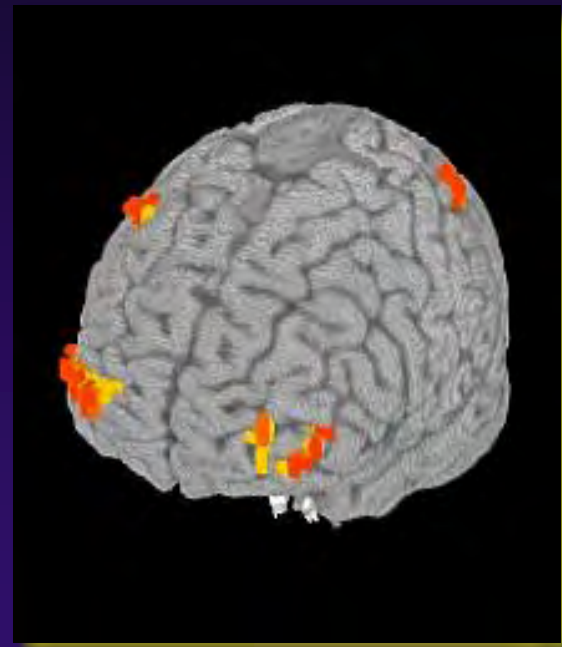


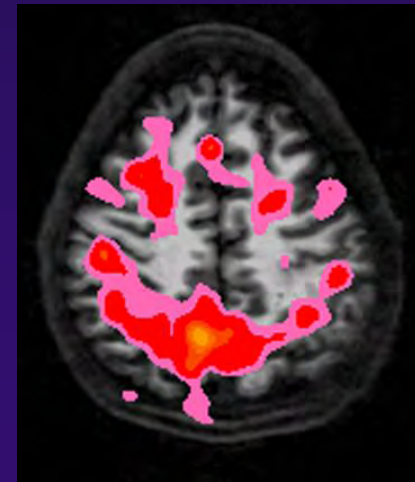
Neuroimaging Findings in Young Drinkers: Does Teenage Drinking Harm the Brain?



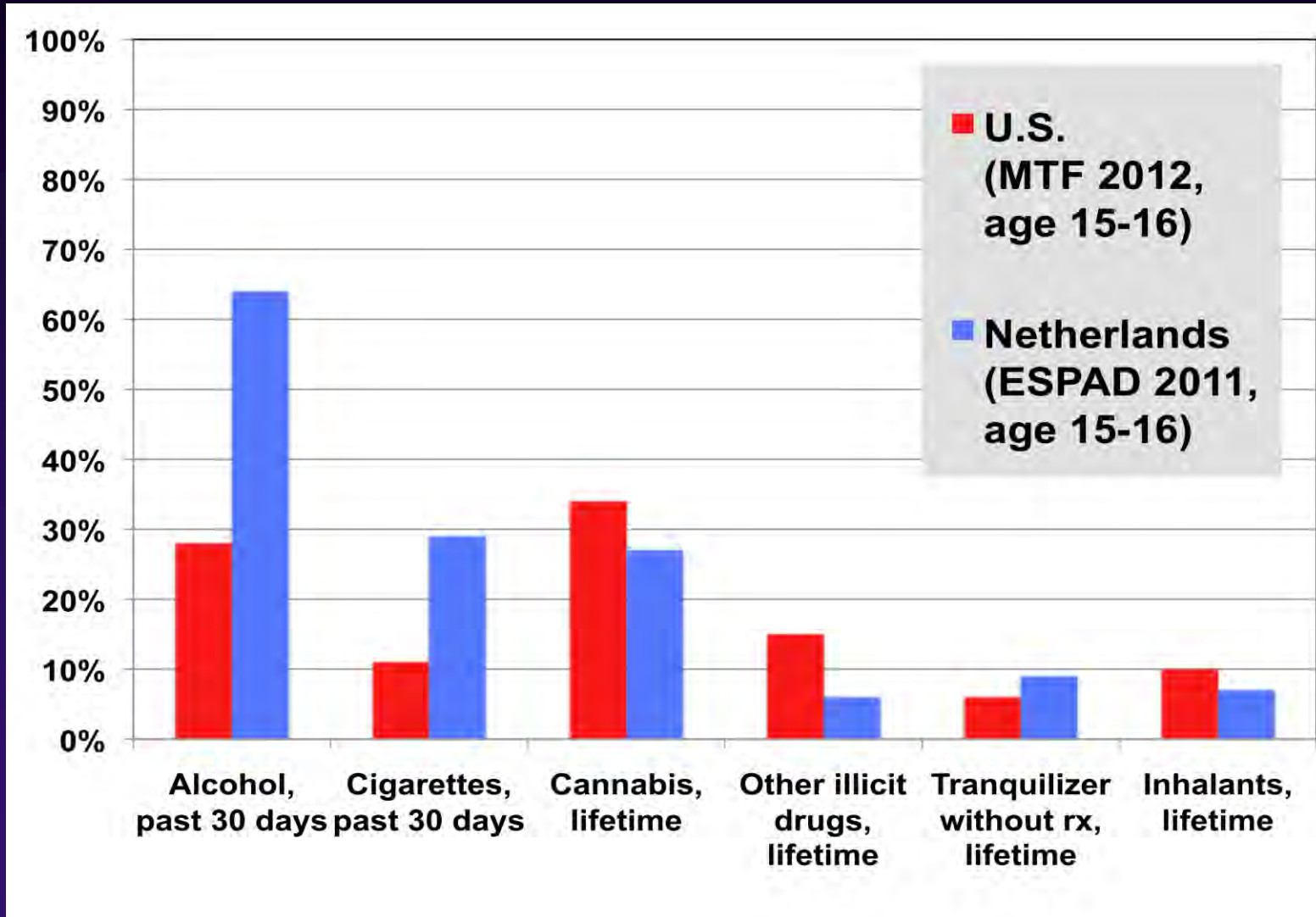
Susan F. Tapert, Ph.D.
University of California, San Diego

Overview

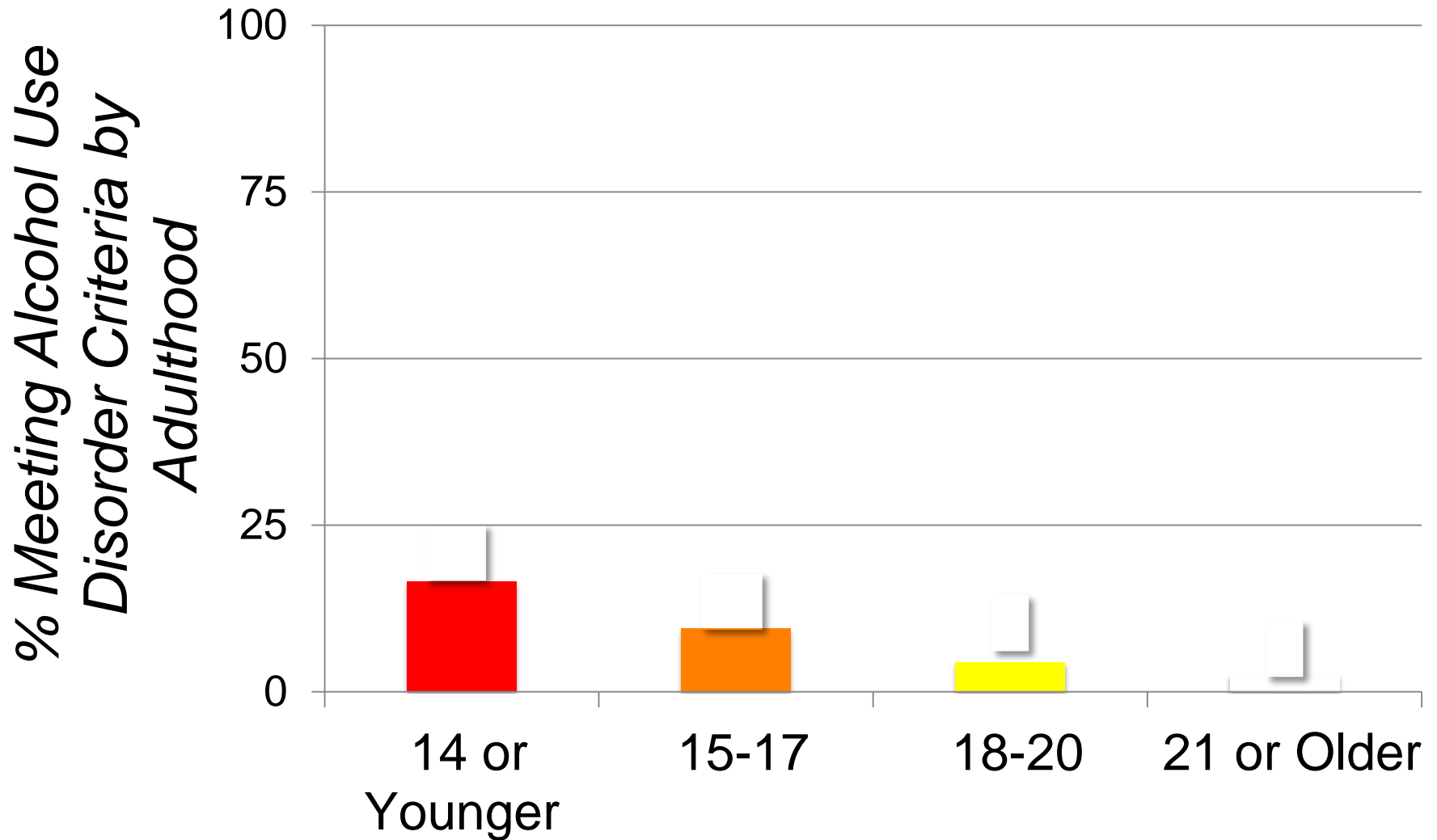
- **What is normal adolescence?**
- **How do binge drinkers differ?**
- **Does the media have a role?**
- **Prevention implications**



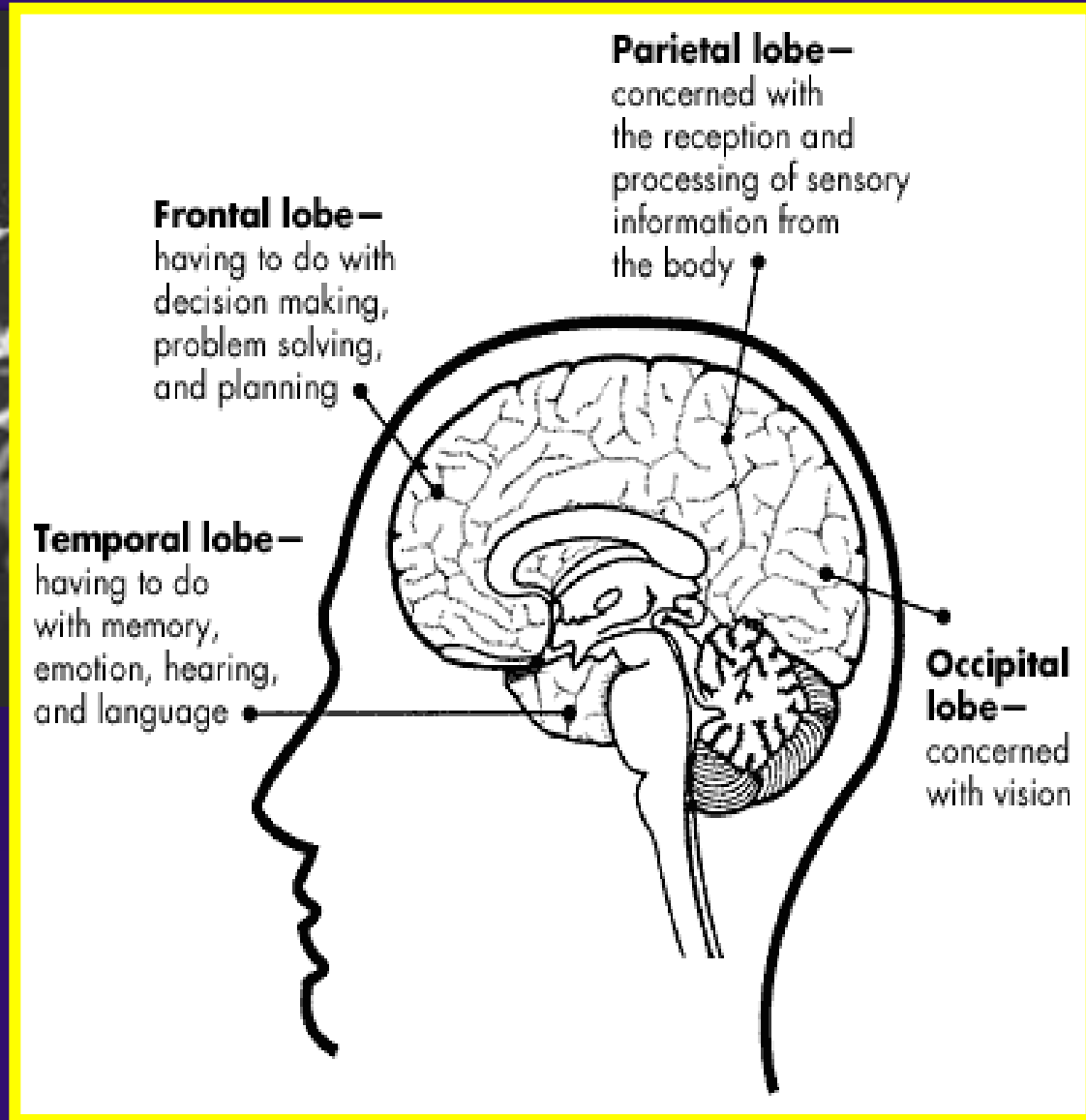
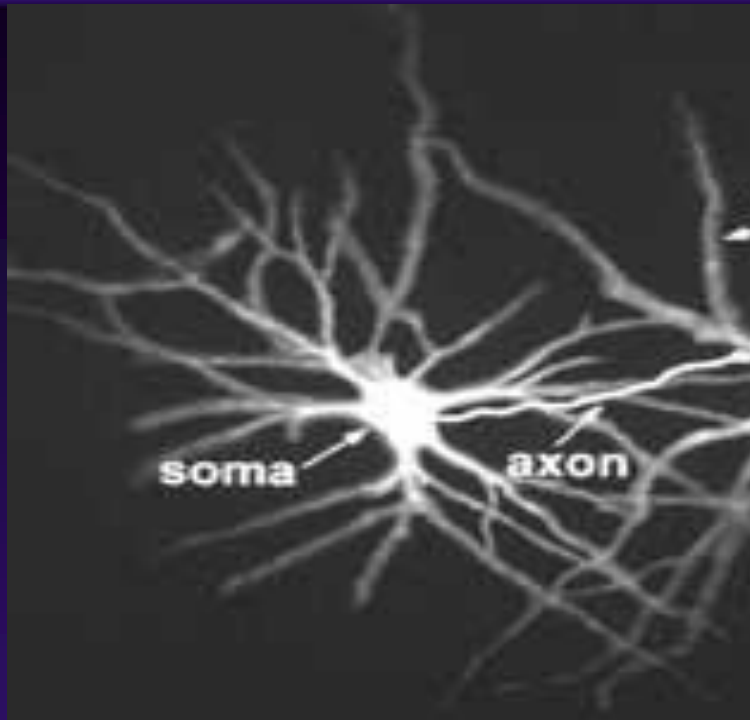
Past Month Use of Substances



