

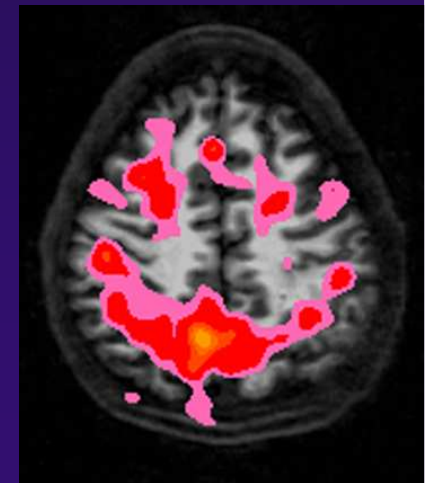
The Neurobiology of Adolescent Alcohol Consumption



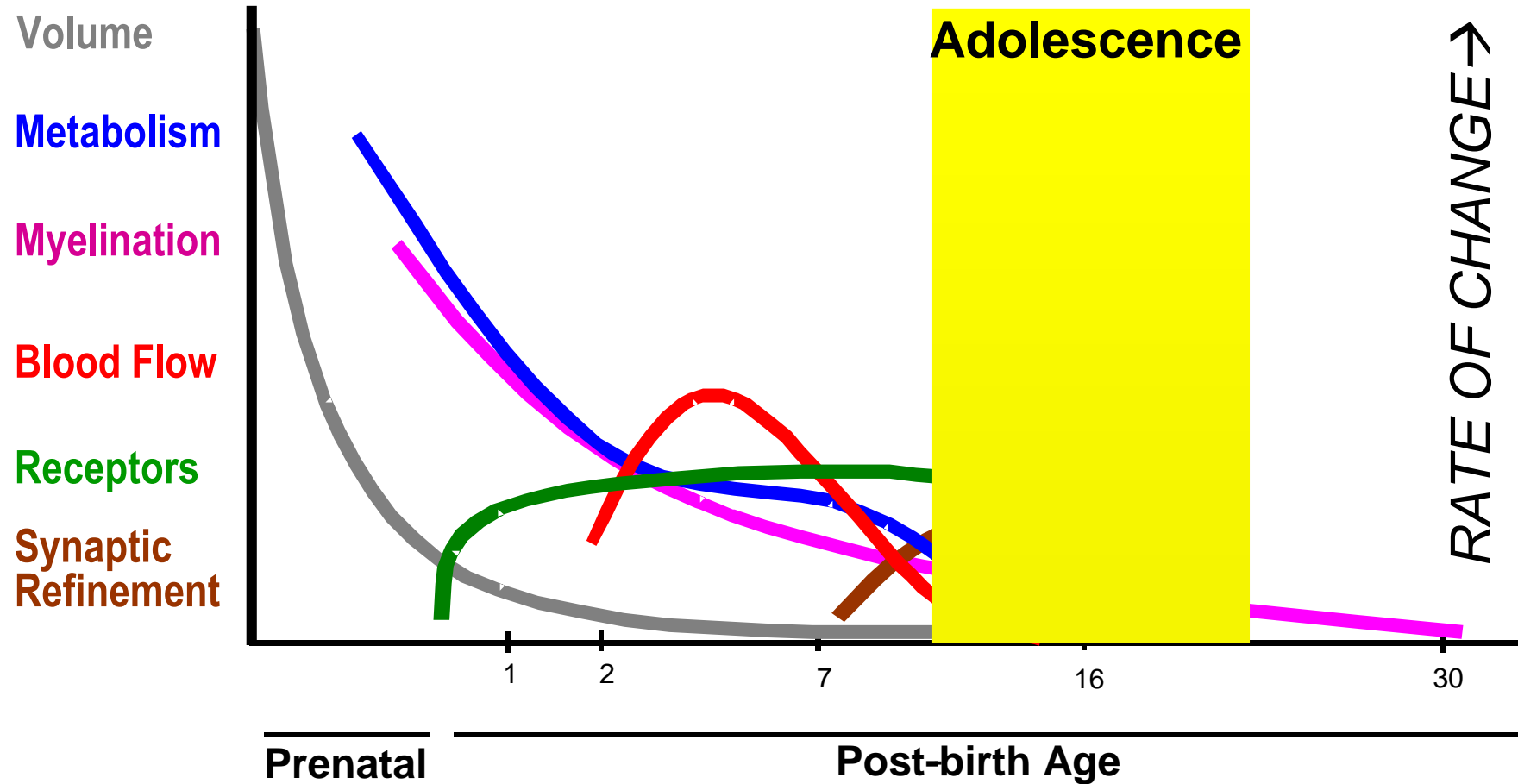
Susan F. Tapert, Ph.D.
University of California, San Diego, United States

Overview

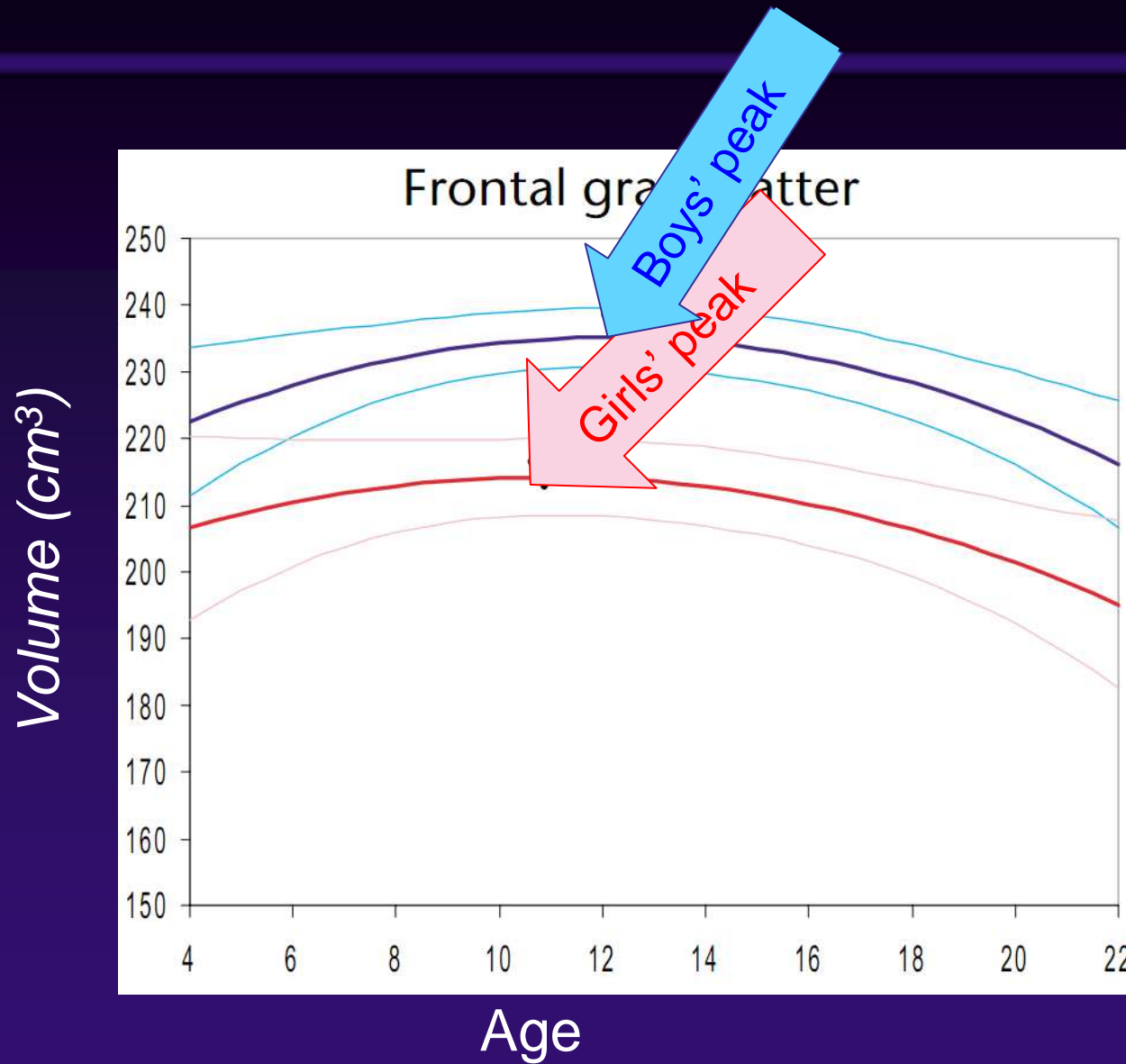
- **Typical brain development**
- **Alcohol & brain structure**
- **Alcohol & brain function**



