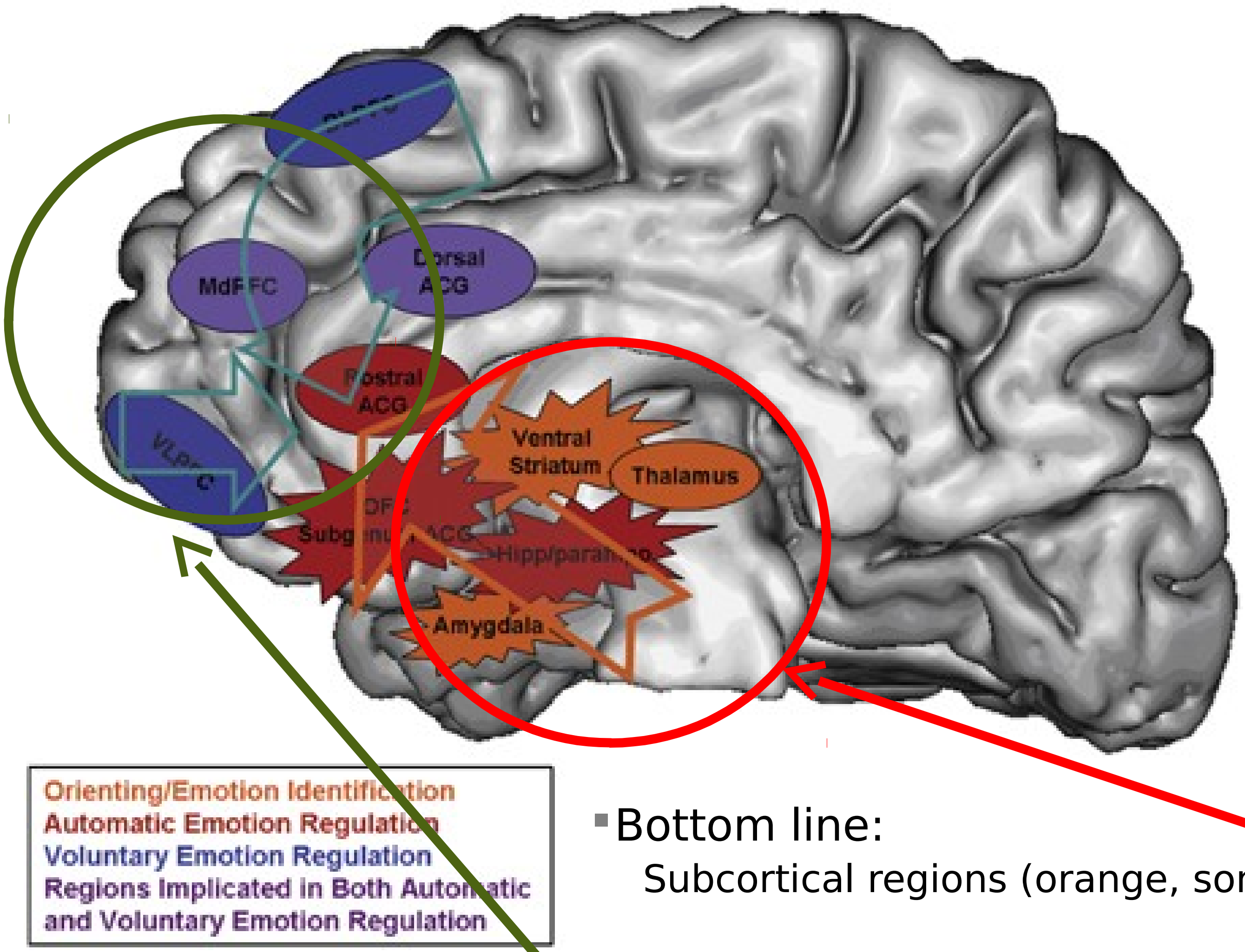
Males: blue line; Females: red line

Uematsu A, Matsui M, Tanaka C, Takahashi T, et al. (2012) Developmental Trajectories of Amygdala and Hippocampus from Infancy to Early Adulthood in Healthy Individuals. PLoS ONE 7(10): e46970. doi:10.1371/journal.pone.0046970
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0046970

The age of attaining peak cortical thickness in children with ADHD compared with typically developing children.