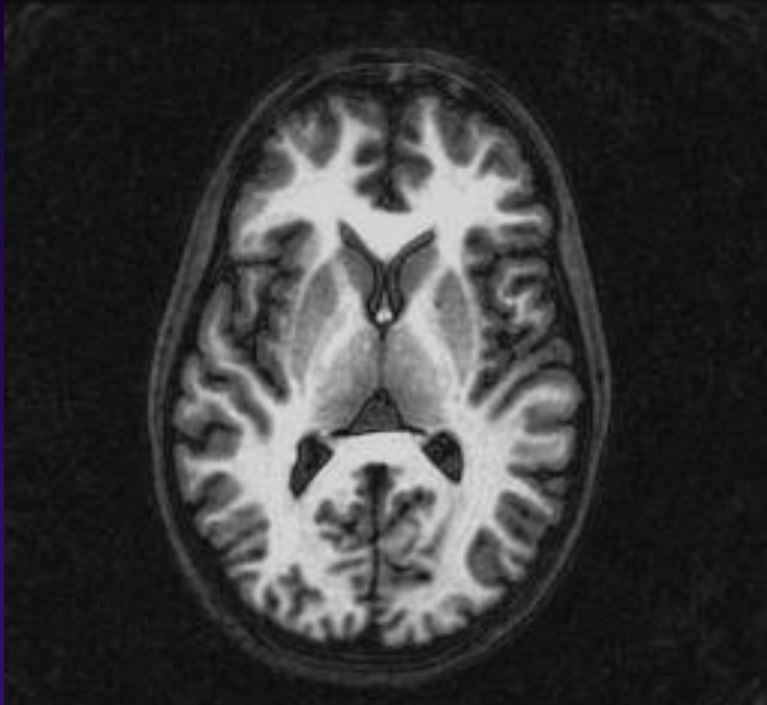
Age of First Drink



Quick Brain Review!