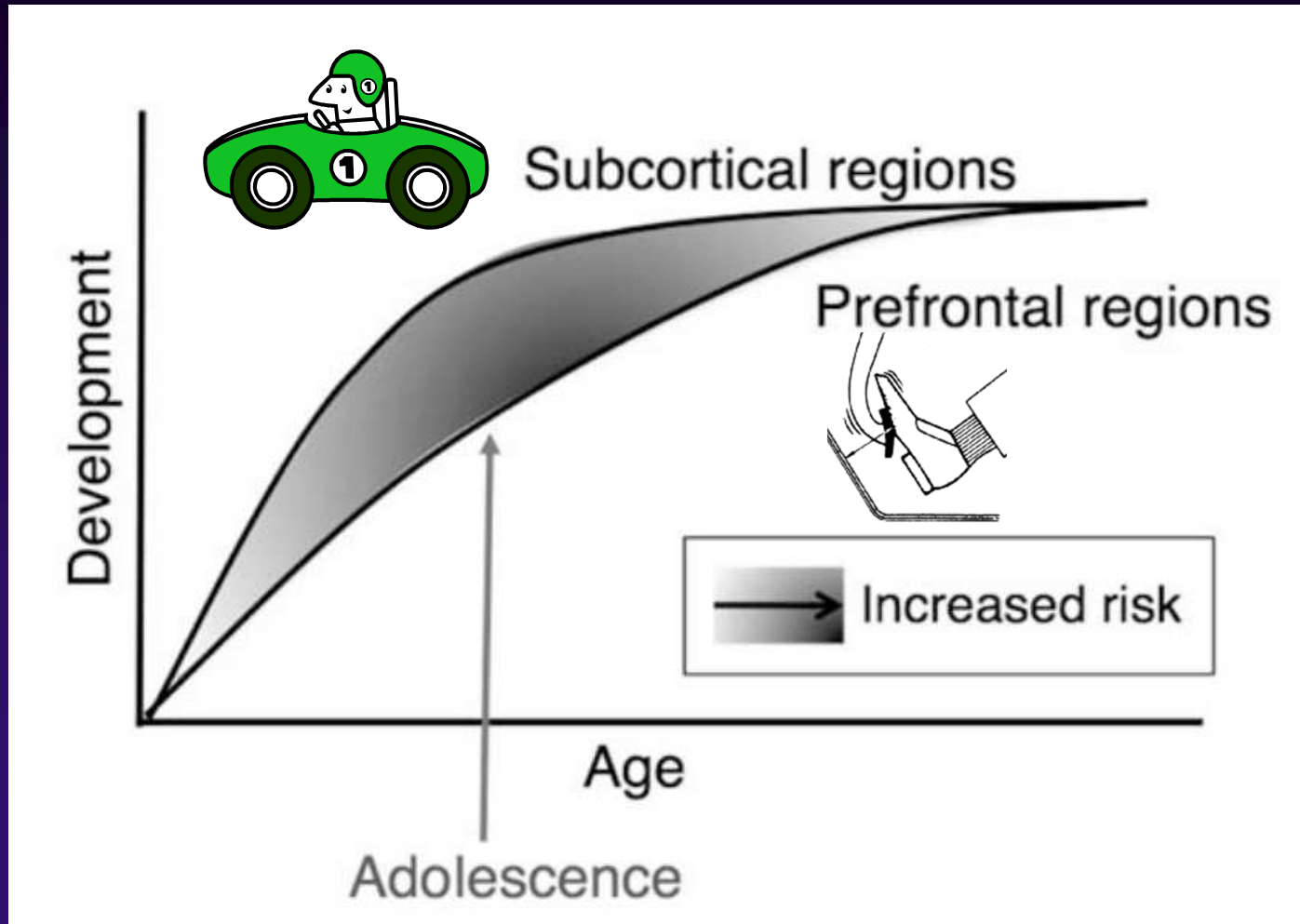
Brain Development



Gender Differences



Reward and Control Systems



Subject Characteristics

	Light Drinkers	Heavy Drinkers
Age	16.5	16.8
Female	41%	37%
Family history of alcoholism	62%	58%
Parent annual salary	\$100,00	\$104,00
IQ score	110	112
Drinks per month *	1	42

* $p < .05$

Summary

- **Adolescent heavy drinkers show:**



- ✓ 10% less information retrieved

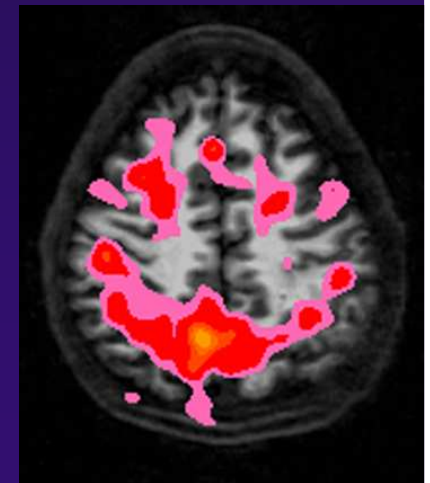
- ✓ Attention / executive deficits

- ✓ Slowed processing speed

- **Do problems relate to brain?**

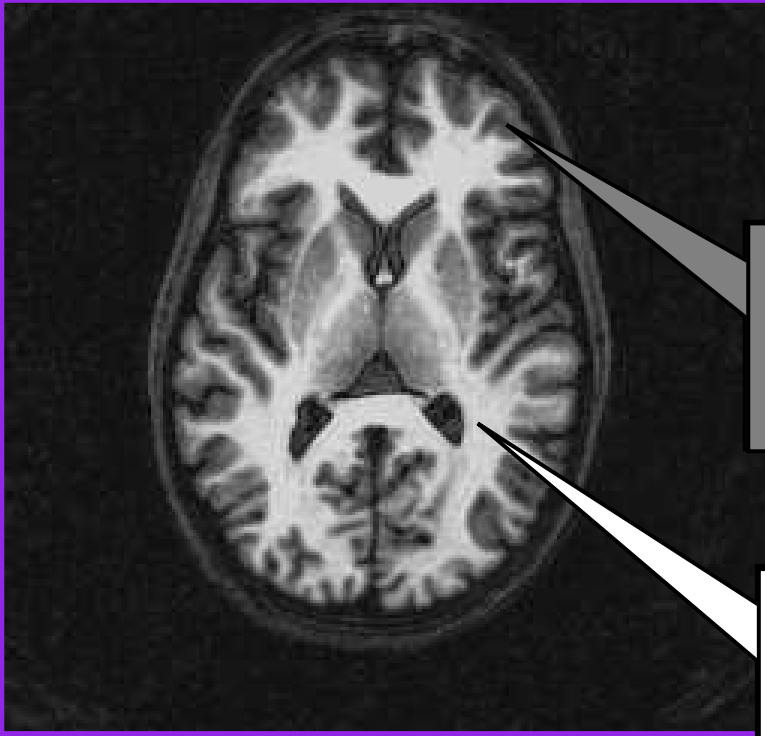
Overview

- Typical brain development
- **Alcohol & brain structure**
- Alcohol & brain function



Brain Studies

Top View



Side View



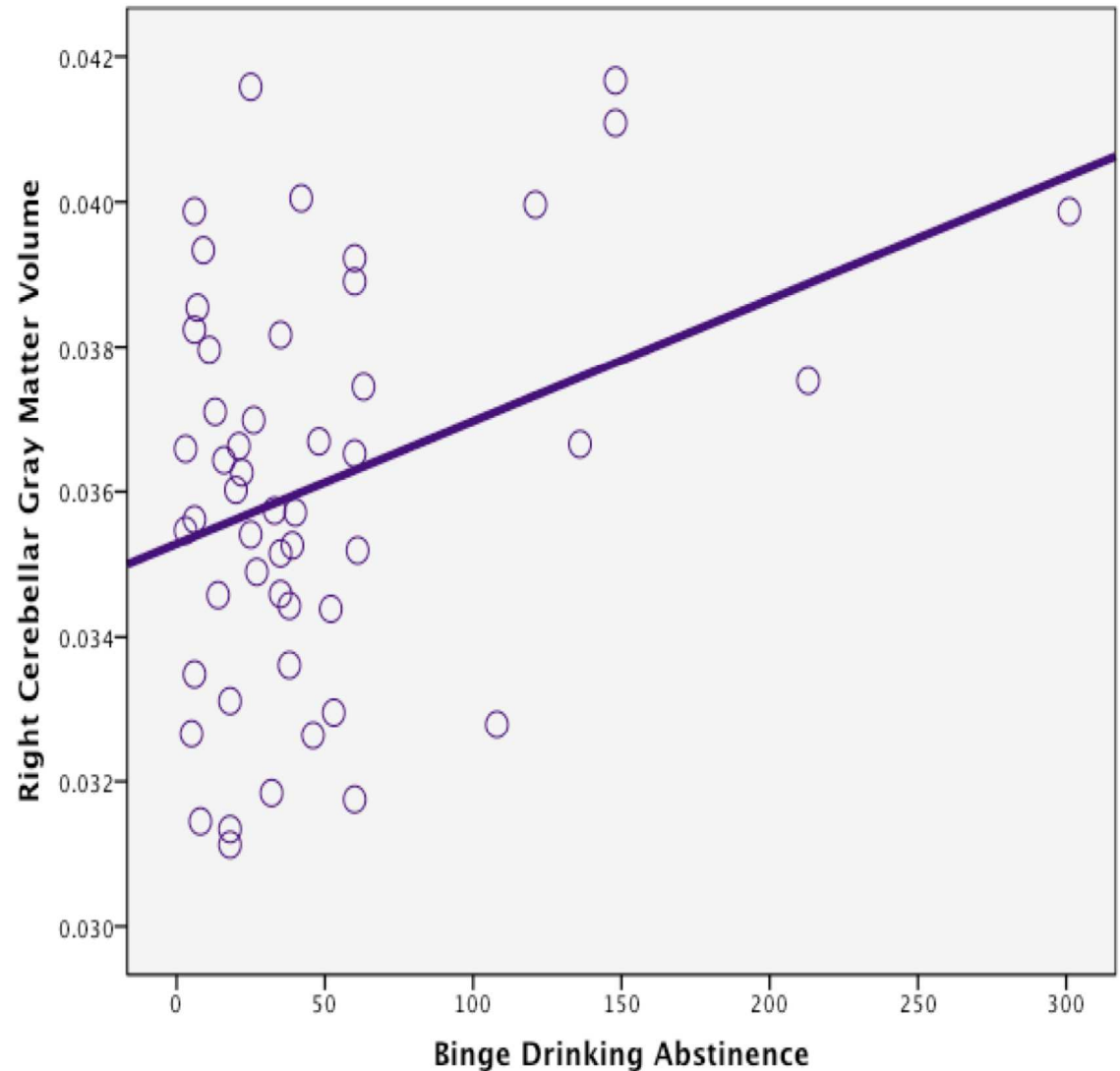
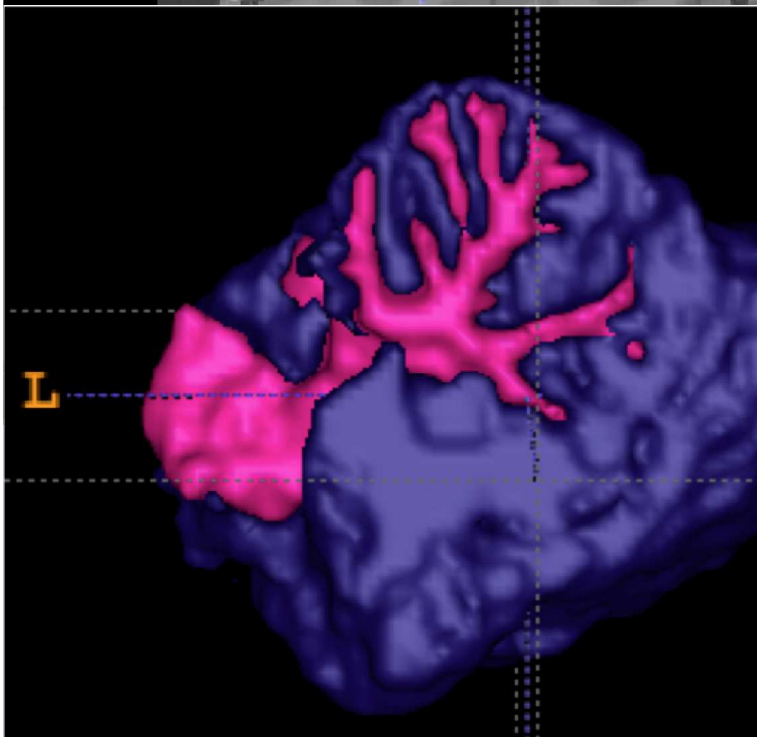
Gray
Matter