Shaw P et al. PNAS 2007;104:19649-19654



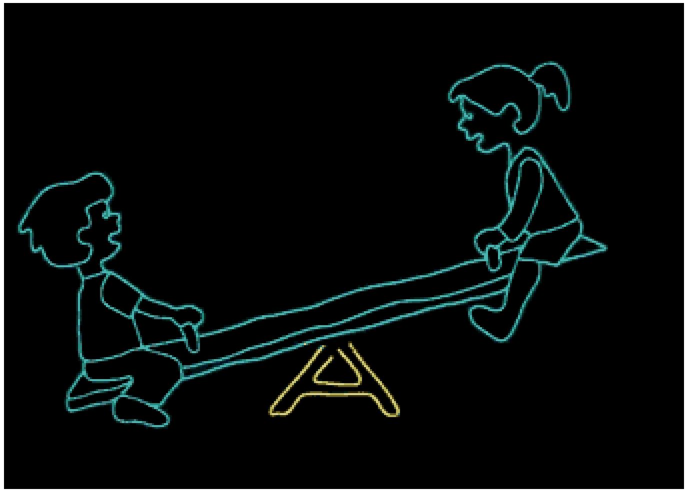
- Bottom line:
  - Subcortical regions (orange, some red): develop early
  - Cortical regions (blue, purple): developmental trajectory extends into adulthood

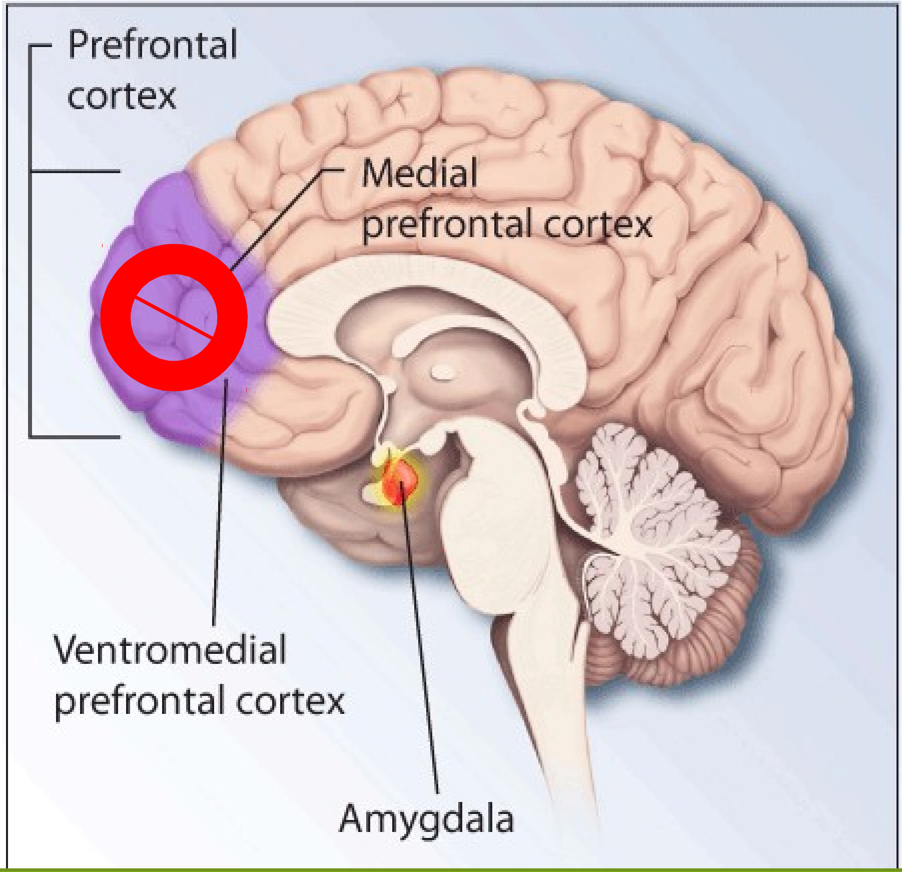
How can the dynamic interplay among intrapersonal and interpersonal characteristics lead to deviations from typical developmental trajectories?