Gray & White Matter

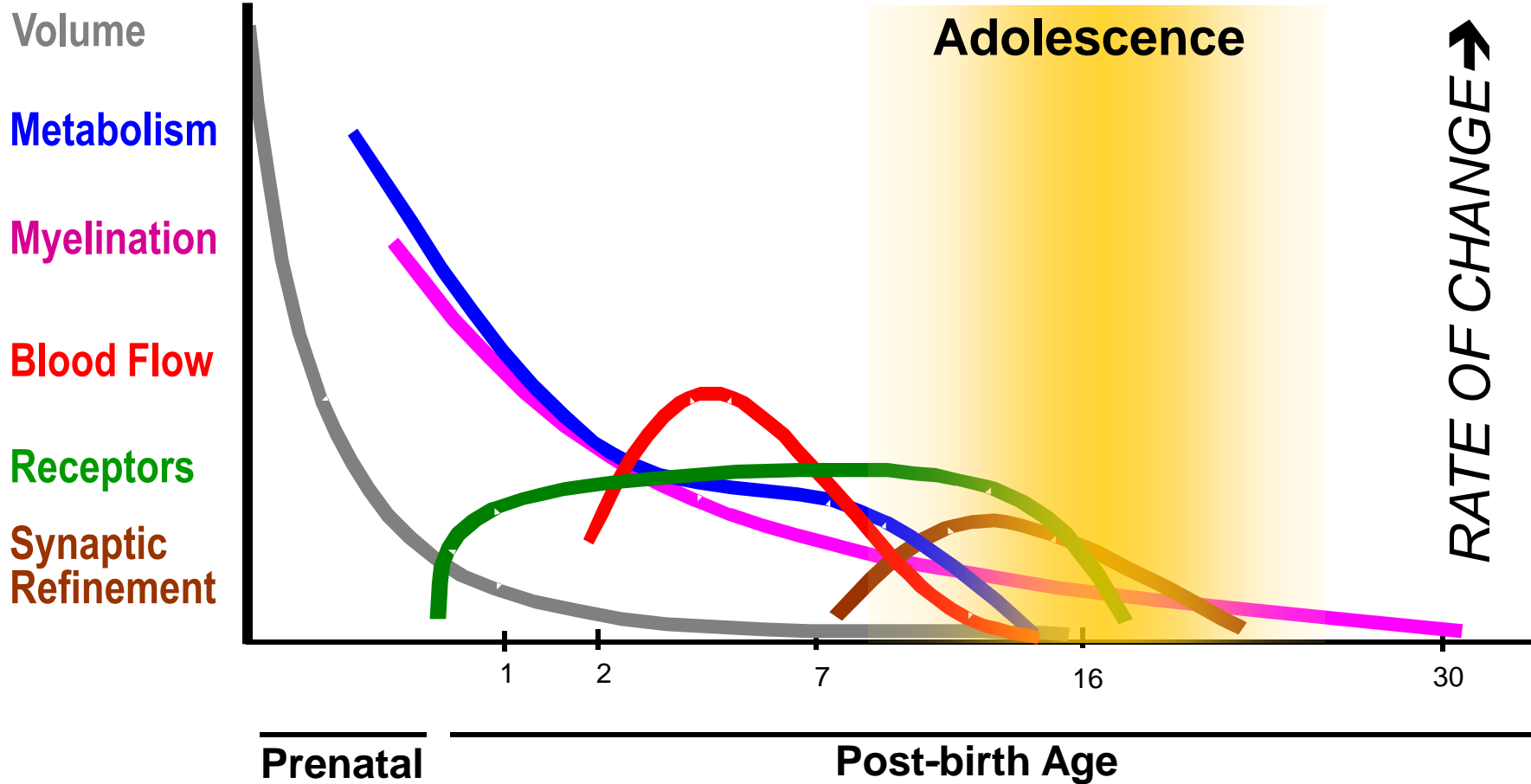


Top view

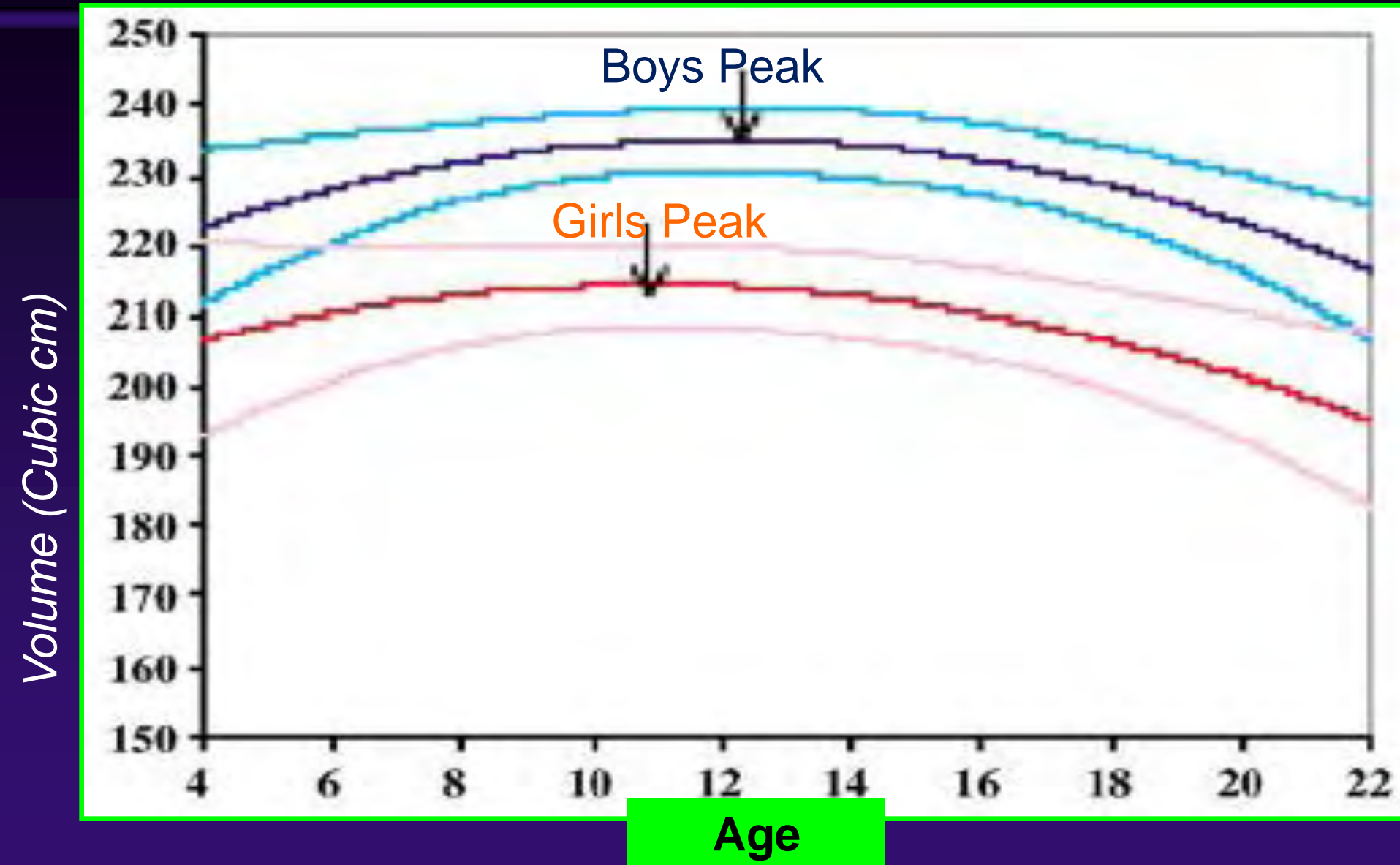


Side view

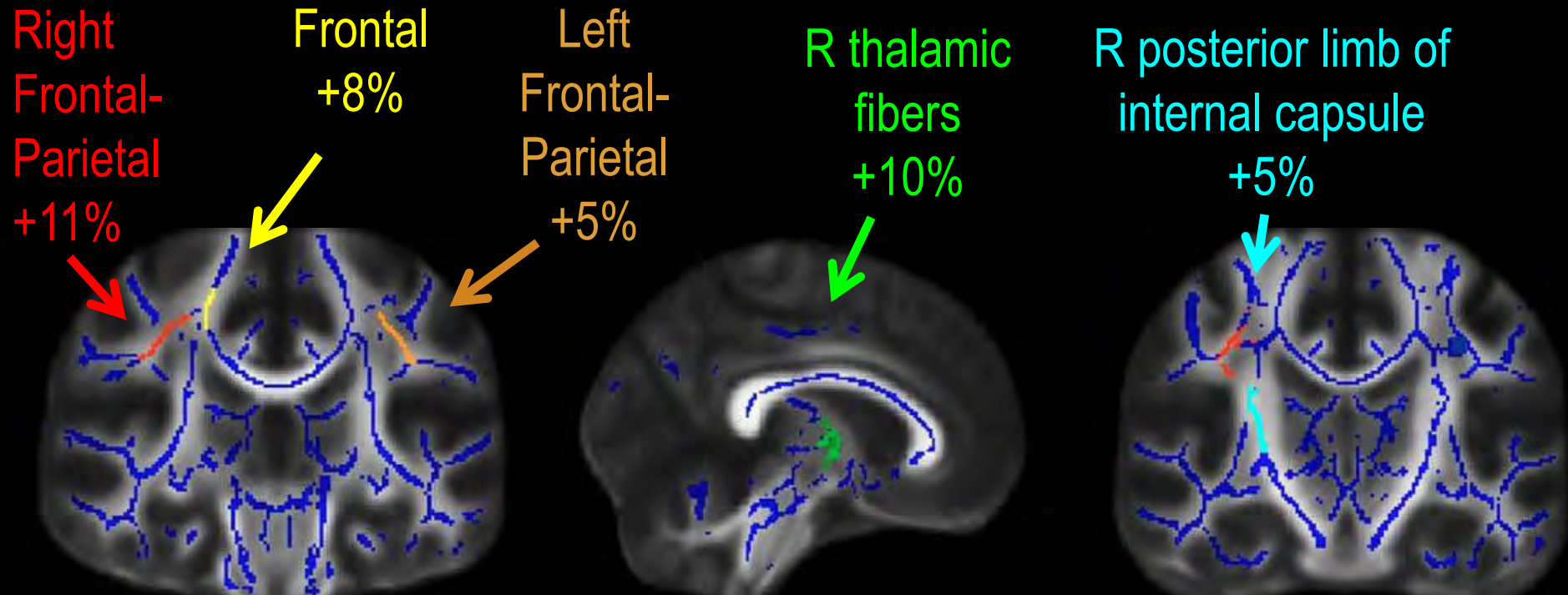
Adolescent Brain Development



Prefrontal Gray Matter



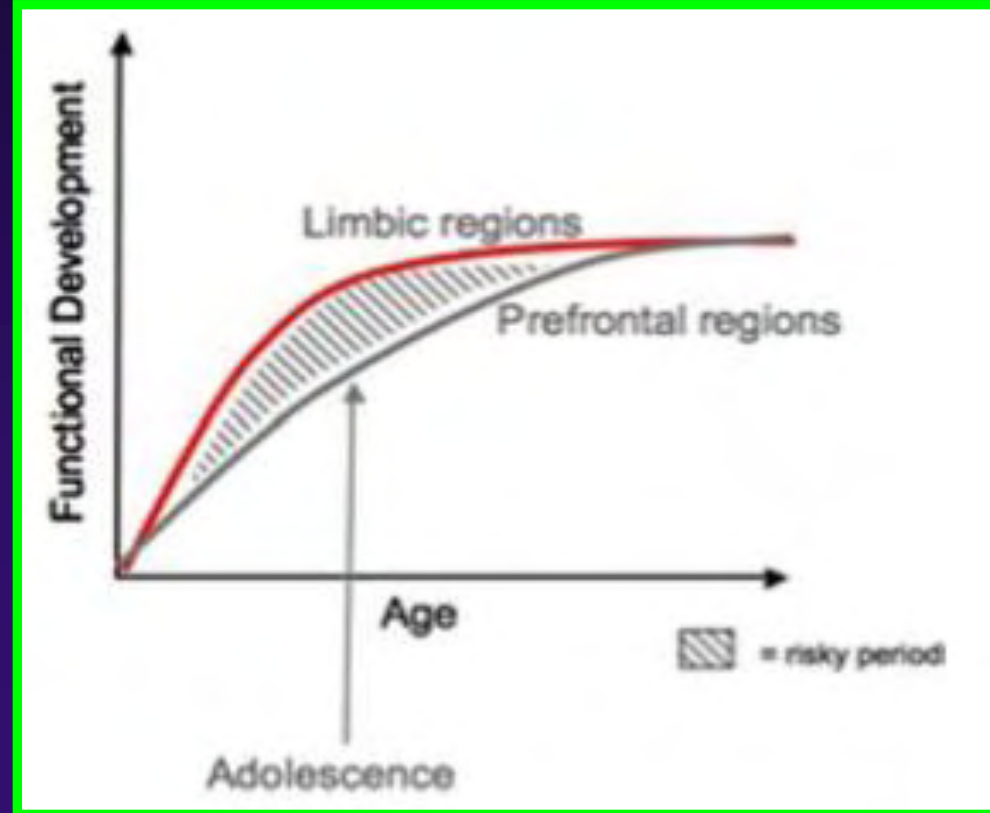
White Matter Change



Significant fiber improvement, age 17.5 to 19

Adolescent Brain Development

- 2-4x higher rate of death, crime, substance use
- Overactive limbic/subcortical + underdeveloped frontal lobe



Adolescent Binge Drinking

✓ What is normal adolescence?

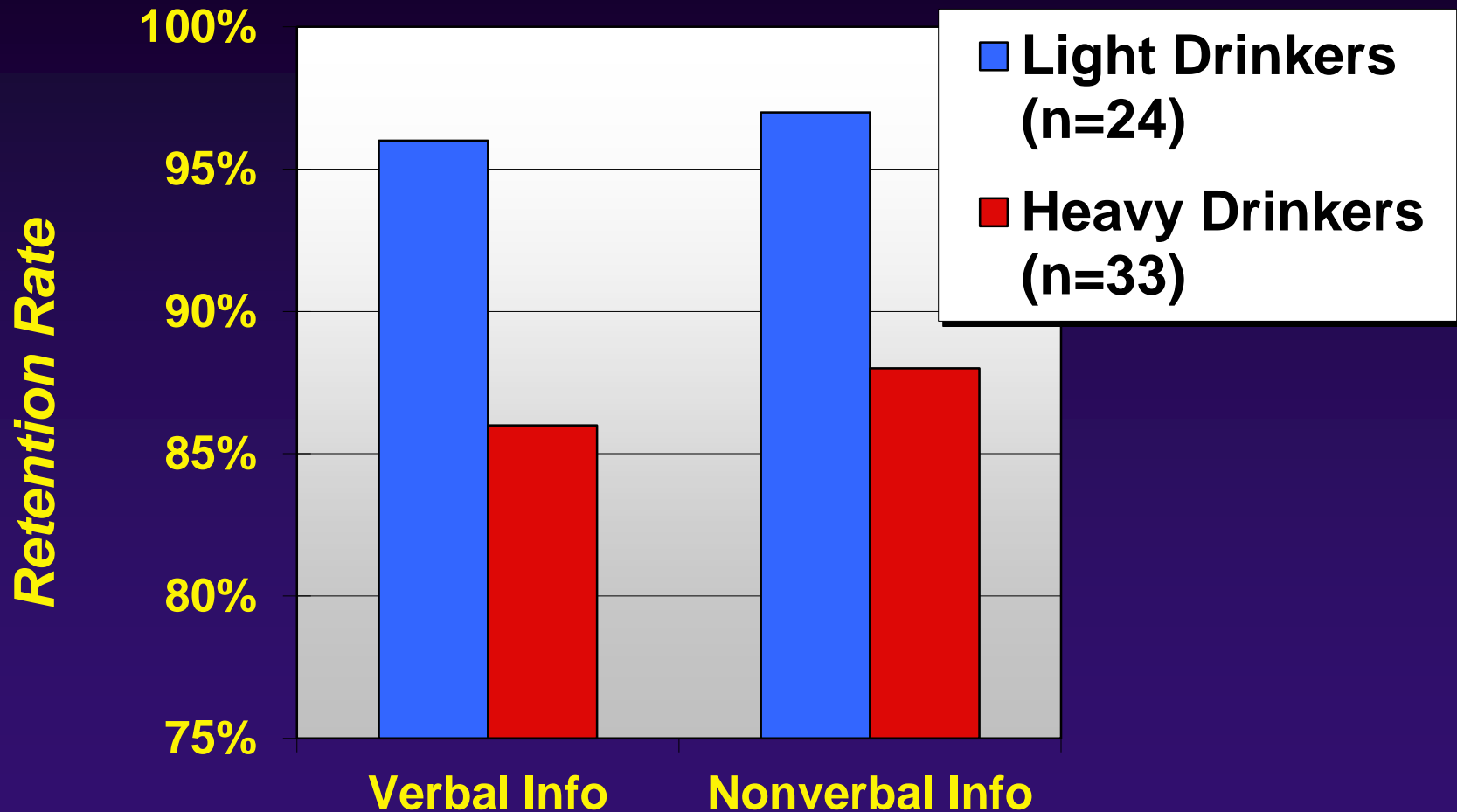
□ How do binge drinkers differ?

□ Does the media
have a role?