White
Matter

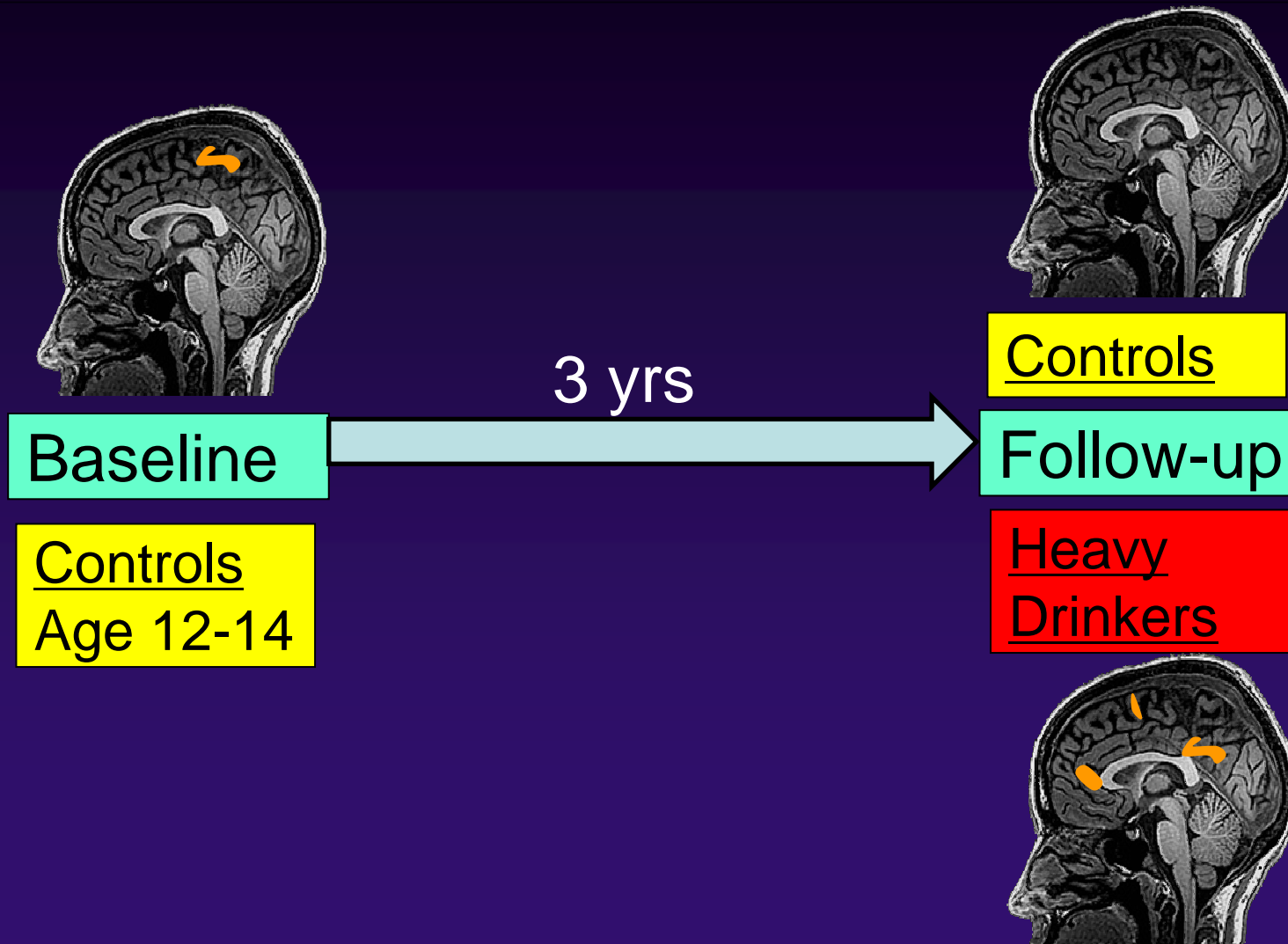


Cerebellar Volume

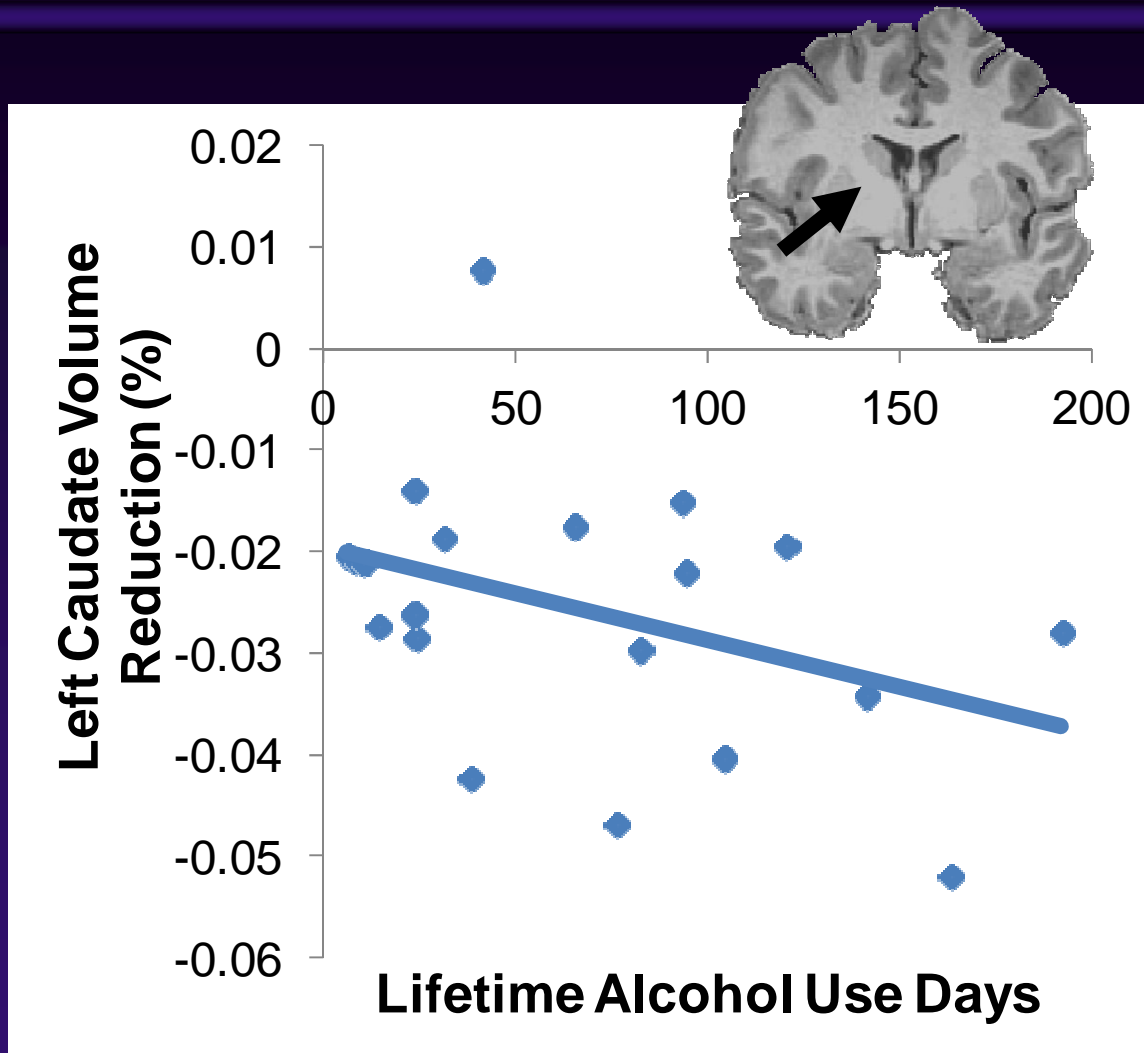
$N=106$ teens:
↑ peak drinks
predicted smaller cerebellum