Adaptive Emotion Regulation

Regulatory Control

Emotion

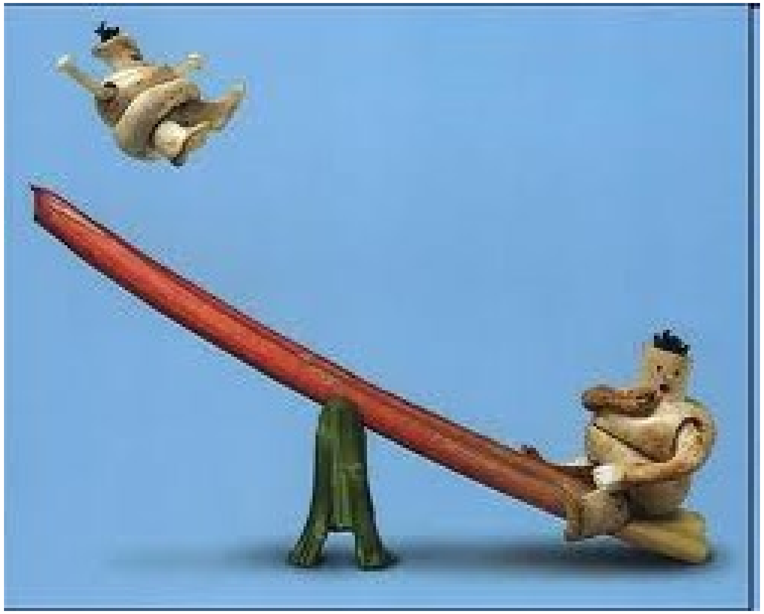


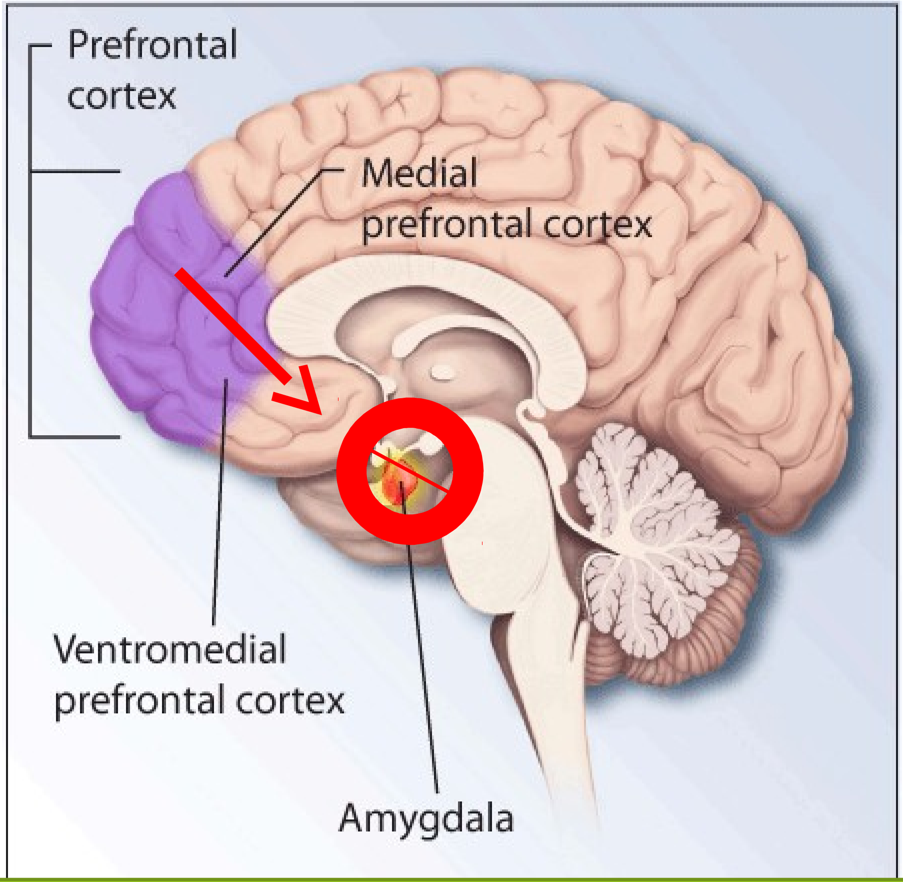


Under-regulation

Regulatory Control

Emotion





Detachment/Over-regulation

Regulatory Control

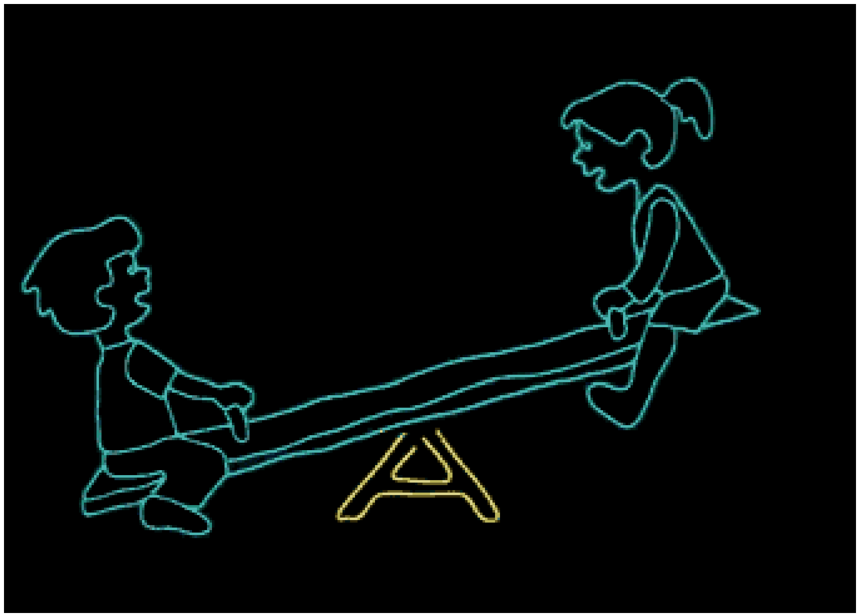
Emotion

Regulatory Control

Emotion

Regulatory Control

Emotion



What determines whether one develops adaptive or maladaptive emotion regulation capacities?