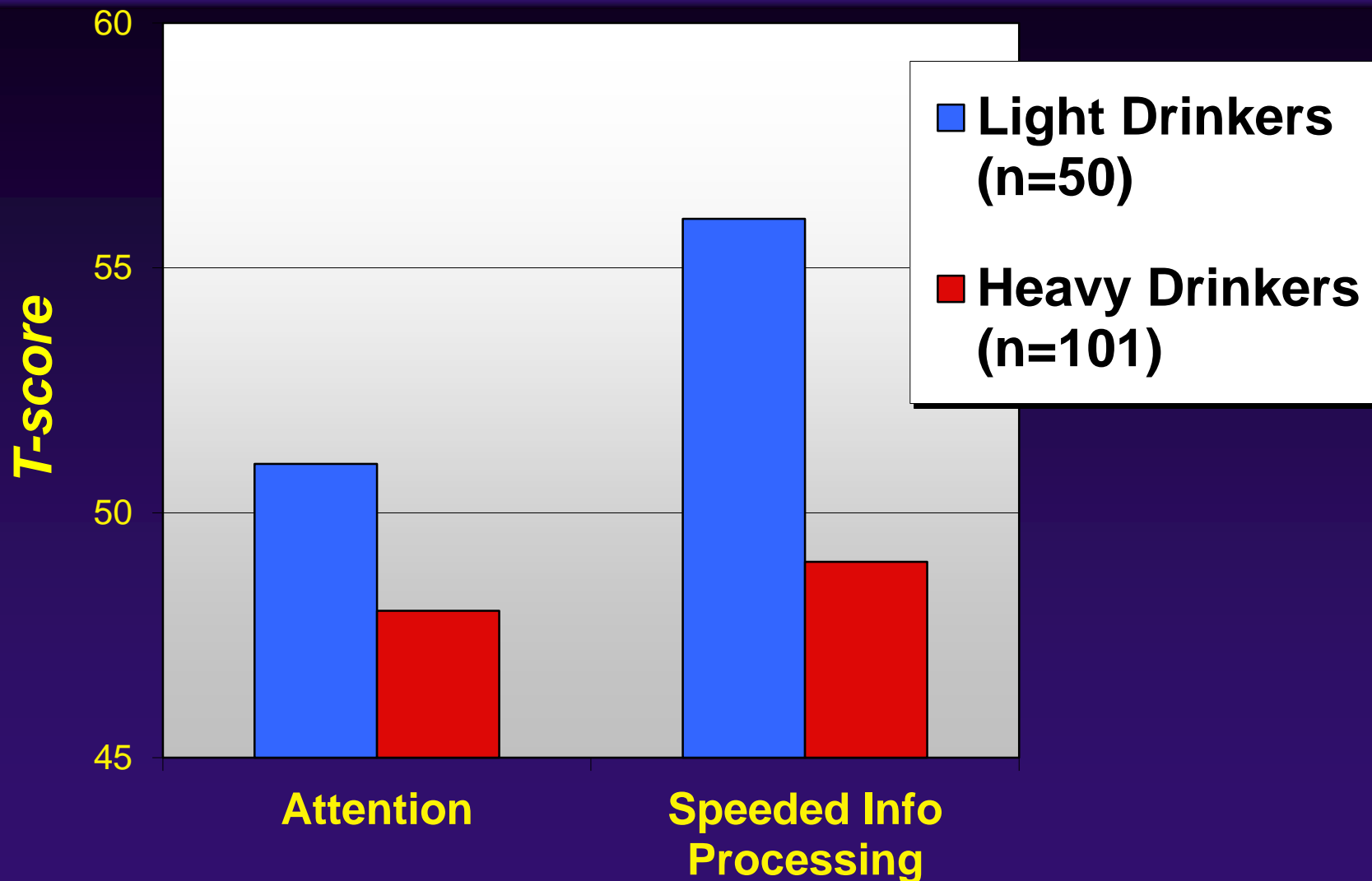
□ Prevention implications



Memory

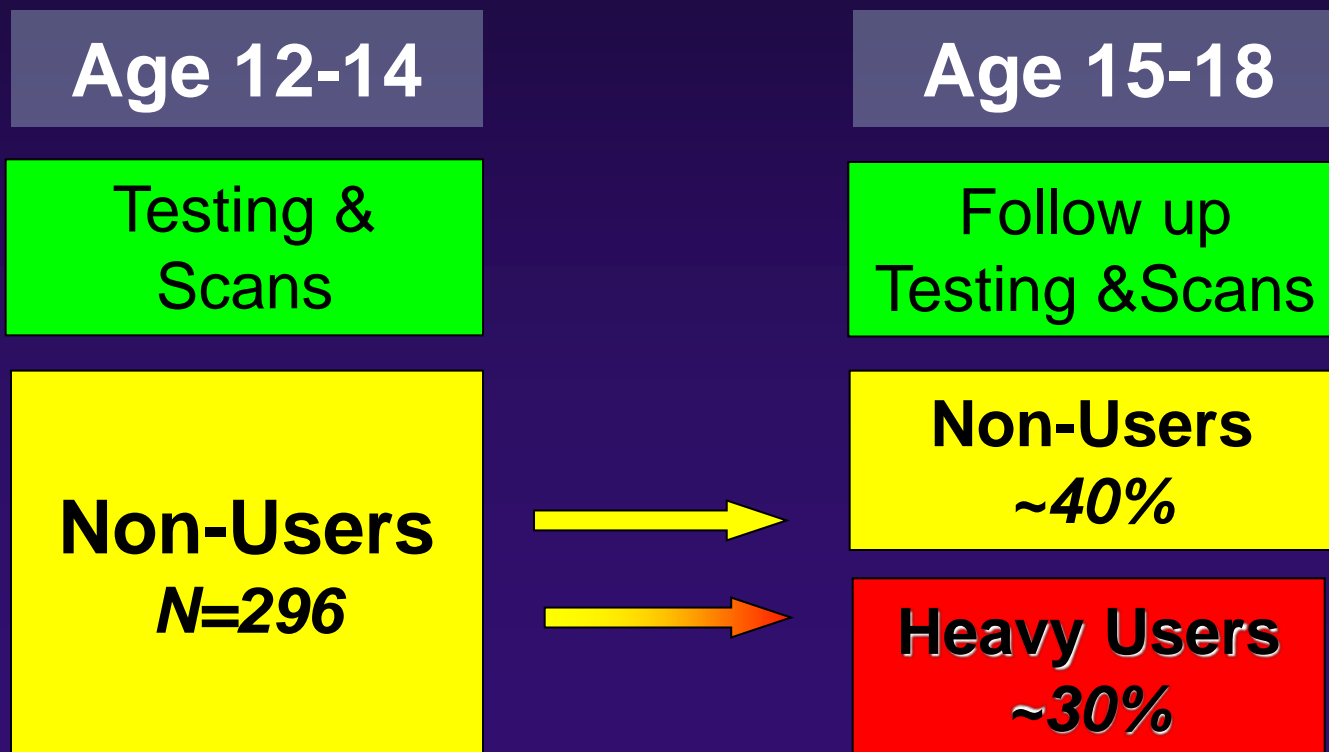


Attention

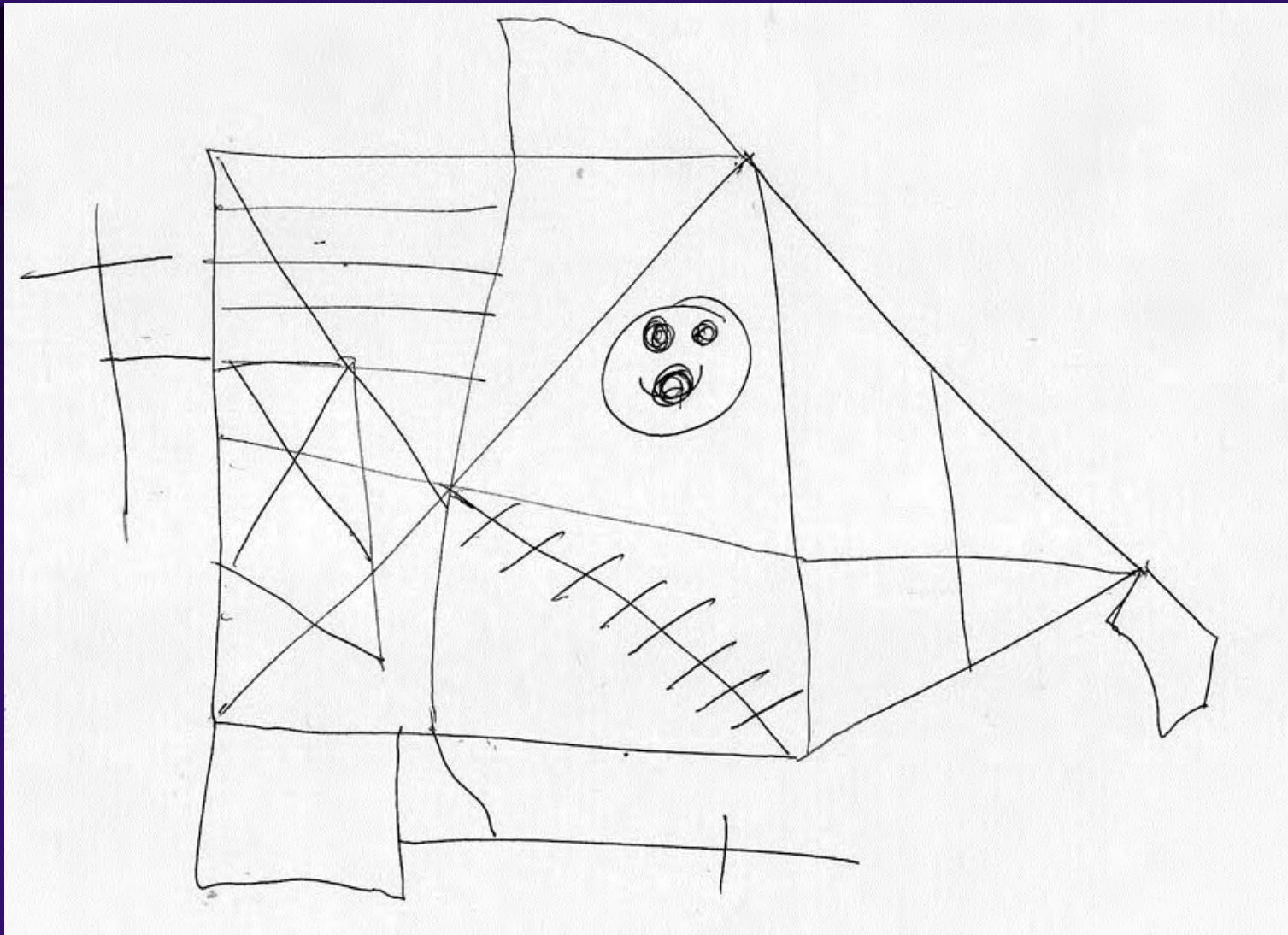


Longitudinal Study of Initiation

- Recruited from middle schools
- Followed annually: cognitive test, brain imaging, interviews