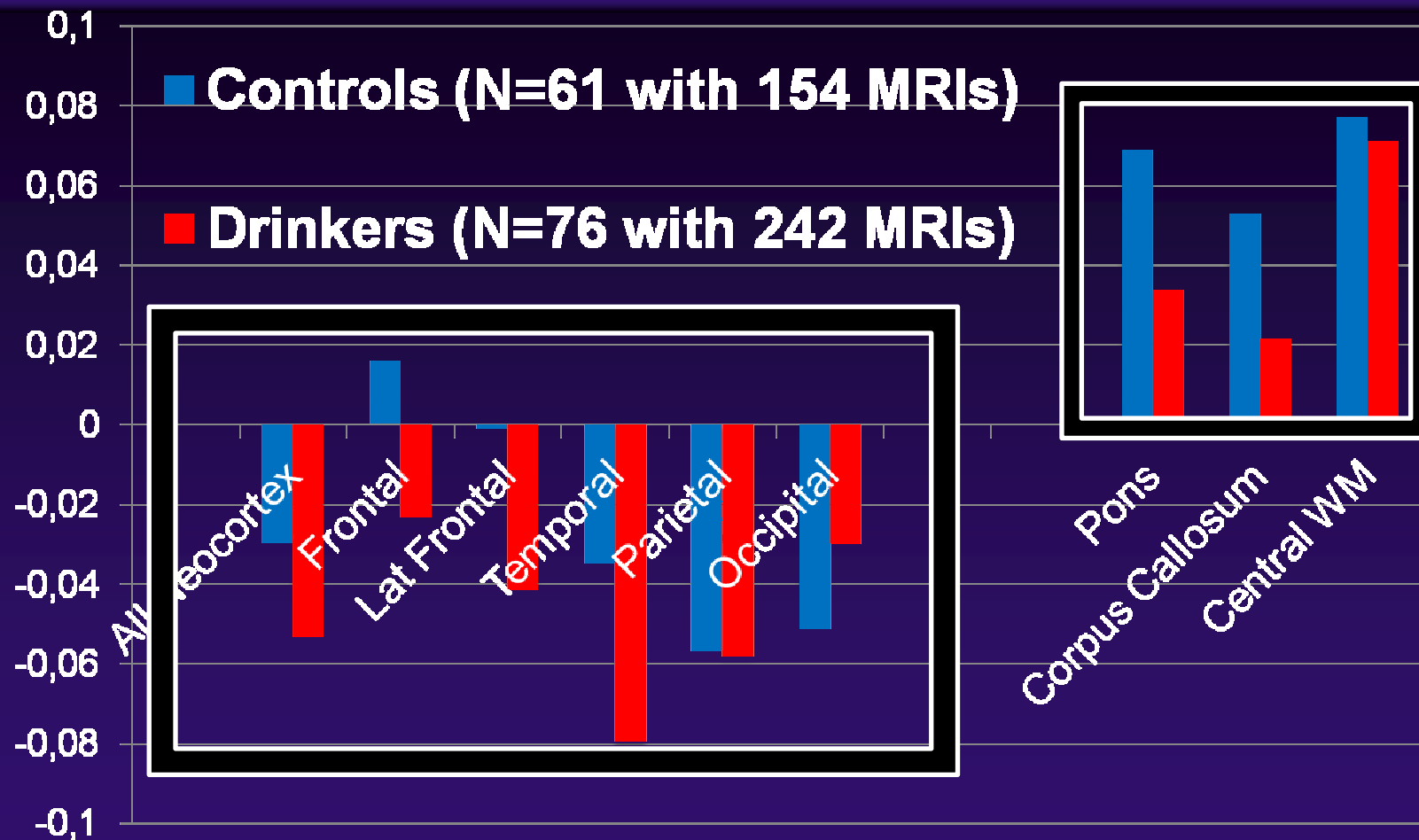
Pre- and Post-initiation Scans



Post-Drinking Effects



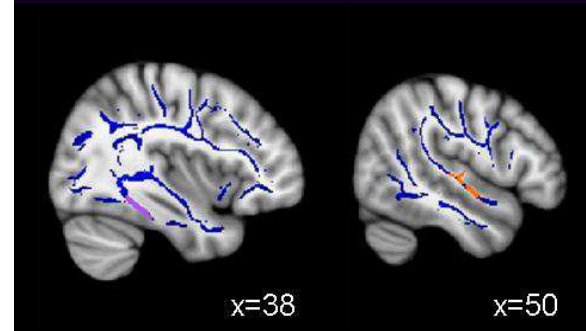
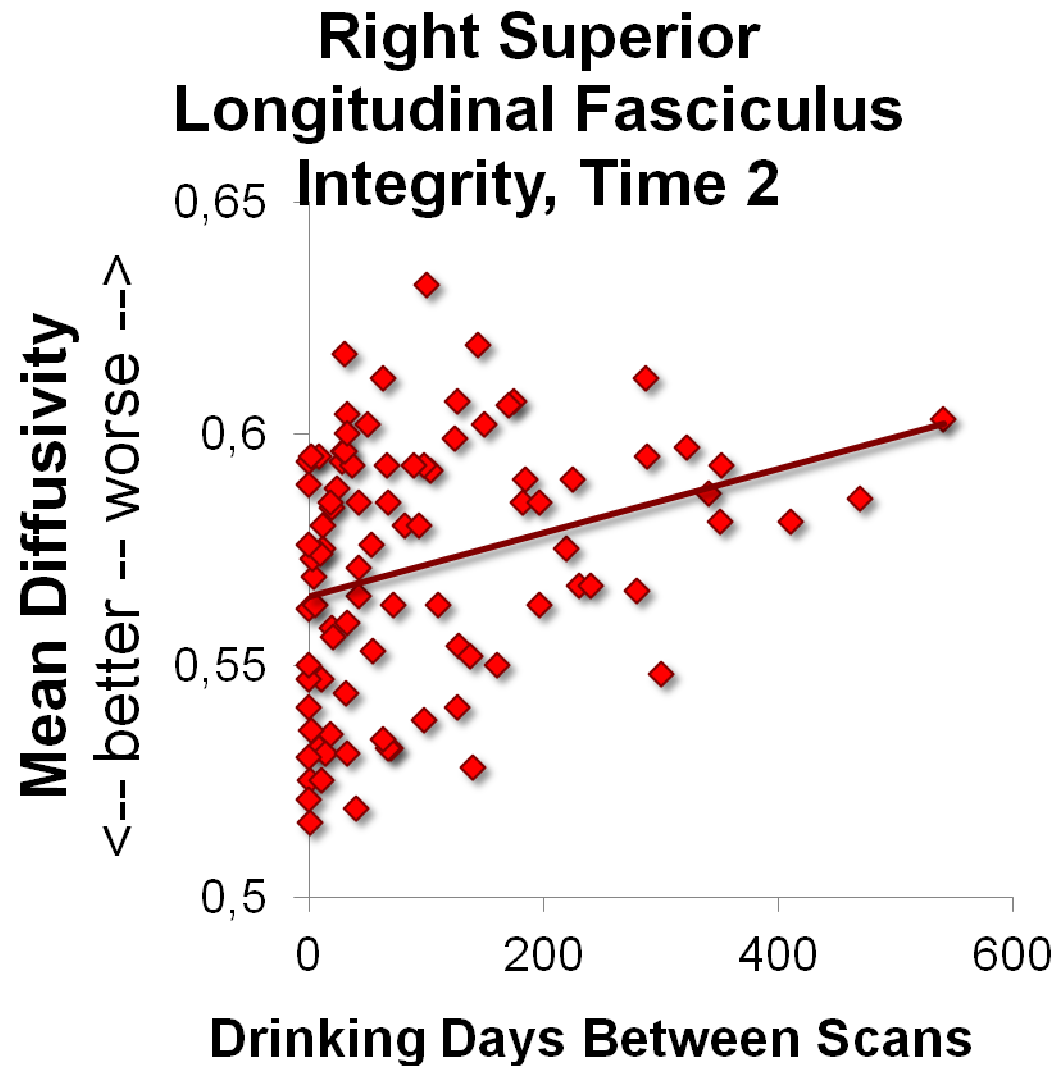
Post-Drinking Effects



Heavy Drinkers = More ↓ Gray Matter, Less ↑ White Matter

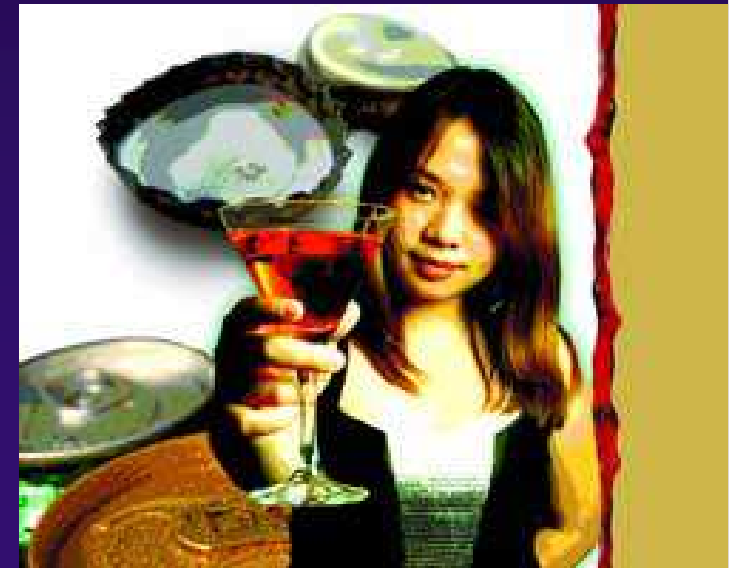
Squeglia, Tapert, et al., in preparation