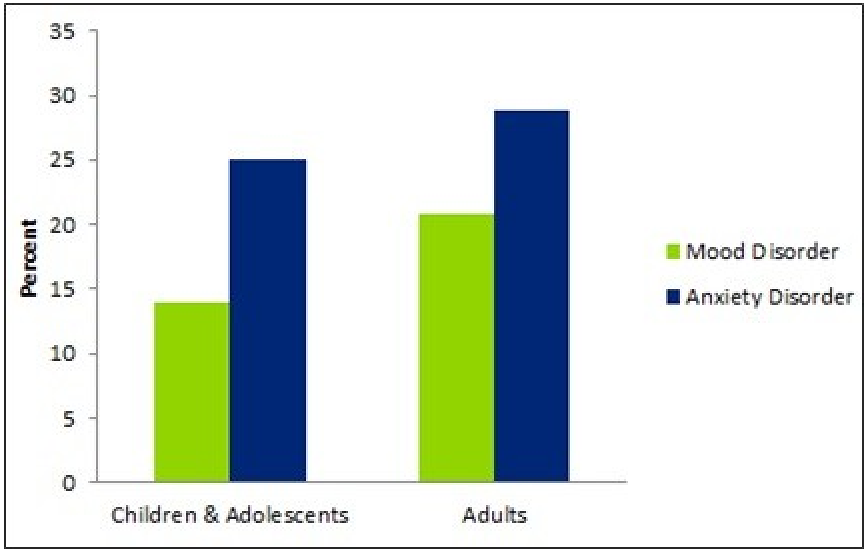
Factors that Interact to Determine Success at Emotion Regulation

- **Intraindividual**

Neurobiological Expressions

- **Interindividual moderators**: Prenatal and family

Anxiety and Related Internalizing Conditions as a Model



Source: NIMH Statistics, "Any Mood Disorder in Children"

Table 1 Gender distribution among nondepressed/nonanxious, subthreshold-depressed/anxious and depressed/anxious groups

	Levels of anxiety		Levels of depression	
	Boys %	Girls %	Boys %	Girls %
No anxiety/depression	50.35	49.65	50.35	49.65
Subthreshold- anxiety/ depression	38.24	61.76	38.24	61.76
Full anxiety/depression	24.07	75.93	24.07	75.93

N = 12,395.

Balázs, J., et al. (2013). Adolescent subthreshold-depression and anxiety: Psychopathology, functional impairment and increased suicide risk. *Journal Of Child Psychology And Psychiatry, 54(6), 670-677.* doi:10.1111/jcpp.12016

Neurobiology

- Intraindividual moderators
  - Prenatal environment
  - Family environment
    - Parent mood/anxiety disorders
    - Family interaction patterns
  - School/peer environment