Complex Figure Memory

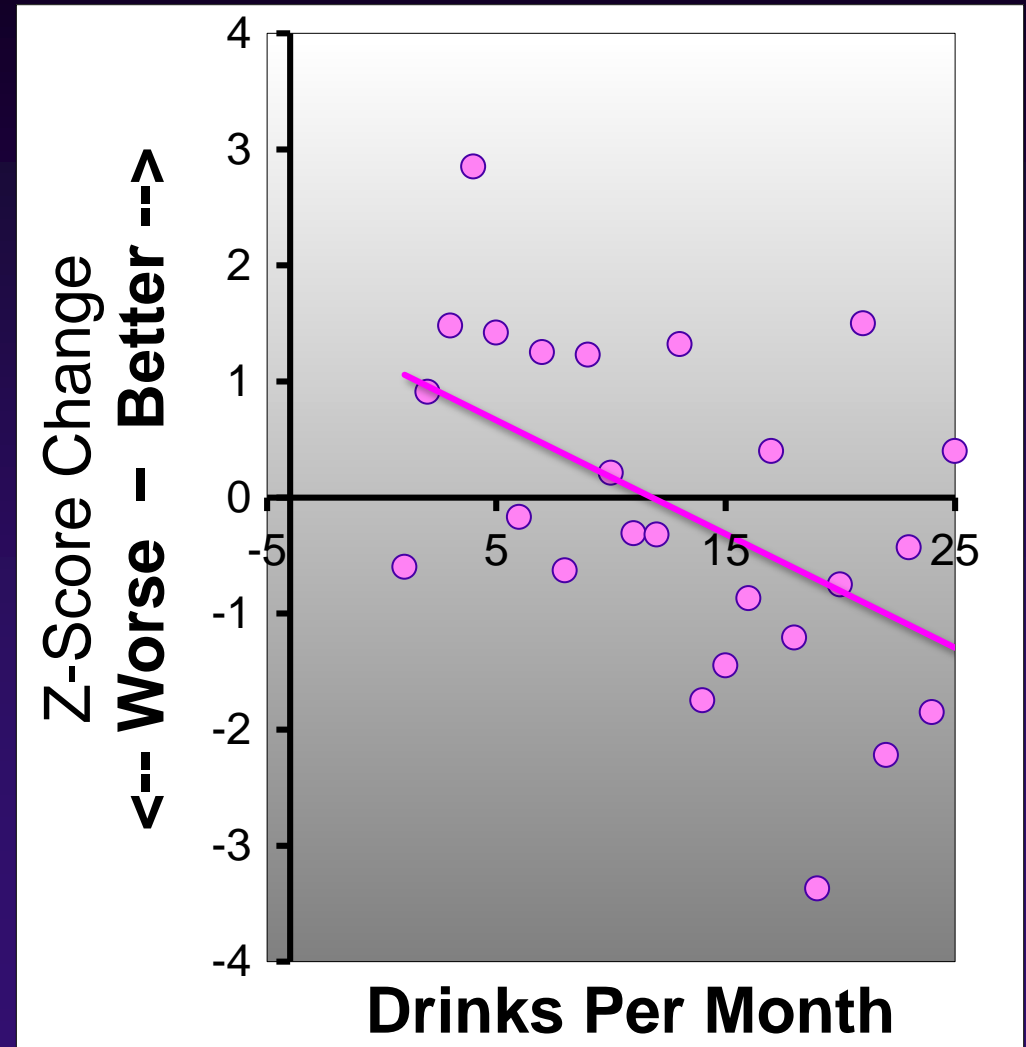


Initiation of Drinking: Females

More drinks



worse
picture
memory

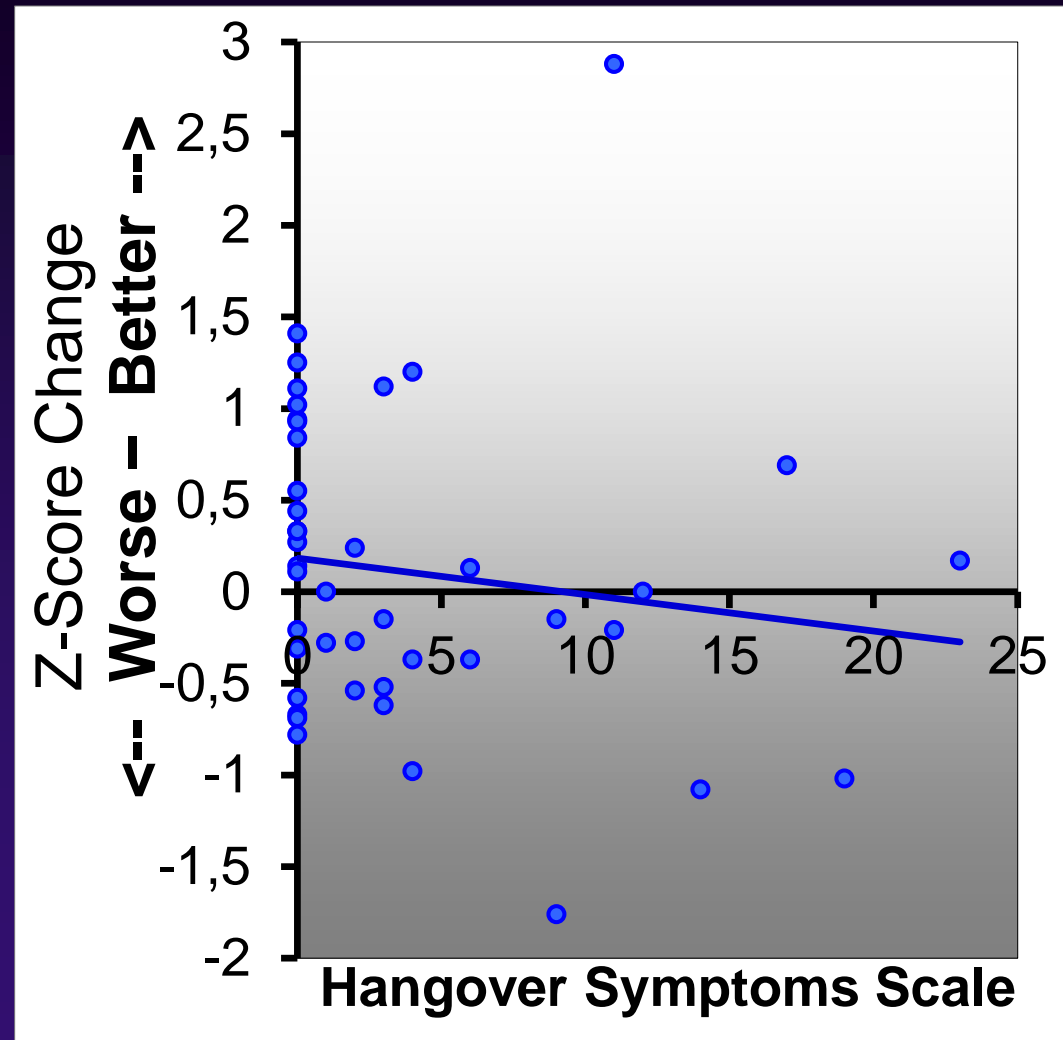


Digit Vigilance

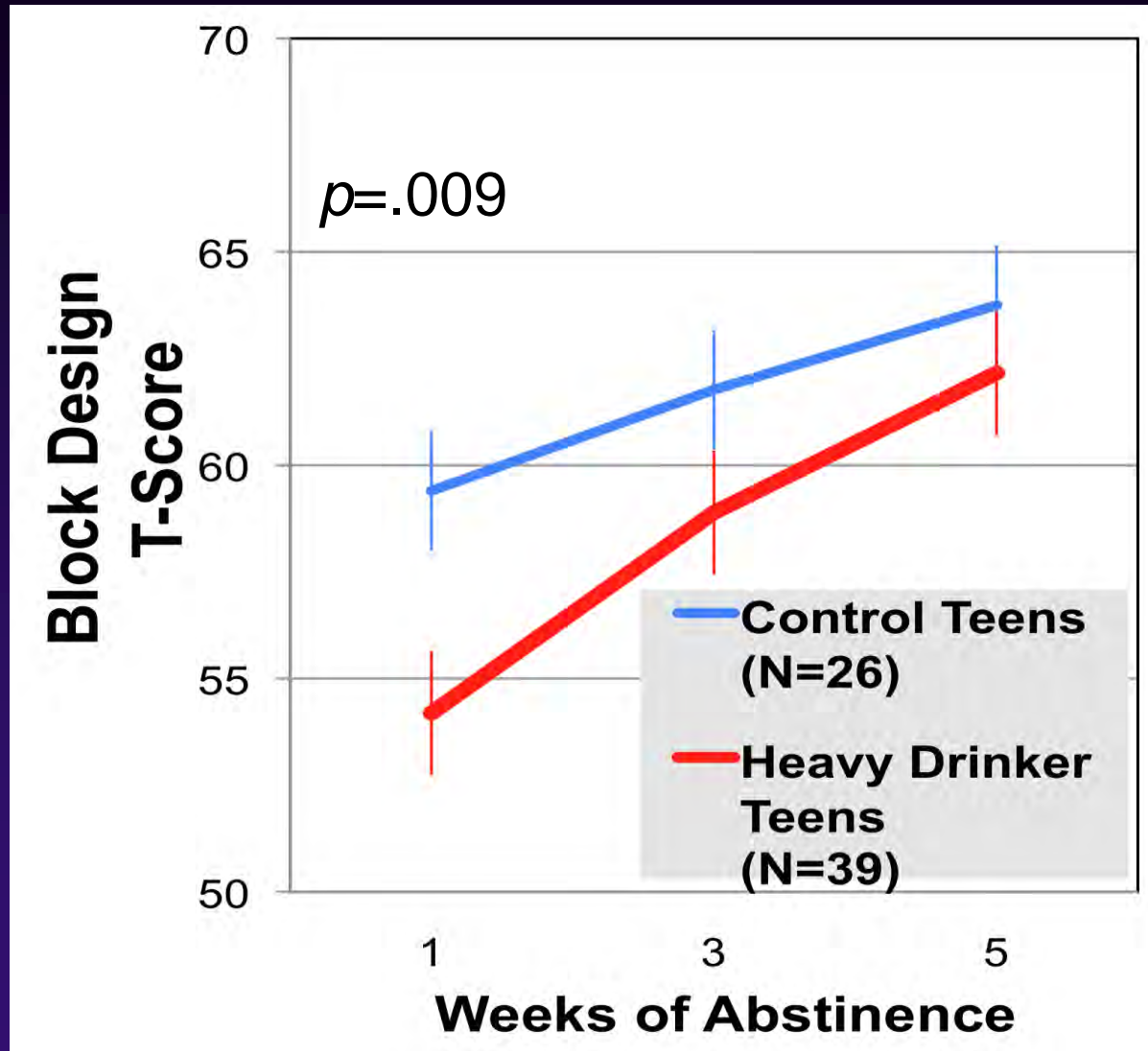
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8 4 1 5 8 9 3 1 9 6 0 3 9 8 7 6 2 7 3 9 5 9 8 7 6 8 6 3 2 5 8 8 0 9 0
3 4 6 4 9 4 2 9 8 3 9 6 0 1 8 2 4 3 0 5 3 9 0 6 5 9 6 7 9 3 4 6 8 7 8
6 8 0 4 5 8 2 8 8 4 3 2 5 8 0 4 3 4 8 1 4 0 3 5 5 9 0 7 4 3 4 2 8 3 5
3 9 0 2 0 4 6 9 6 6 4 6 3 4 9 7 8 7 9 4 9 5 2 2 3 5 6 3 7 1 2 5 3 5 9
3 9 4 6 8 9 5 7 5 3 5 8 6 7 5 2 9 0 2 0 8 1 0 9 5 7 9 1 8 6 8 7 6 6 2
4 6 8 1 5 9 6 1 7 8 0 5 8 5 2 7 9 4 9 0 5 8 1 8 9 3 2 8 3 8 7 9 7 8 4
8 8 2 3 3 7 6 3 0 4 6 4 4 1 2 7 9 9 5 2 5 2 5 2 1 5 7 3 4 1 8 6 0 2 2
3 6 1 2 3 7 1 0 0 9 6 5 9 0 6 9 7 4 4 6 1 0 7 7 7 9 8 5 2 3 0 6 9 4 4
9 1 7 5 7 8 6 6 6 2 7 7 9 1 4 6 6 7 7 9 5 8 3 4 9 0 2 3 2 0 7 6 7 1 6
8 1 8 7 1 5 9 0 1 1 6 5 9 4 7 9 0 9 4 4 3 2 5 0 4 8 0 0 1 8 8 2 9 7 8
3 1 4 9 0 8 5 3 6 3 2 4 9 5 0 1 0 4 6 9 6 3 7 8 5 1 9 1 8 0 0 3 7 6 4
5 0 4 7 2 3 0 9 8 7 7 6 7 2 2 1 8 7 8 6 0 0 4 4 7 1 1 5 2 2 8 6 0 9 9
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7 9 0 8 6 8 4 8 6 5 0 8 5 8 3 9 7 7 1 2 6 5 9 5 1 0 3 3 7 7 2 5 3 1 8
5 7 3 6 0 5 2 4 3 2 5 1 9 0 5 3 1 6 7 8 8 2 4 7 7 9 1 1 7 2 4 1 5 2 7
3 0 7 2 6 2 4 6 1 7 6 5 3 1 9 3 3 2 5 9 1 3 6 4 0 8 2 4 0 4 4 9 1 2 6
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1 8 0 9 3 0 6 0 4 5 4 1 9 2 0 0 8 7 4 1 3 8 8 6 2 7 1 9 1 7 1 0 6 8 8
0 3 1 2 1 4 2 0 6 7 5 4 7 0 9 1 6 6 5 5 6 0 1 0 3 2 5 5 2 6 7 5 3 5 6
7 1 9 8 3 8 2 2 0 8 5 1 9 2 0 5 0 6 0 2 4 7 4 2 8 9 6 5 3 5 8 4 1 7 6
6 1 0 3 1 9 4 9 6 1 8 0 6 6 9 8 4 3 3 0 5 0 3 4 7 0 8 5 4 0 7 1 8 1 0
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5 0 8 6 3 3 0 8 4 9 6 5 8 5 2 7 3 3 1 6 5 8 2 5 0 5 6 4 9 4 7 4 3 0 2
9 4 0 8 8 8 6 9 6 3 2 0 9 1 0 2 0 3 9 0 4 6 5 1 5 5 5 3 3 8 6 2 4 5 9 ✕

Initiation of Drinking: Males

More hangovers
→
worse attention



Recovery with Abstinence



Summary

- **Adolescent heavy drinkers show:**



- ✓ 10% less information retrieved
- ✓ Reduce spatial skills for girls
- ✓ Can recover with abstinence
- **Do problems relate to brain?**

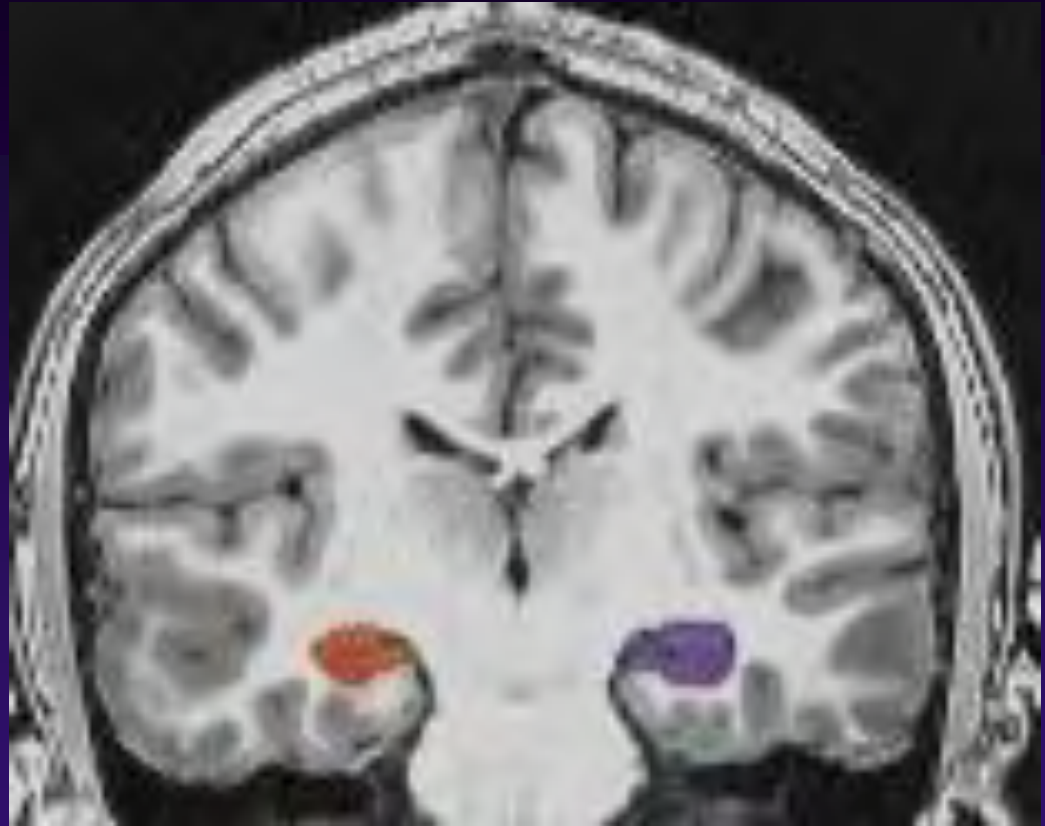
MRI

- **Safe**
 - Non-invasive
 - No radioactivity
- **Issues**
 - Motion
 - Artifact