Increased Drinking → Worse White Matter



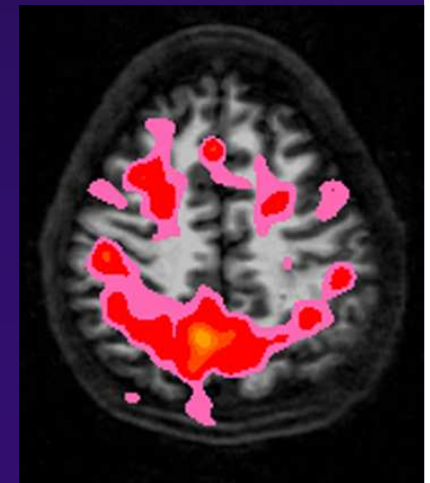
Heavy drinking adolescents

1. Smaller hippocampus
2. Smaller cerebellum
3. Greater reduction in gray matter
4. Less growth in white matter



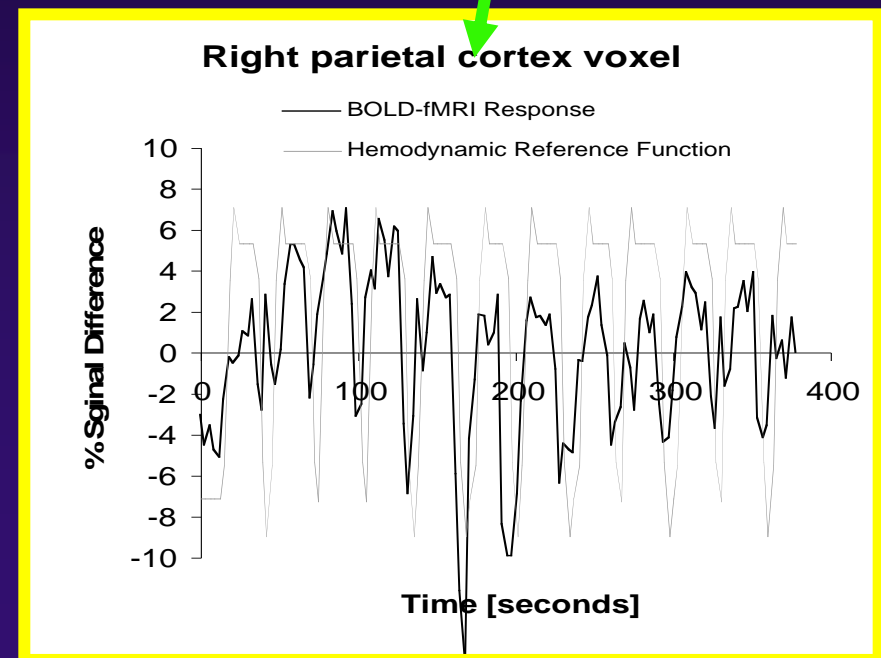
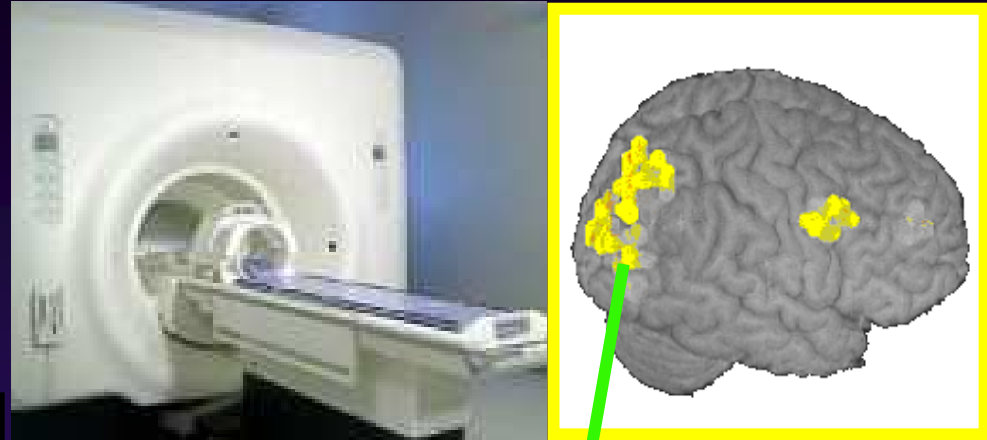
Overview

- Typical brain development
- Alcohol & brain structure
- Alcohol & brain function



Functional MRI

- ◆ MRI
- ◆ Task
- ◆ Changes in blood oxygenation
- ◆ Identify brain areas involved in task
- ◆ Safe

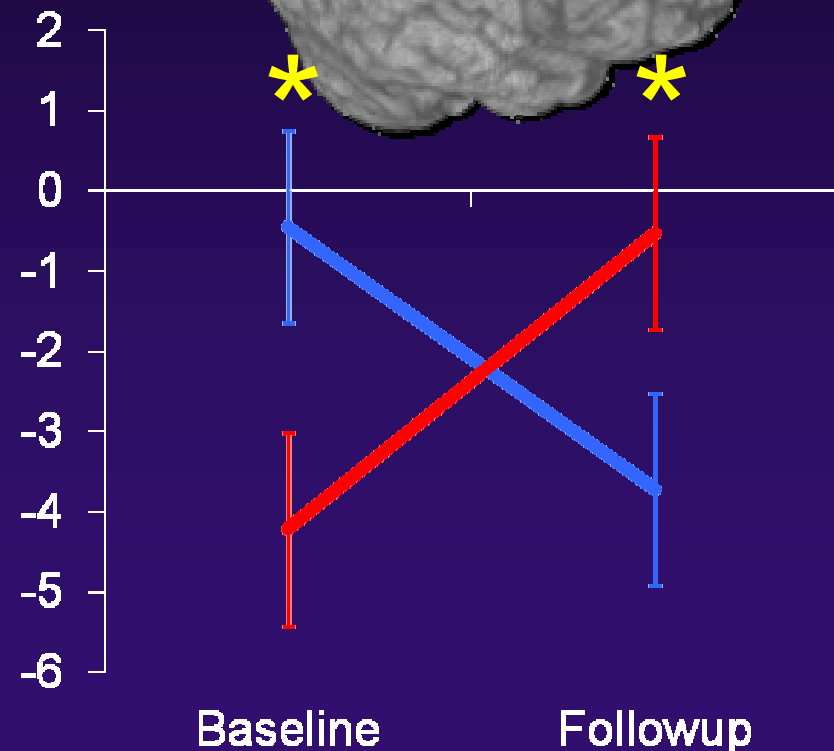
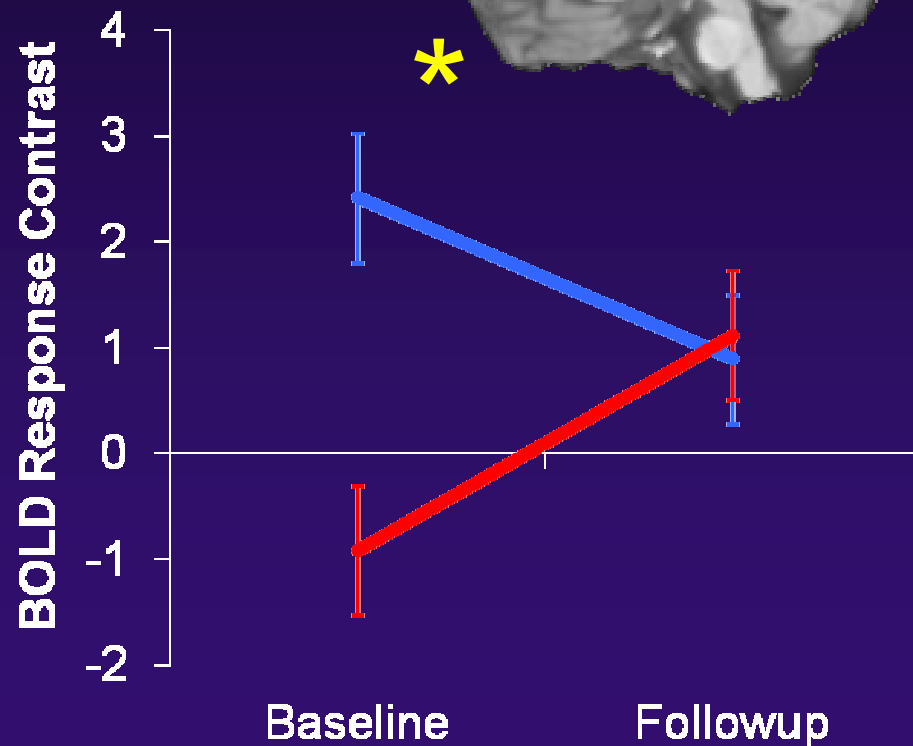
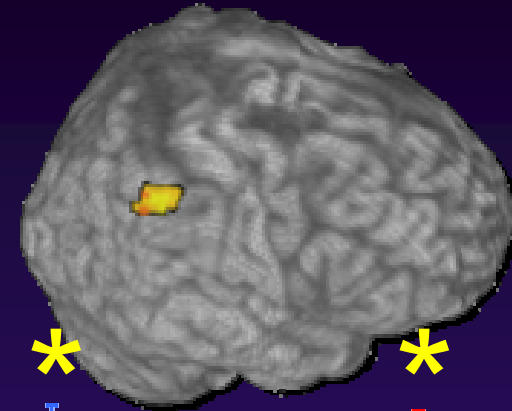
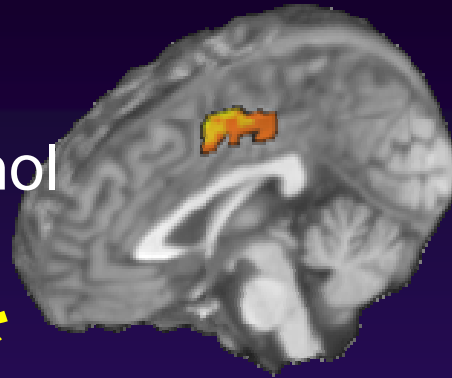