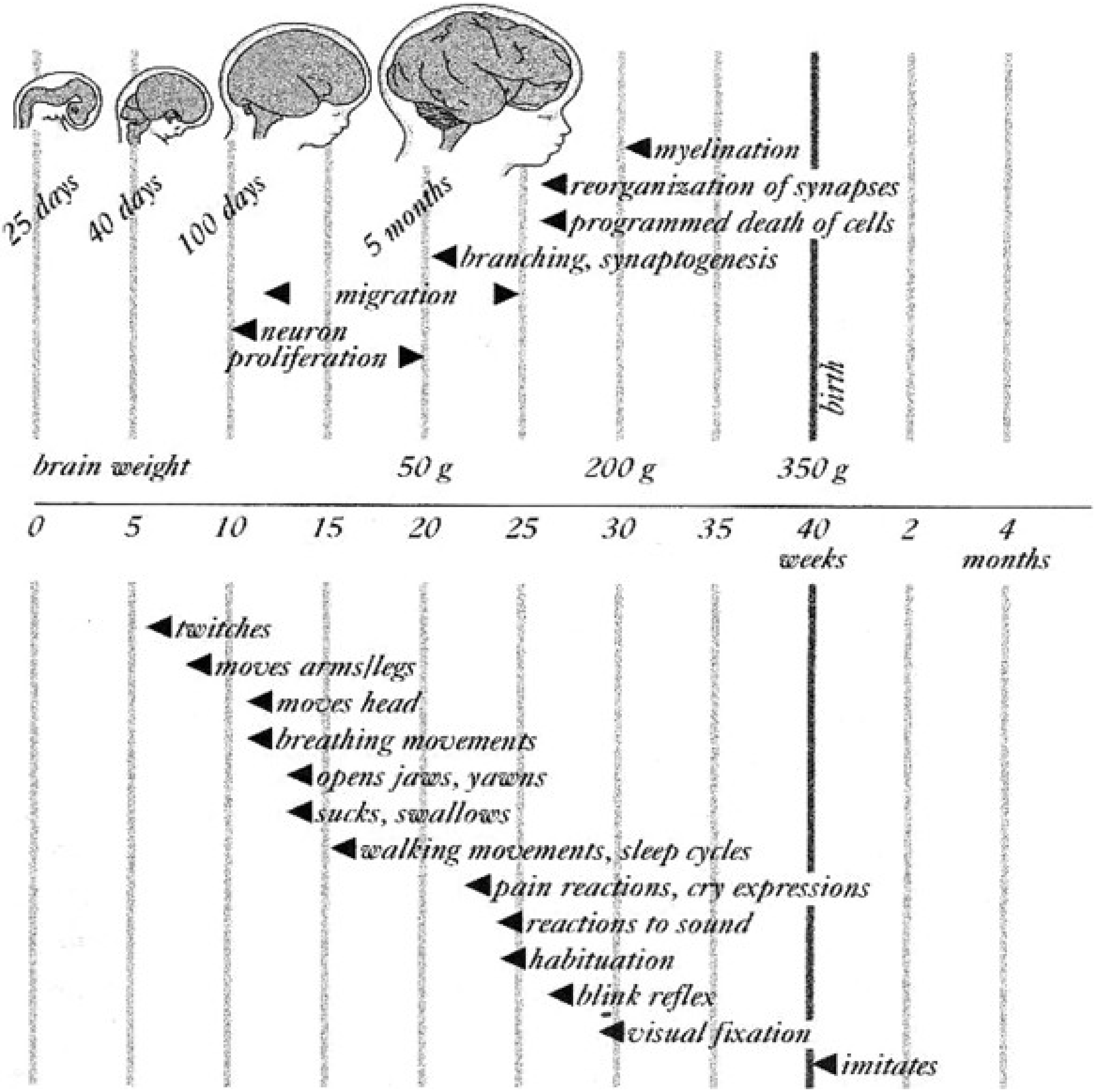
- Interactions

- McGrath article Genetic Profile

- Maternal physical health
- Maternal mental health

Prenatal Environment

Outcomes associated with fetal risk exposure during pregnancy



The development of the brain displayed in a schematic form. *Source*: The Newborn Brain. Edited by Lagercrantz H, Hanson M, Evrard P, Rodeck C. Cambridge University

Table 3
Logistic regression analysis of anxiety status.

Variable	*B* (*SE B*)	exp *B*
Constant	.81 (.16)**	1.11
Age	−.16 (.14)	.85
Sex	.04 (.32)	1.04
Mother's anxiety score	.01 (.01)	1.01
Prenatal risk factors	.57 (.22)**	1.76
Visuospatial deviation	.14 (.05)**	1.15
Prenatal risk factors × visuospatial deviation	.10 (.06)*	1.11

Note: R^2 = 13.50 (Nagelkerke). Model $\chi^2(21.28) = p < .01$.
* $p < .05$.
** $p < .01$.

Table 4
B and exp *B* (proportionate change in odds for being high-anxious) 0, 1, 2, and 3 prenatal risk factors (linked to level of visuospatial deviation).