Hippocampal Volume

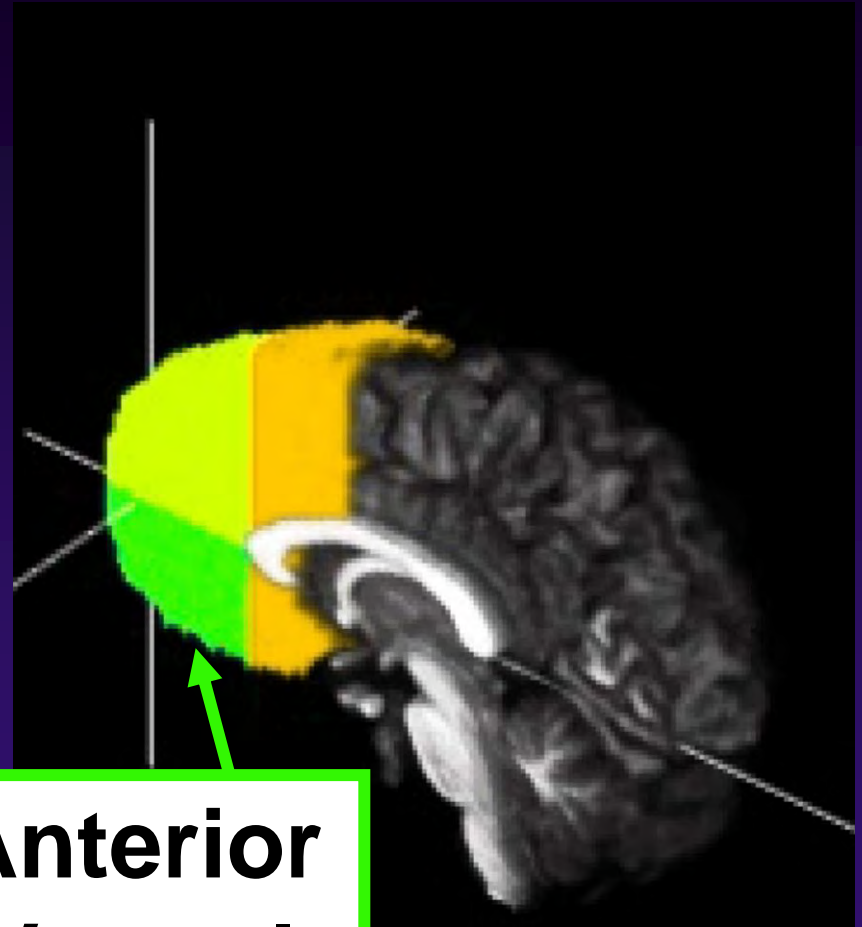
- Critical for memory
- Ages 15-18
- 3+ days abstinence
- Left hippocampus smaller in drinkers



Right / Left

Prefrontal Cortex Volume

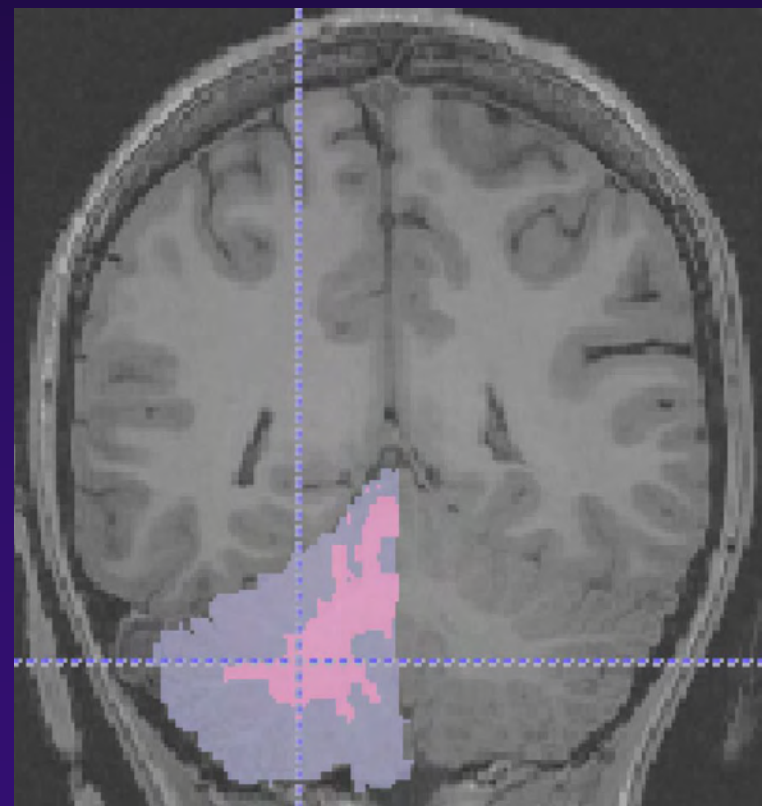
- Key for planning and reasoning
- Ages 15-17
- 3+ days abstinence
- Smaller in drinkers
 - Especially girls



**Anterior
Ventral**

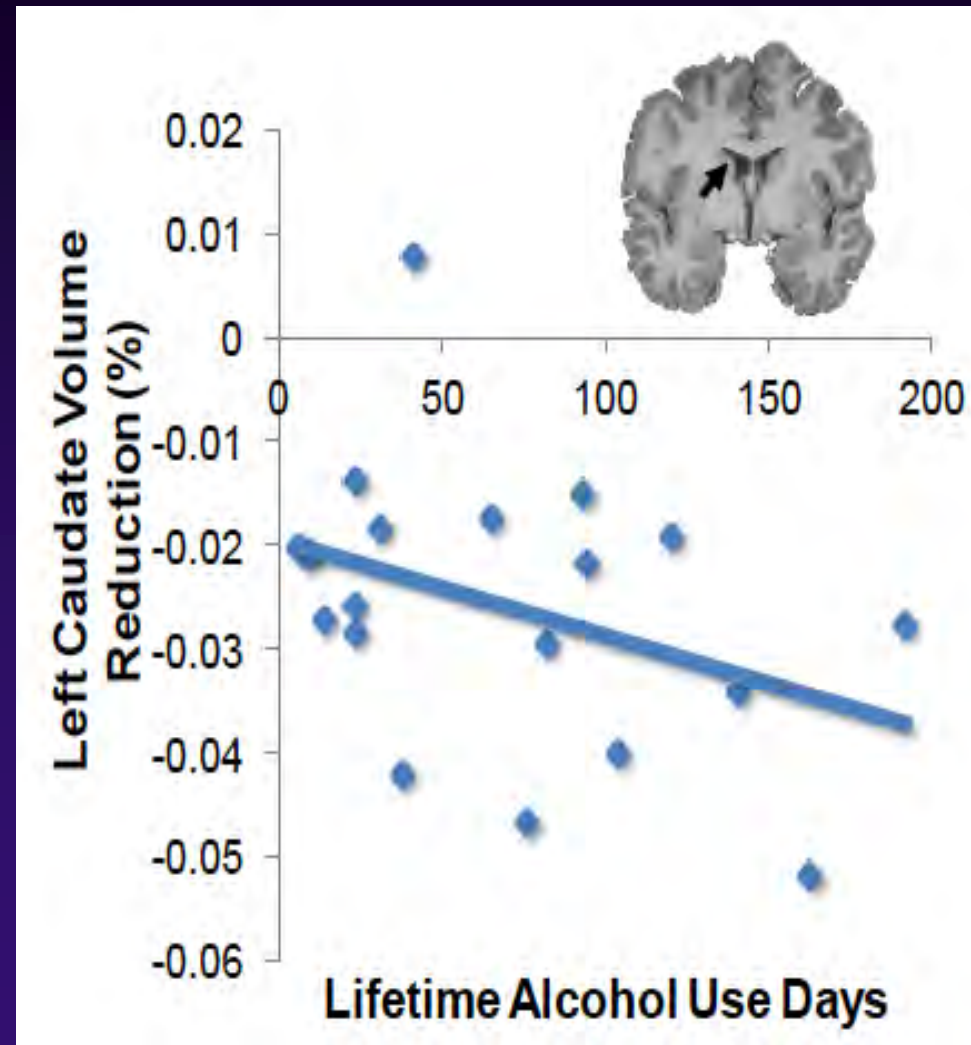
Cerebellar Volume

- Important for balance and attention
- Higher peak drinks predicted smaller:
 - Left cerebellar gray matter
 - Left cerebellar white matter
 - Right cerebellar gray matter
- Improves with abstinence



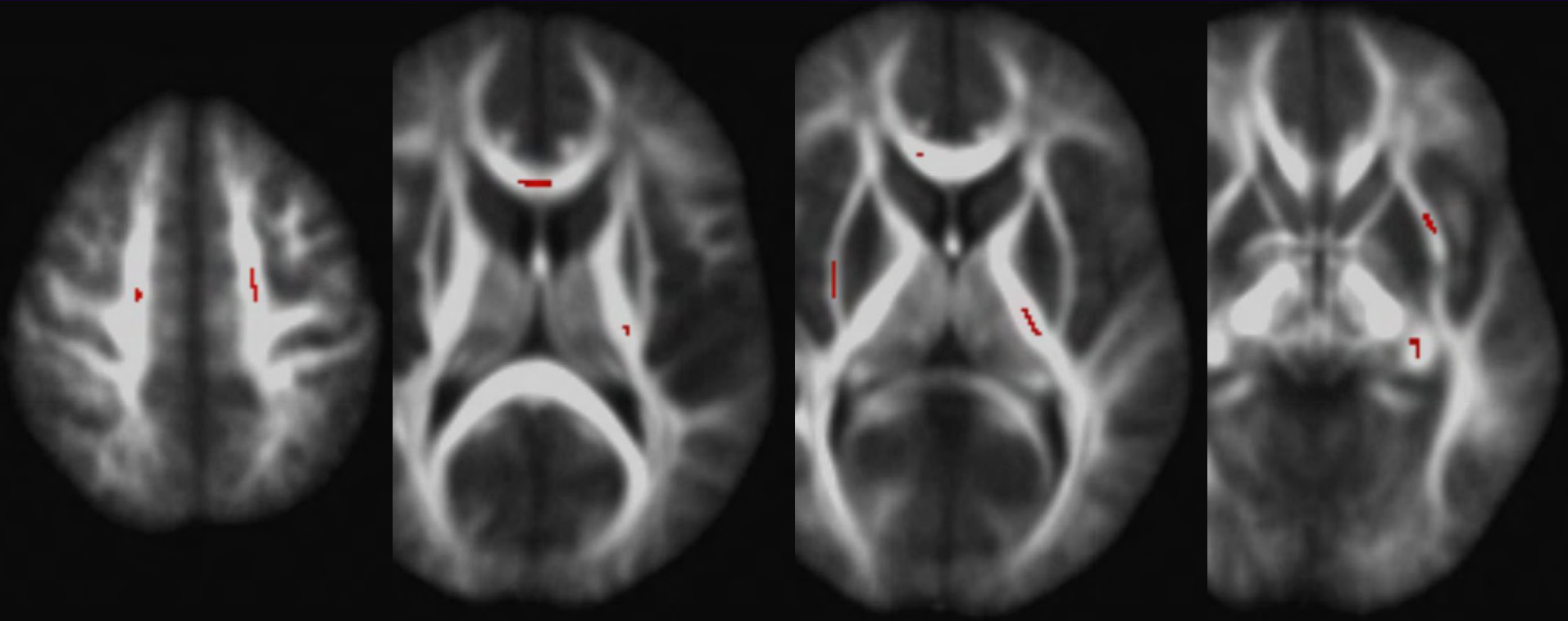
Volume Changes After Drinking

- Smaller volumes in future drinkers:
 - Areas key to inhibition
- Reductions after drinking:
 - Temporal gyrus
 - Thalamus
 - Caudate
 - Brain stem