Adolescents Who Initiate Alcohol Show ↑ Activation

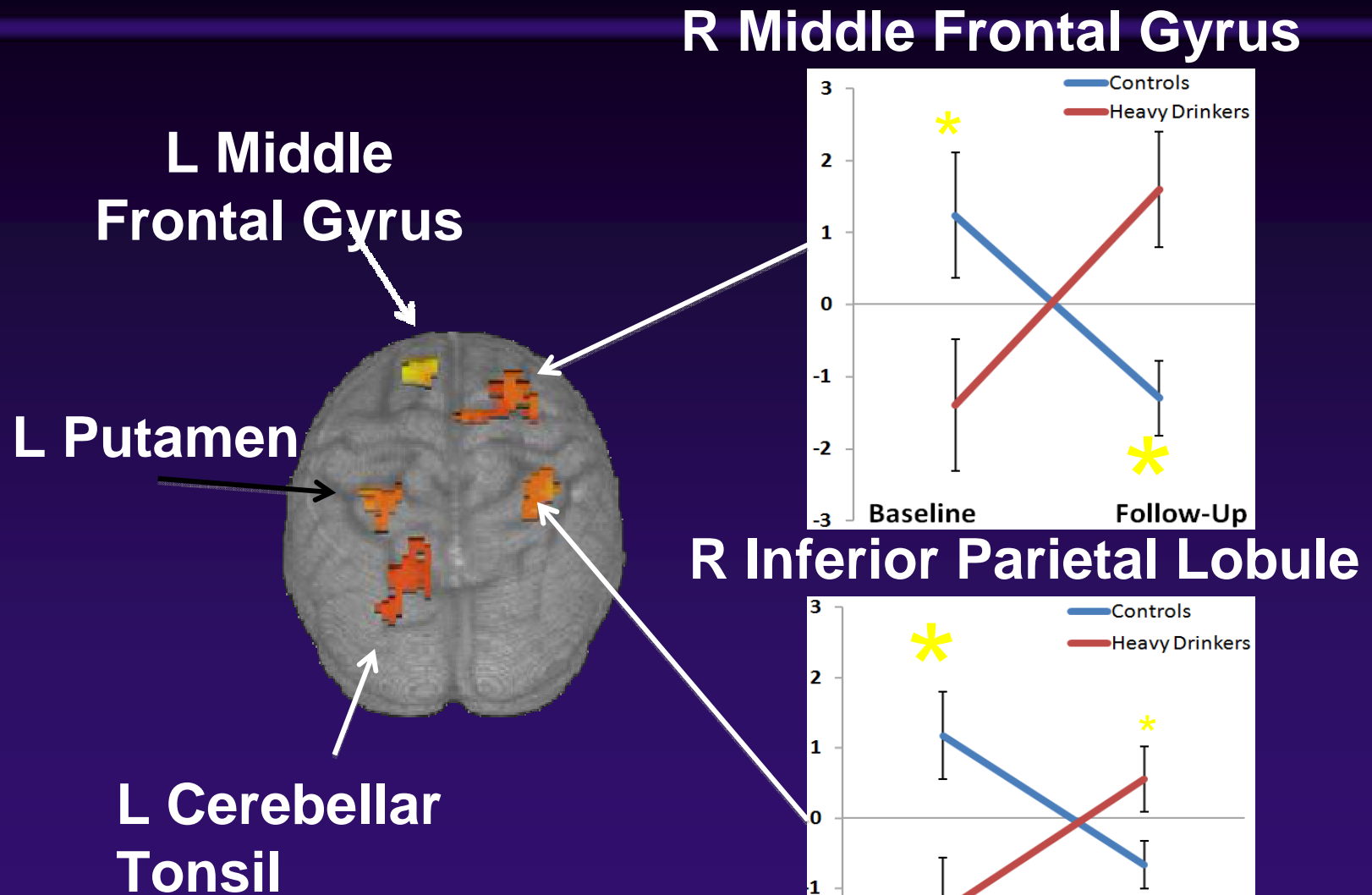
LEFT MEDIAL FRONTAL GYRUS

RIGHT INFERIOR PARIETAL LOBULE

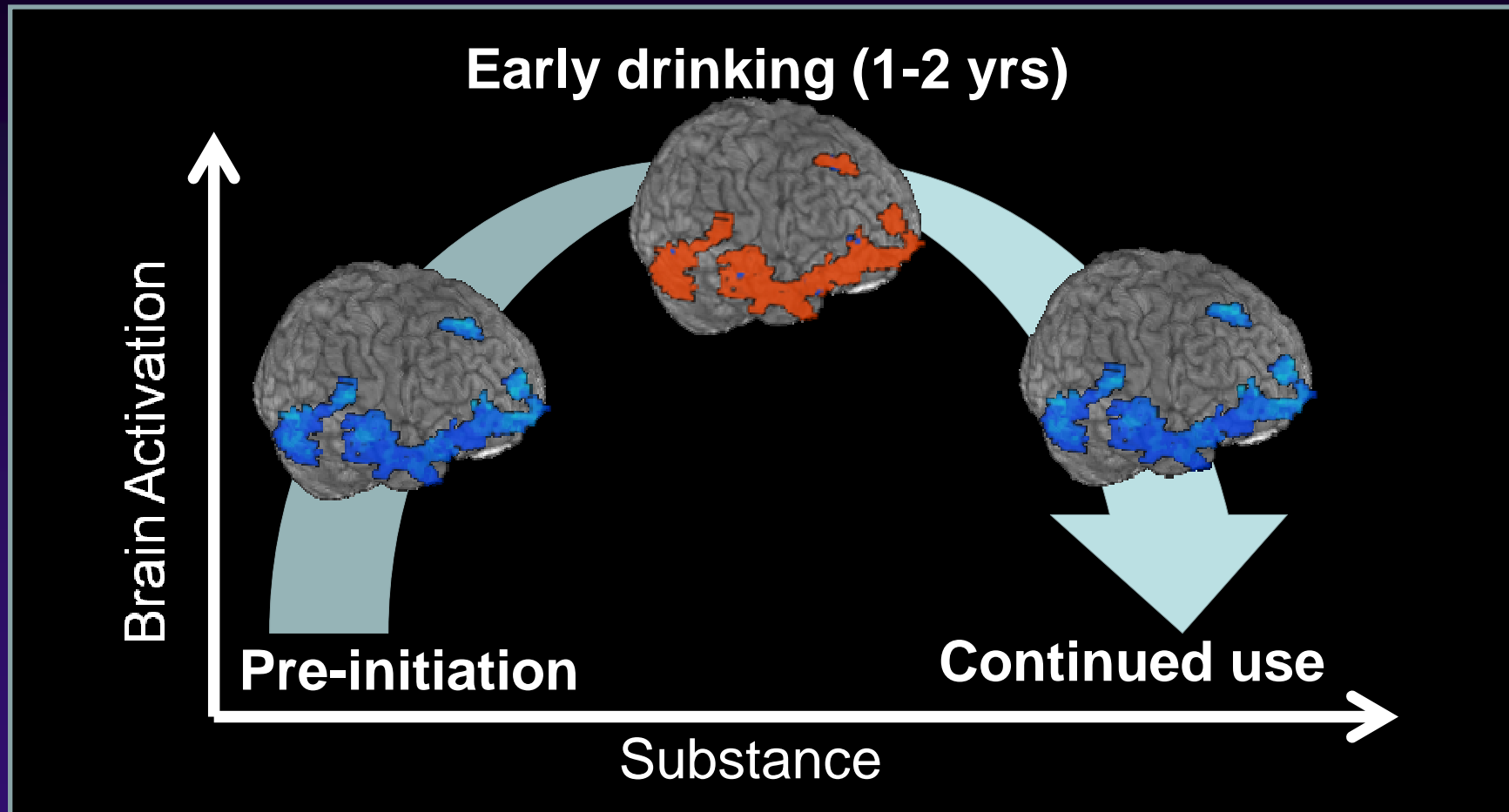
— Never drank
— Started alcohol



Same Pattern for Inhibition Task



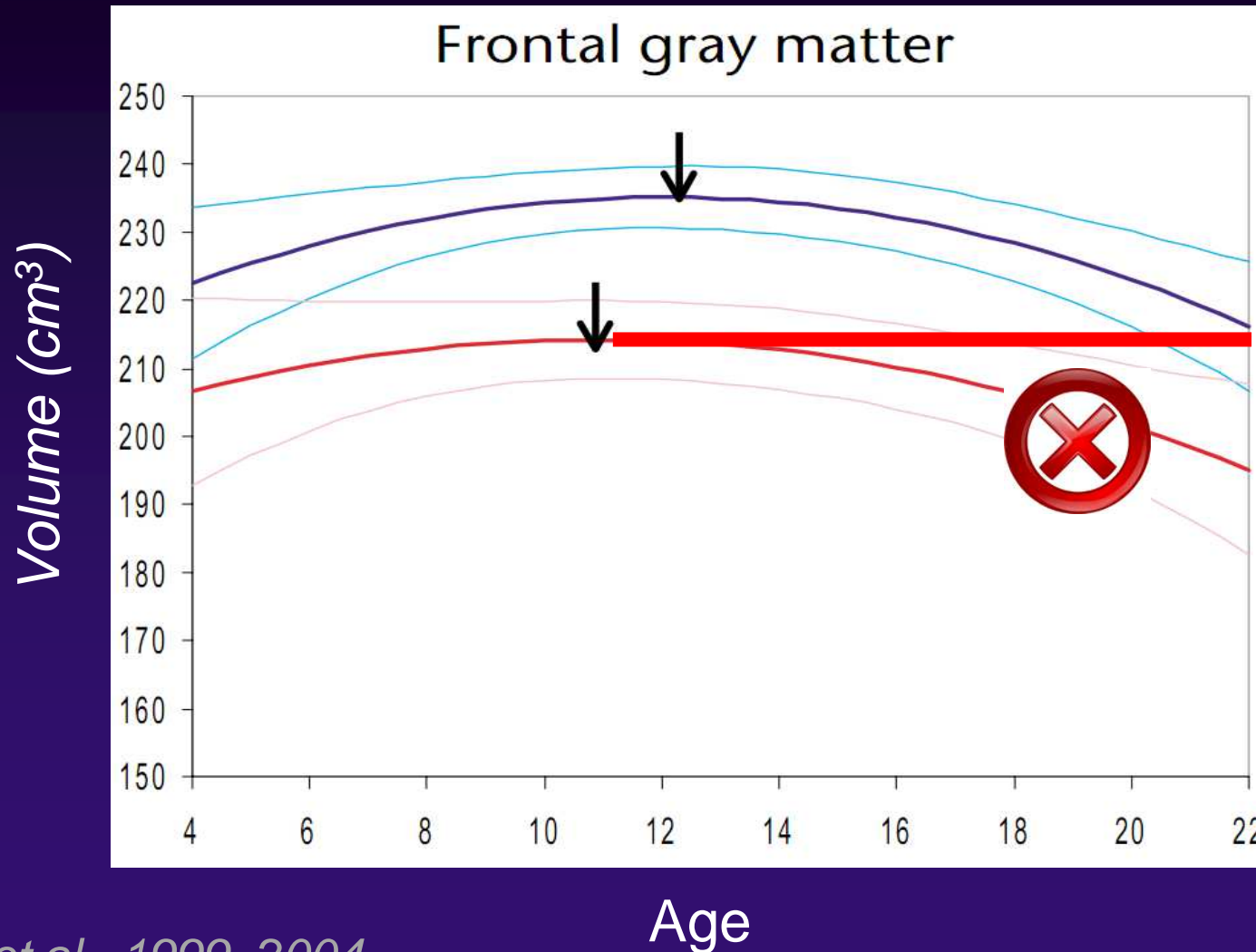
Brain Activation and Adolescent Alcohol Use



Sex Differences

- **Neuropsychological testing:**
 - **Females:** ↓ visuospatial fxn
 - **Males:** minimal (↓ sustained attention)
- **Brain structure:**
 - **Females:** ↑ frontal cortical thickness=
↓ cognition
- **Brain function:**
 - **Females:** ↓ brain activation=↓ cognition

Interrupted Developmental Trajectory?