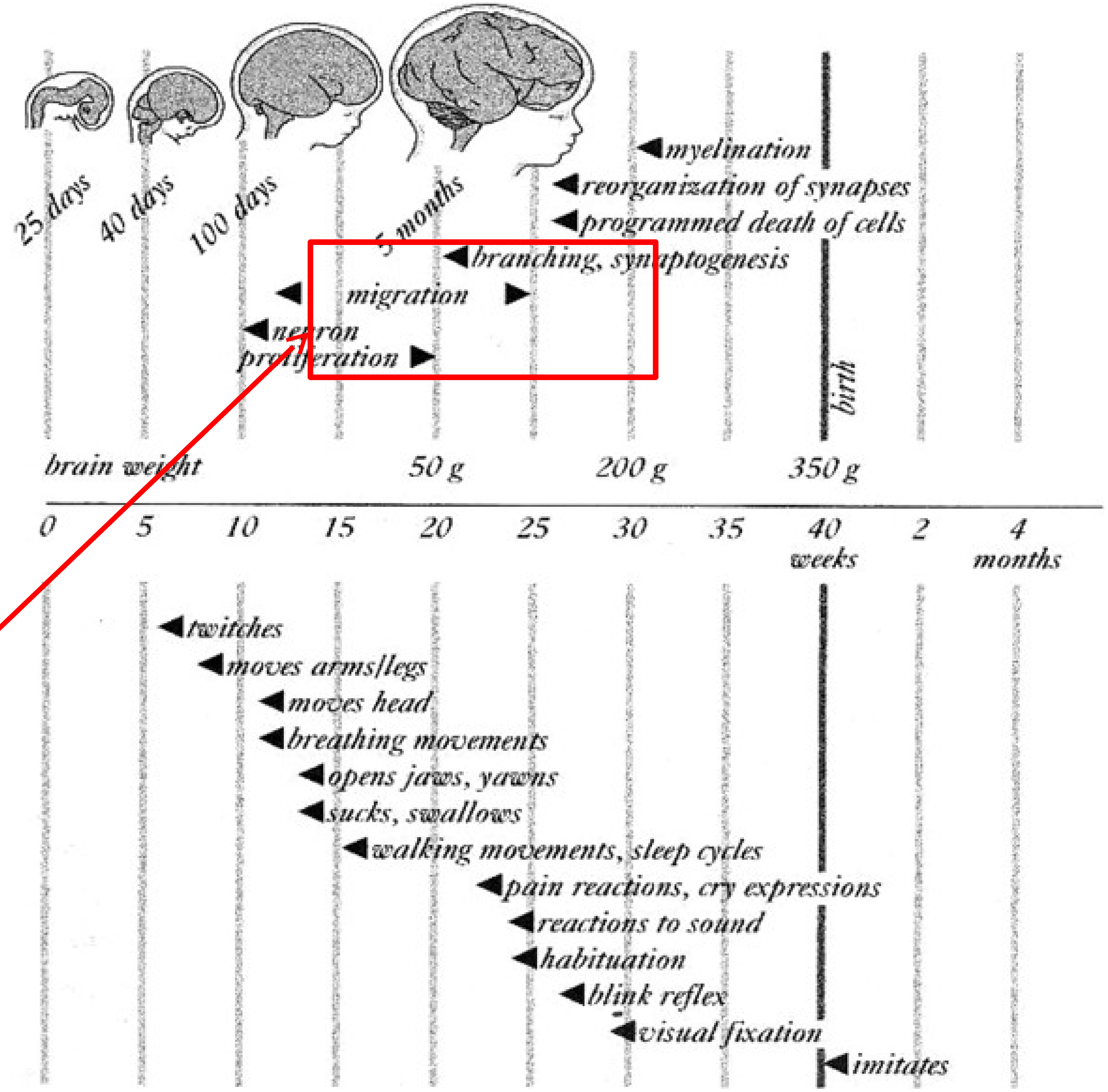
	0 prenatal risk factor × visuospatial deviation	1 prenatal risk factor × visuospatial deviation	2 prenatal risk factor × visuospatial deviation	3 prenatal risk factor × visuospatial deviation
B	.06	.17	.27	.66
exp *B*	1.06	1.18	1.31	1.92

Cumulative prenatal risk exposure significantly predicted anxiety in 8-12 year olds

Simon, E., Bögels, S., Stoel, R., & De Schutter, S. (2009). Risk factors occurring during pregnancy and birth in relation to brain functioning and child's anxiety. *Journal Of Anxiety Disorders*,*23*(8), 1024-1030. doi:10.1016/j.janxdis.2009.07.002