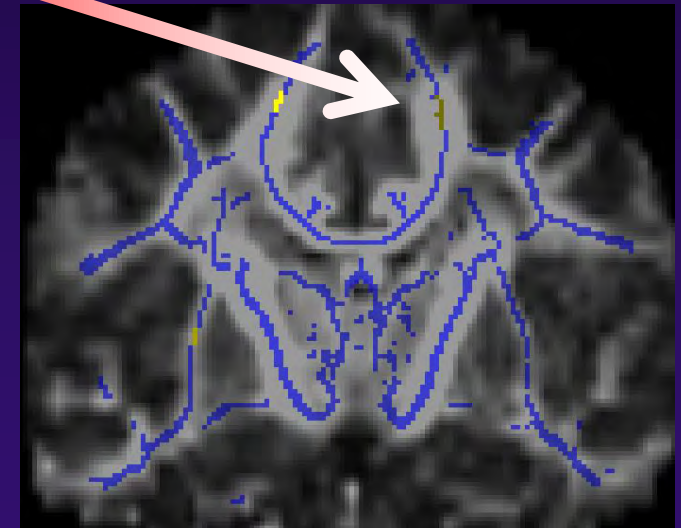
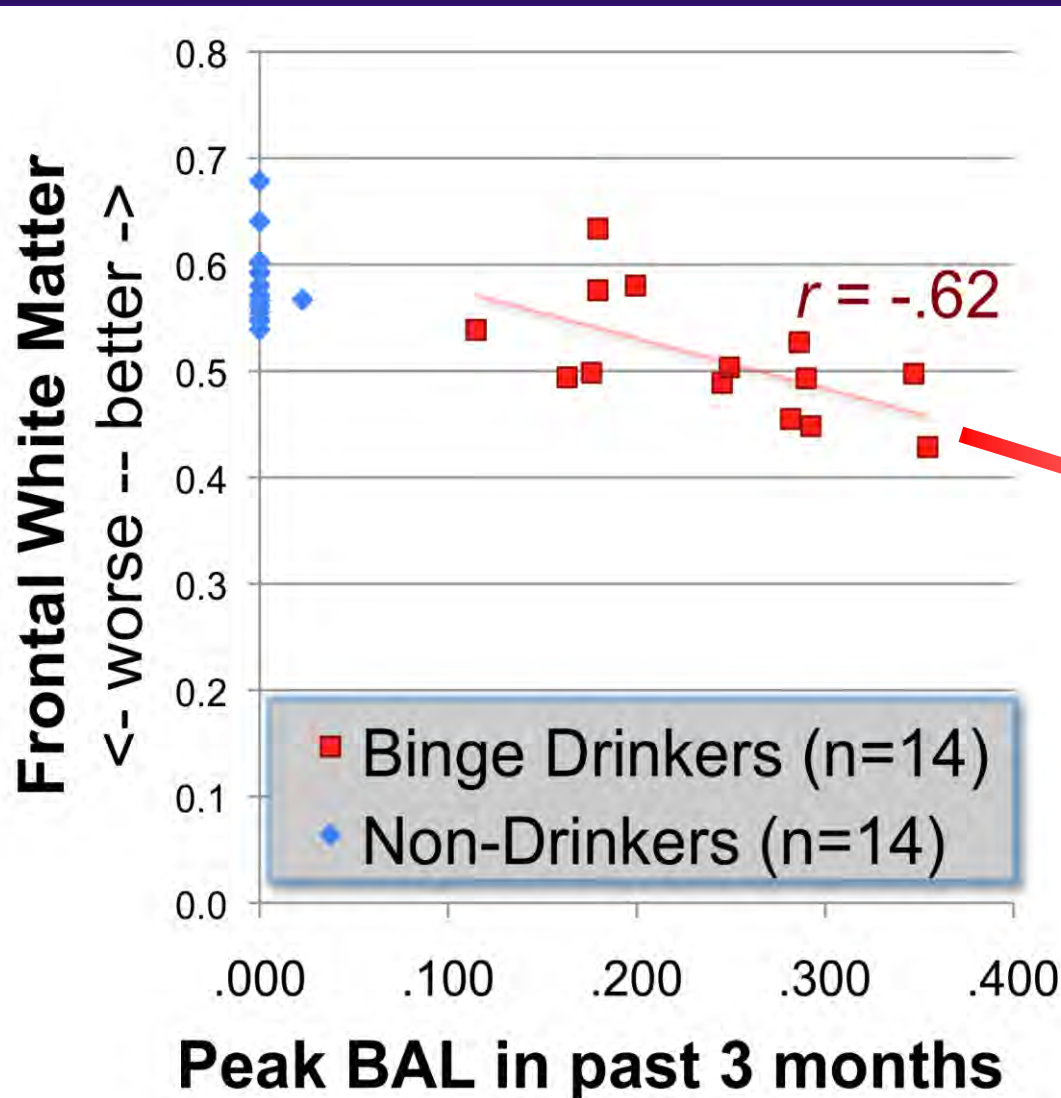


White Matter in Binge Drinkers

- **Bingers** poorer than Controls

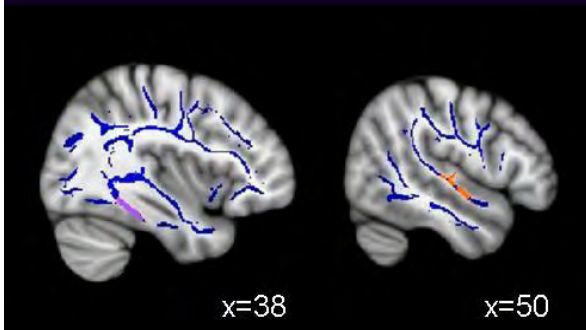
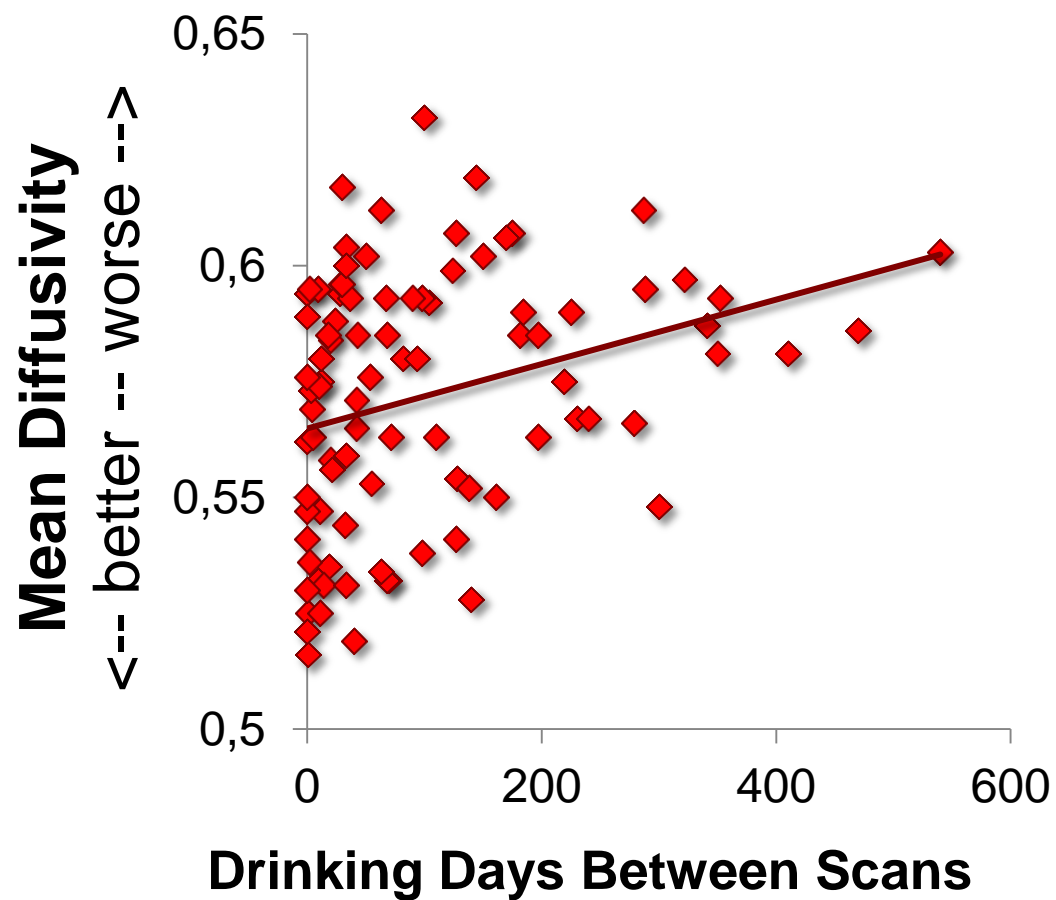


Higher BAL → Worse White Matter



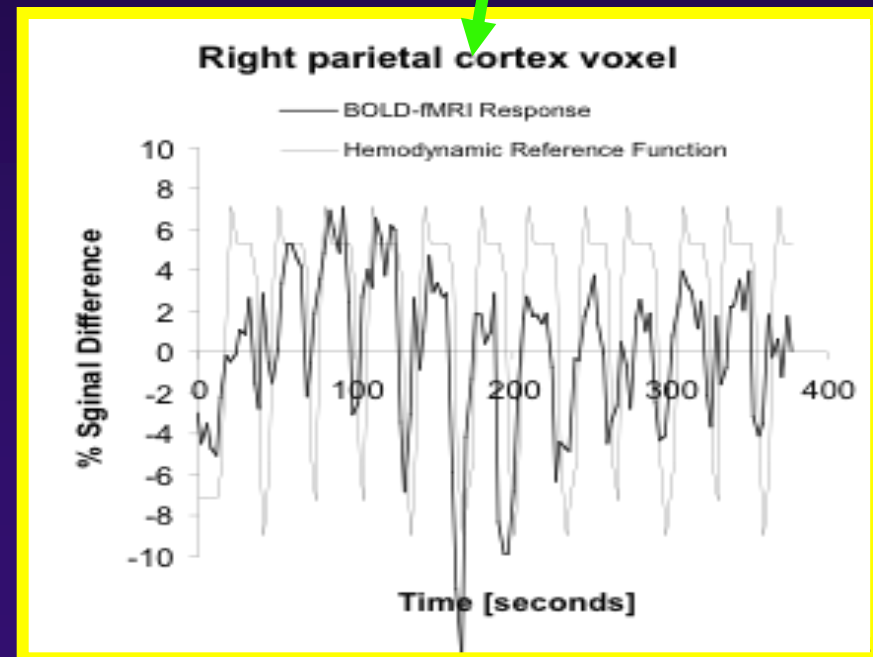
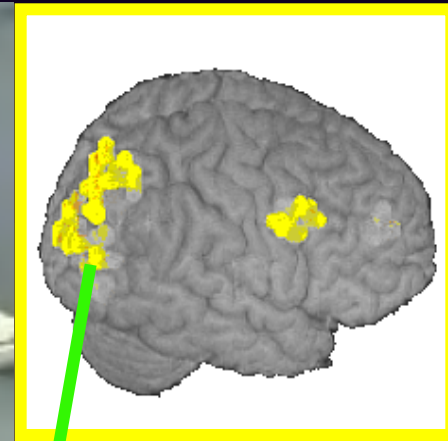
Increased Drinking → Worse White Matter