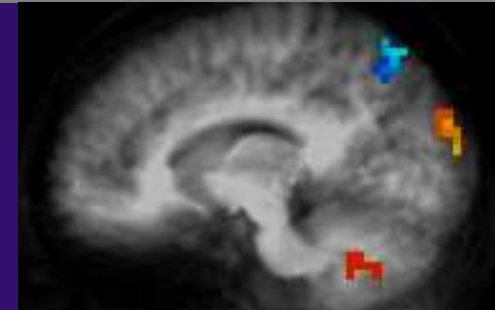
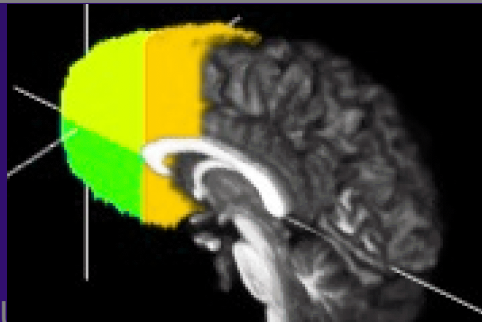
Giedd et al., 1999, 2004

Heavy Drinking Adolescents

- **Neurocognition**
 - Pre-drinking: no differences
 - Post-drinking:
 - **Females:** ↓ visuospatial fxn
 - **Males:** minimal (↓ sustained attention)
- **Brain structure**
 - Pre: ↓ volume
 - Post: ↓ ↓ volume
- **Brain functioning**
 - Pre: ↓ activation
 - Post: ↑ activation during early drinking

Summary

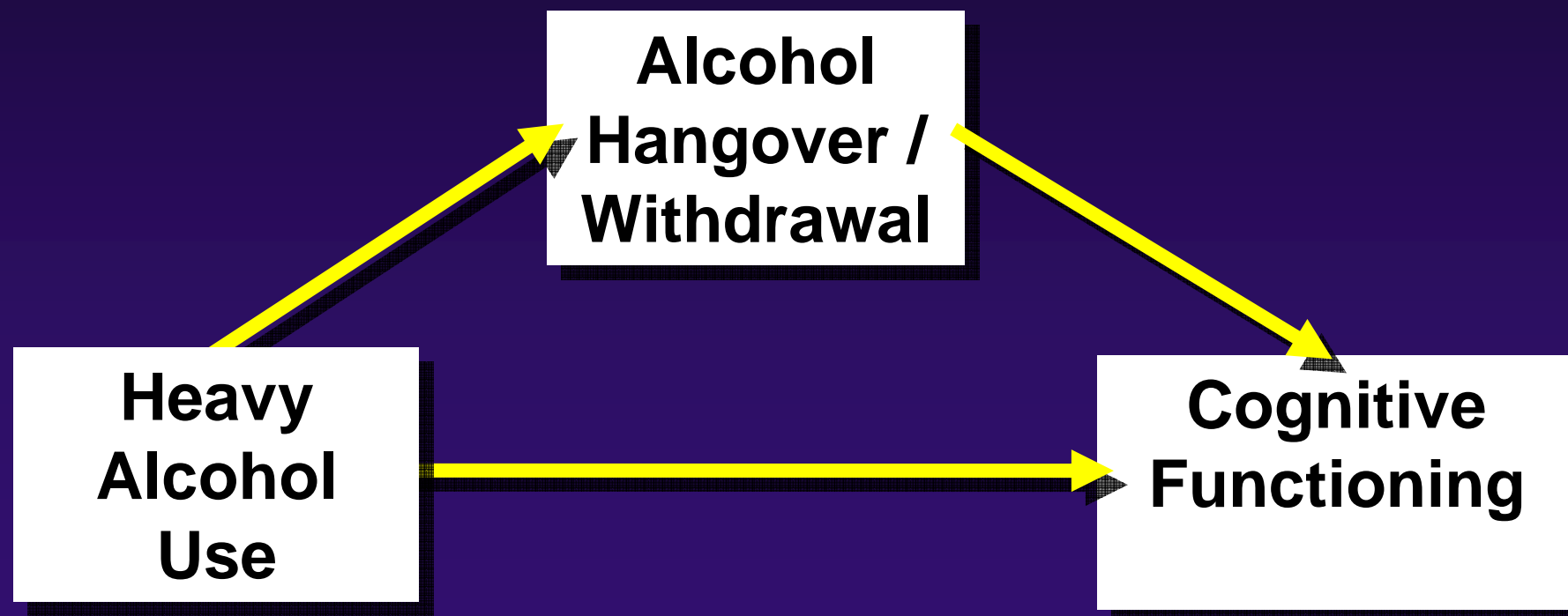
Deficit	Associated Brain Findings	
	Structure	Function
↓Memory	↓Hippocampus	-
↓Attention/ Executive	↓Prefrontal	↓Prefrontal
↓Spatial	↓White matter quality	↓↑Parietal