Outcomes associated with maternal anxiety during pregnancy

Research focused on 19th-31st weeks of gestation



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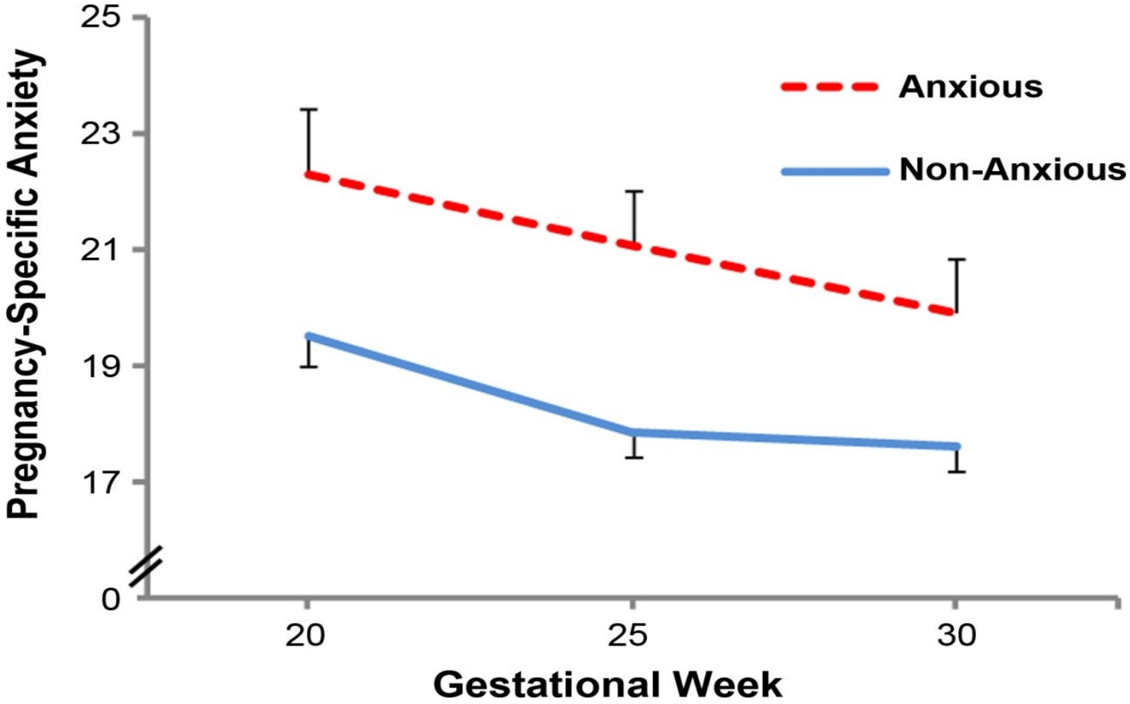
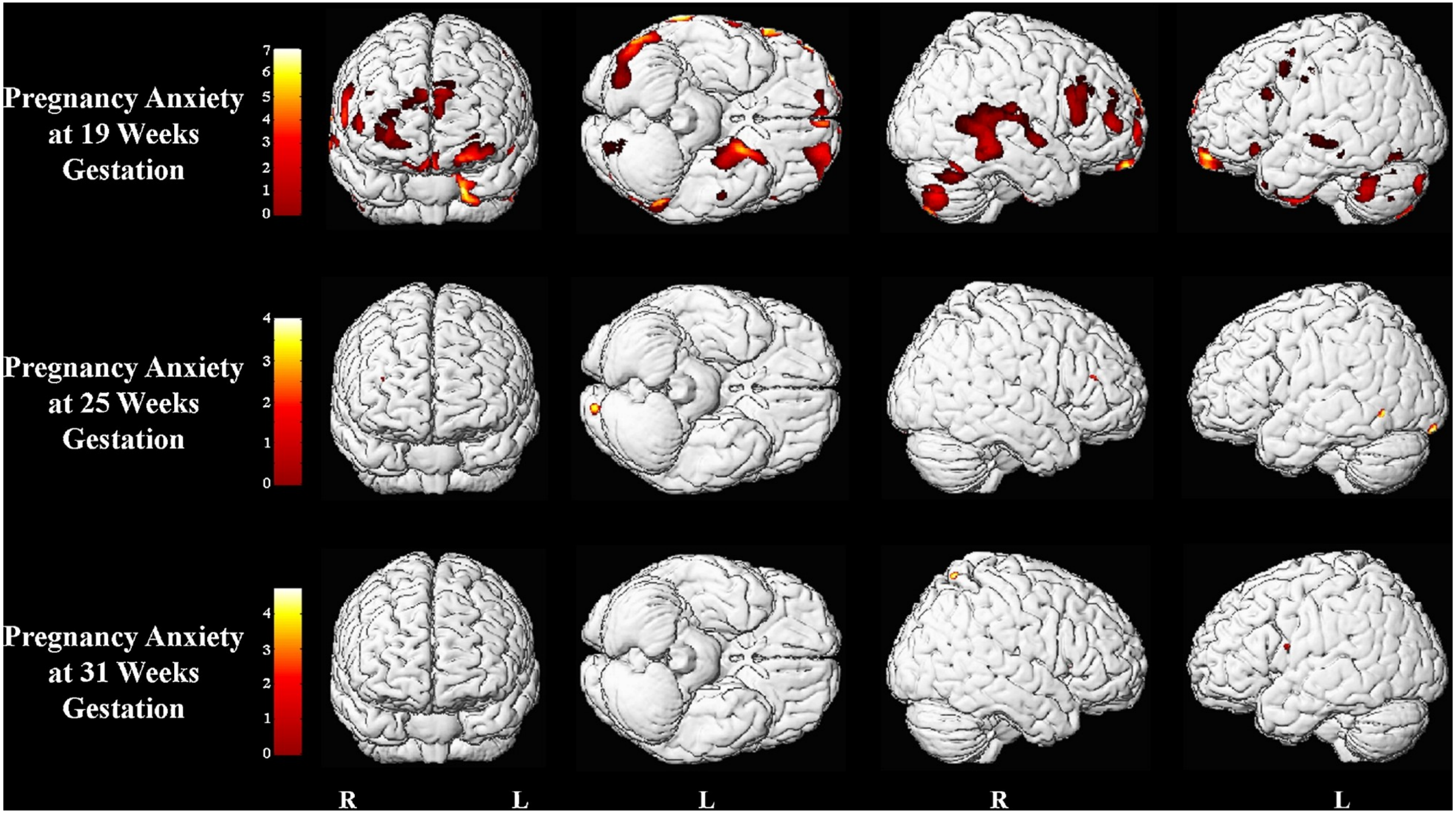


Figure 2 Pregnancy-specific anxiety predicts anxiety classification during preadolescence. Children who are in the normal range for anxiety were exposed to lower pregnancy-specific anxiety. In contrast, children who were exposed to elevated pregnancy-specific anxiety during gestation are significantly more likely to be rated in the anxiou/borderline anxious range.