Right Superior Longitudinal
Fasciculus Integrity, Time 2

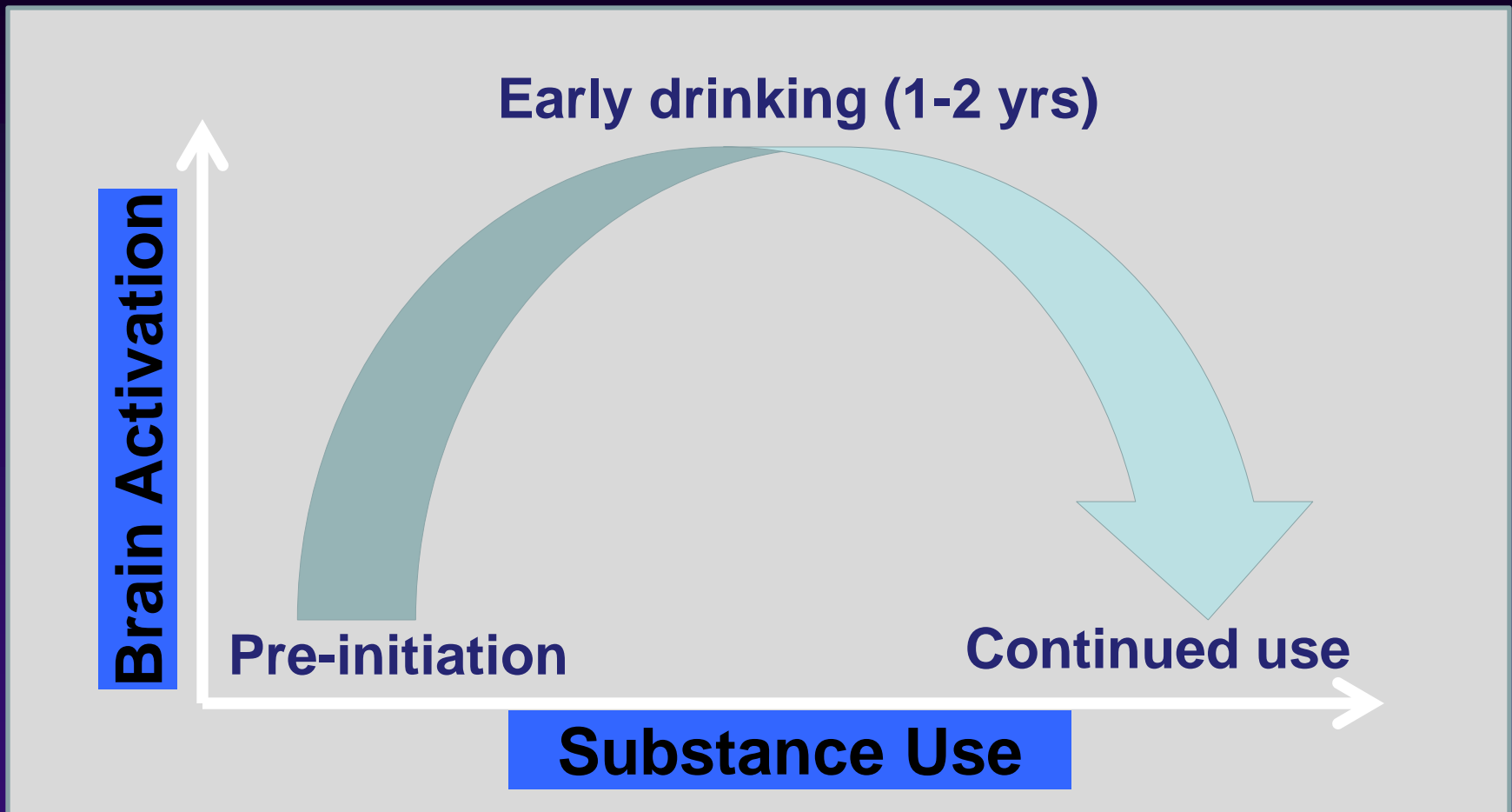


Functional MRI

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

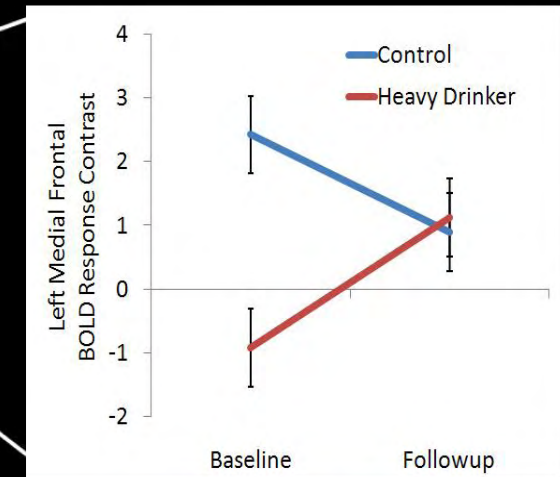
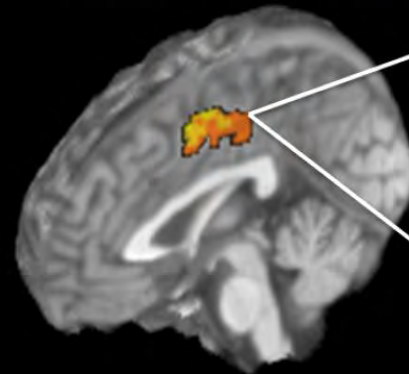
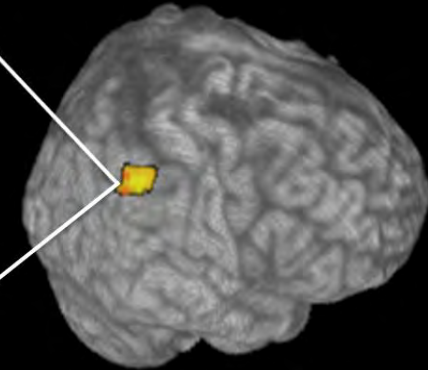
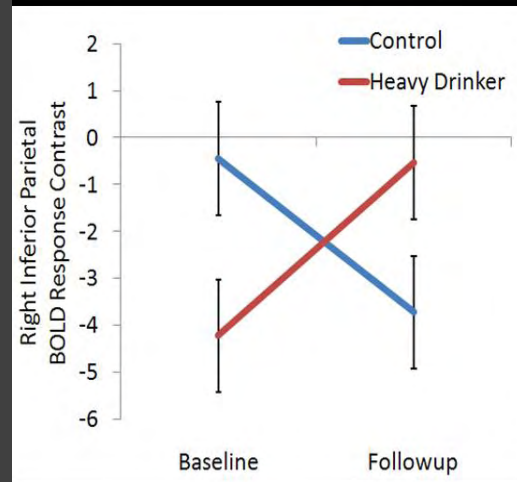


Brain Activation and Early Drinking



Activation Differences over Time

- N=40 age 14
 - 20 bingeing by age 17
 - 20 matched non-drinkers
- Before drinking:
 - Future drinkers:
↓ activation
- After drinking:
 - ↑ activation





Deactivation
Binge < Controls



Greater Activation
Binge > Controls

Summary of Findings

	Alcohol 	Marijuana 
Cognition	↓ Retrieval ↓ Spatial ↓ Attention	↓ Learning ↓ Sequencing ↑ Errors
Brain volume	↓ Hippocampus ↓ Prefrontal ↓ Cerebellum	=
White matter	↓↓ Quality	↓ Quality
Activation	↓ ↑ Spatial ↓ ↑ Learning ↑ Inhibition	↓ ↓ ↑ Spatial ↓ ↑ Learning ↑ ↑ Inhibition

Adolescent Binge Drinking

✓ What is normal adolescence?

✓ How do binge drinkers differ?

□ Does the media
have a role?

□ Prevention implications



Role of Media

- Food
- Violence
- Sex
- Tobacco
- Alcohol
 - \$3 billion/yr



Alcohol Ads & Underage Drinking

- **Ad awareness**

- More positive views on alcohol effects
- Greater plans to drink as adults
- Boys more aware than girls

- **Ad liking**

- More likely to drink
- Humor
- Story
- People with youth appeal
- Animals



Alcohol Cue Task

Alcohol Pictures



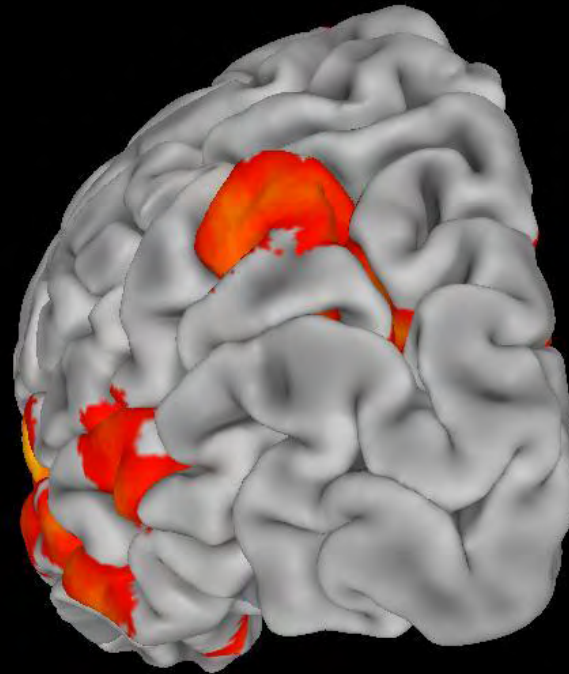
Non-Alcohol Pictures



Youth Response to Alcohol Ads

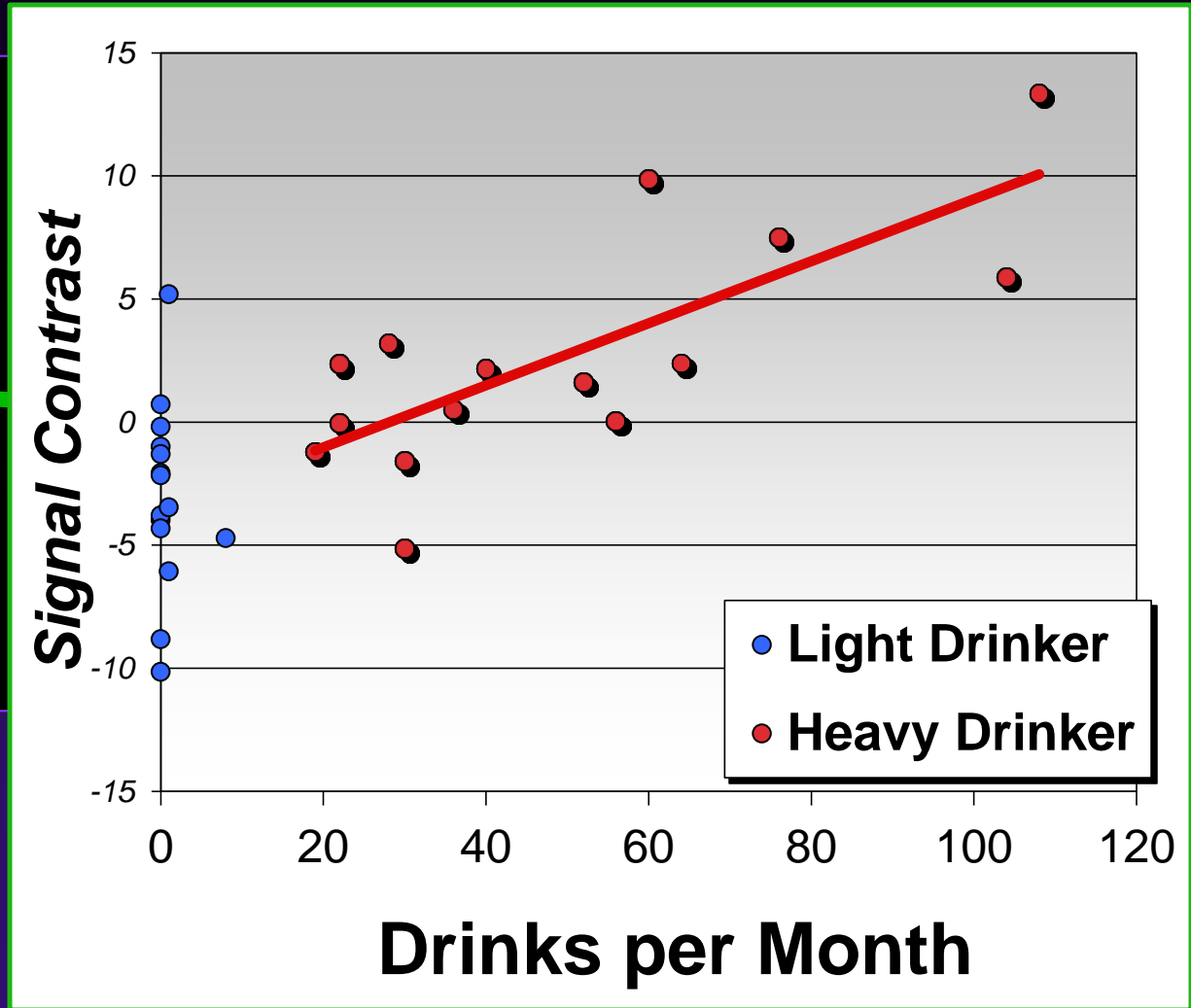
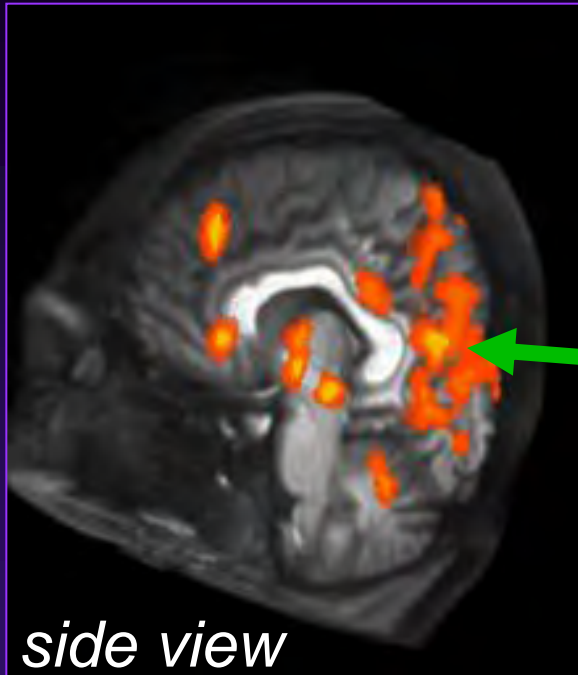
Alcohol pictures relative to non-alcohol pictures:

LEFT
HEMISPHERE



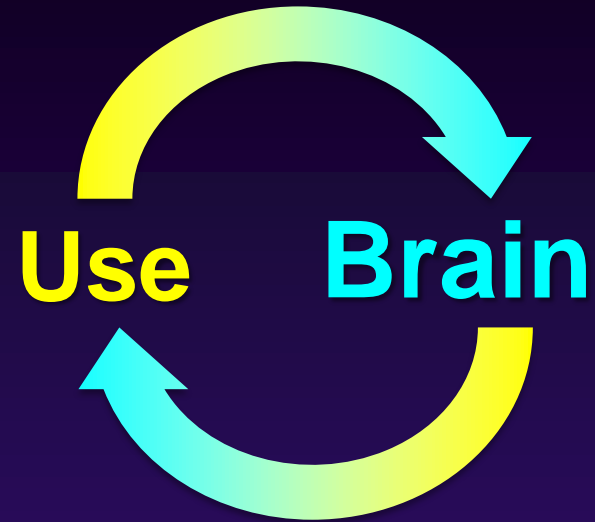
Heavy drinkers had more response to alcohol pictures than Light drinkers

Youth Response to Alcohol Ads



Heavy Drinking Adolescents

- Neurocognition
 - Females: ↓ visuospatial fxn,
 - Males: ↓ attention
- Brain size reductions
- White matter worsens
 - Actively developing
 - Worst for heaviest drinkers
- Brain activation
 - Increases: brain has to work harder



Adolescent Binge Drinking

- ✓ What is normal adolescence?
- ✓ How do binge drinkers differ?
- ✓ Does the media have a role?

□ Prevention implications



Prevention Implications

1. Inform students of risks

- Don't get hungover!
- >12 drinks/mo may harm females' cognition

2. Heavy use linked to impaired learning

- Can improve after >2 weeks of no using
- Before then, have info repeated

3. Delay the start of using alcohol