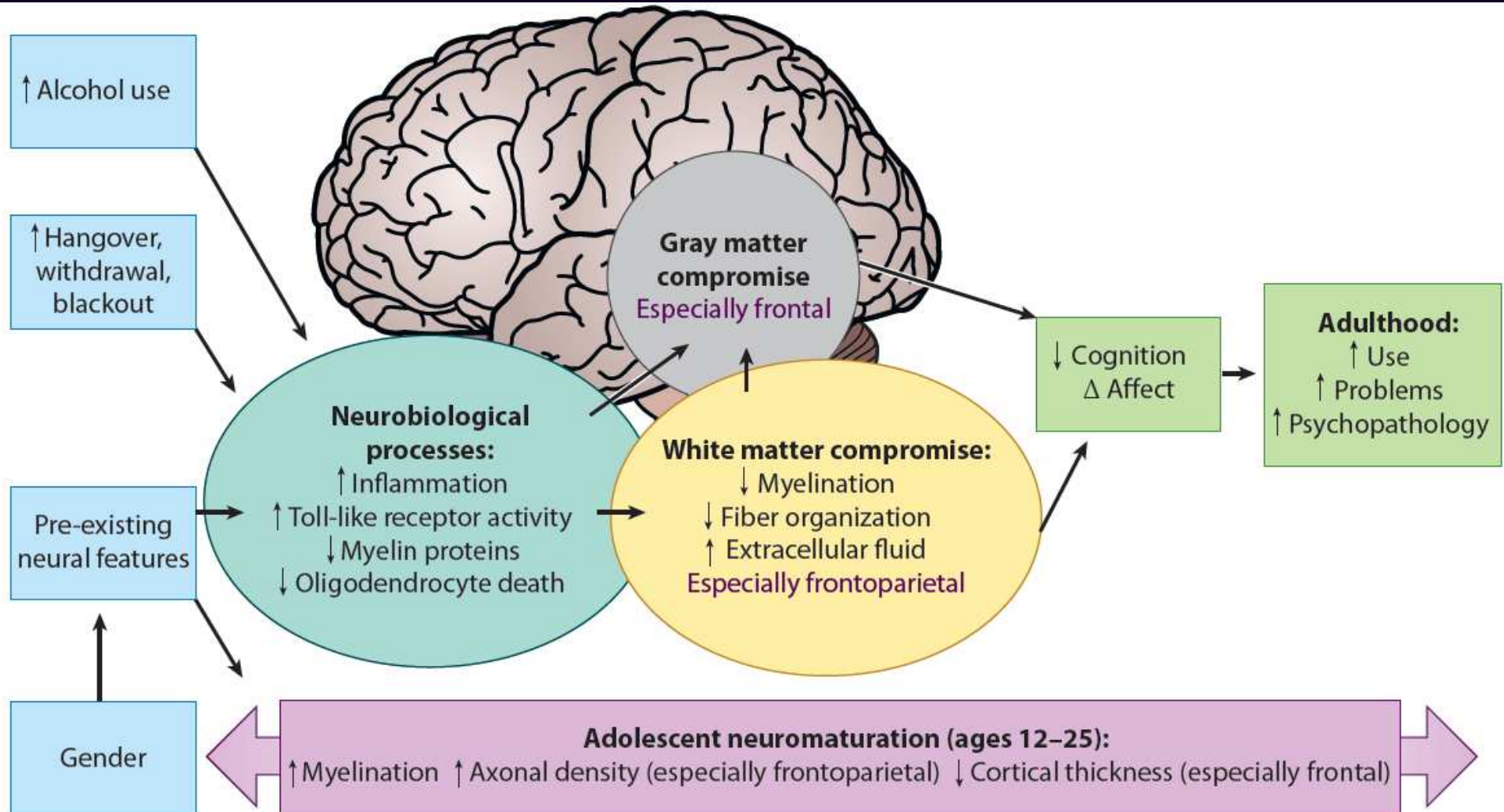
Summary

Adolescence

Young
Adulthood



Teen Alcohol Use & Brain



Implications

1. Prevention: Inform youth of risks

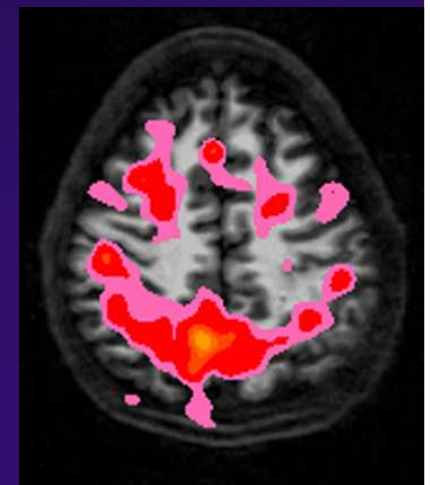
- Brain is still developing
- Don't get hungover!
- >12 drinks/mo may harm females' cognition
- Marijuana has detrimental effects also

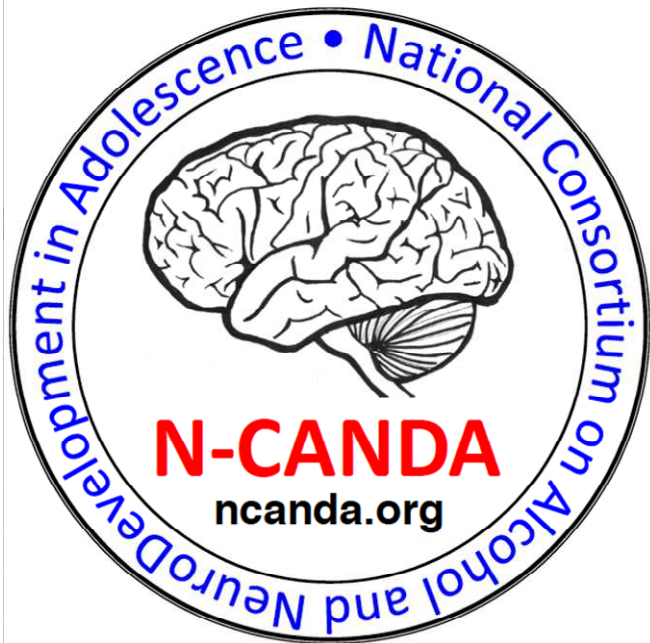
2. Use info to improve interventions

- Cognition improve after >2 weeks abstinent
- Before 2 weeks, must repeat information

Conclusions

- Brain is developing in adolescence
- Heavy drinking: disadvantages
- Prevention and intervention are needed





Administration:

- Sandy Brown - Coordinator
- Susan Tapert

Data:

- Dolf Pfefferbaum
- Kilian Pohl
- Edie Sullivan

Sites:

- U Pittsburgh – Duncan Clark
- SRI – Ian Colrain & Fiona Baker
- Duke Univ – Mike DeBellis
- OHSU – Bonnie Nagel
- UCSD – Susan Tapert

5 Sites:

>50,000 school, community, and random digit dialing recruitment

>7,500 respond to screen

>850 baseline assessments

50%
Representative

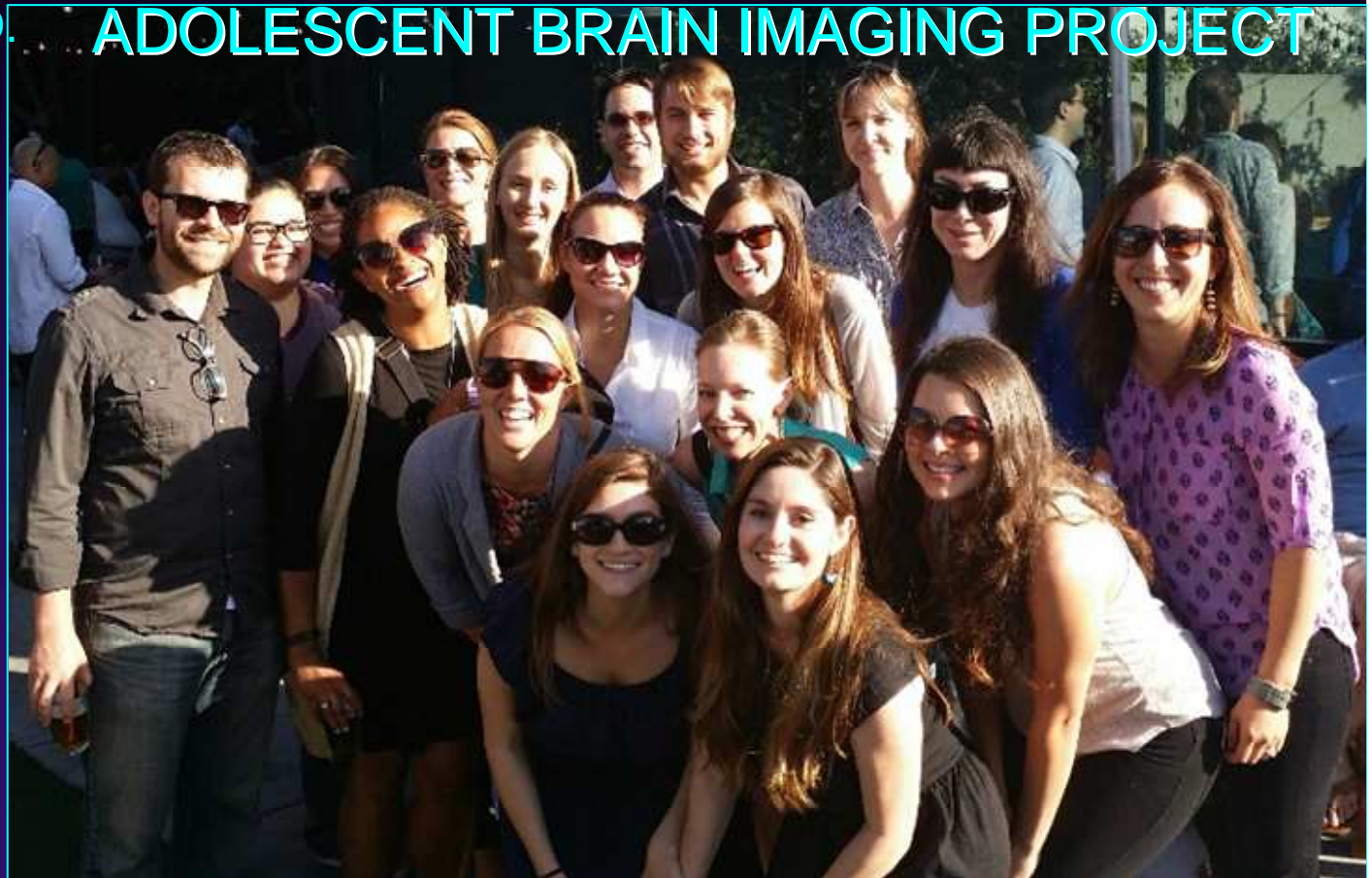
50%
High Risk

3 annual follow-ups:
Interview, Neuropsych, MRI
(~25% heavy drinkers)

Acknowledgements

Lindsay Squeglia, Ph.D.
Joanna Jacobus, Ph.D.
Ty Brumback, Ph.D.
Carmen Pulido, Ph.D.
MJ Meloy, Ph.D.
Sonja Eberson, M.A.
Norma Castro, M.A.
Lotte Berk, M.A.
Alejandra Infante, M.A.
Tam Nguyen
Ashley Tracas
Ashley Imeson
Taylor Trah
Silvia Escobar

ADOLESCENT BRAIN IMAGING PROJECT



Funding Support: U.S. National Institutes of Health:

- U01 AA021692 (Tapert)
- R01 DA021182 (Tapert)
- R01 AA13419 (Tapert)