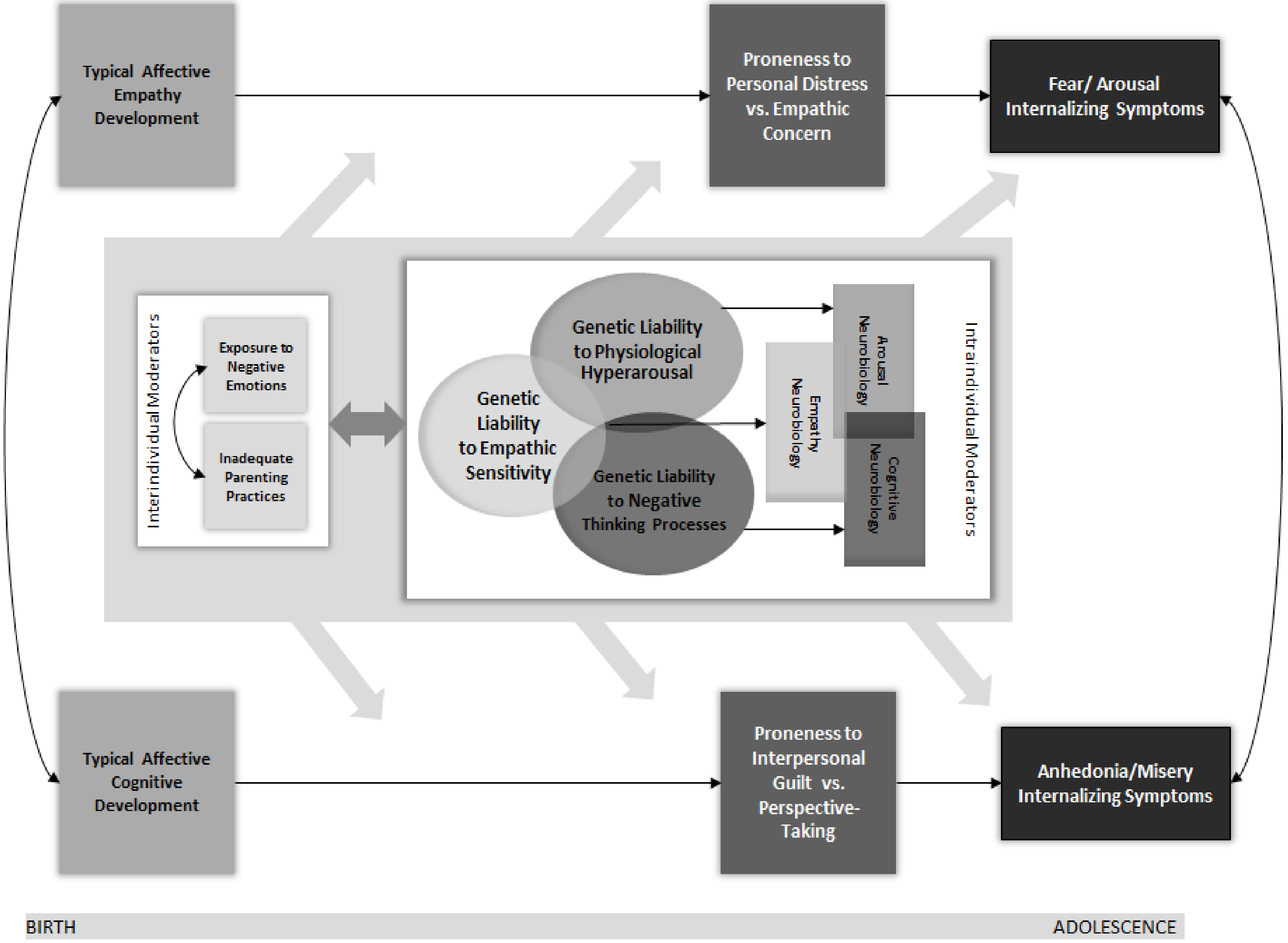
N=178 mothers & their 6-9 year old children

Davis, E. P., & Sandman, C. A. (2012). Prenatal psychobiological predictors of anxiety risk in preadolescent children. Psychoneuroendocrinology, Volume 37, Issue 8, 2012, 1224 – 1233. http://dx.doi.org/10.1016/j.psyneuen.2011.12.016



Areas of reduced gray matter volume in association with pregnancy anxiety at 19, 25 and 31 weeks gestation. Voxels with p <0.001 (uncorrected) are displayed.

Buss et al. (2010). High pregnancy anxiety during mid-gestation is associated with decreased gray matter density in 6–9-year-old children. Psychoneuroendocrinology, 35(1), 141 – 153. dx.doi.org/10.1016/j.psyneuen.2009.07.010



Tone & Tully (2014). In press. *Development & Psychopathology*