

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



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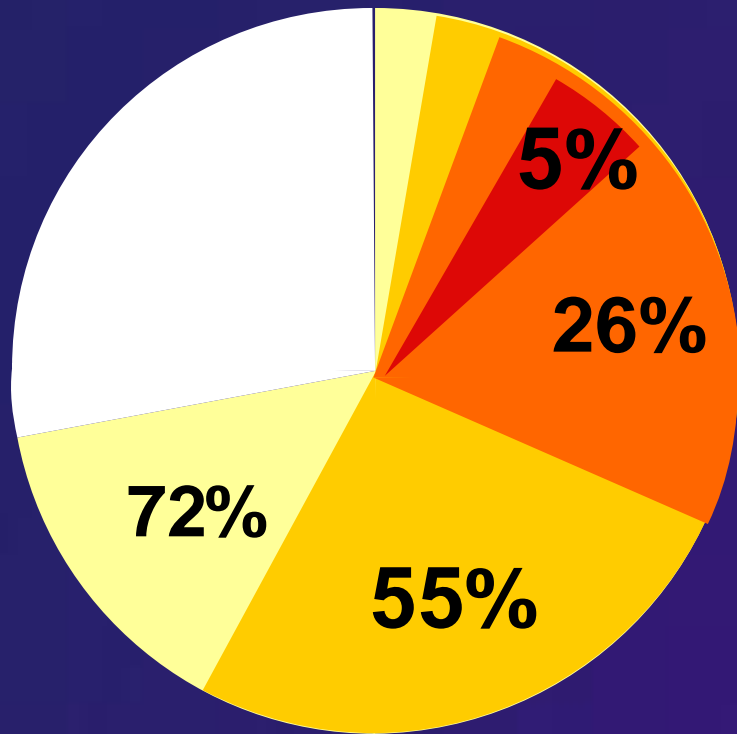


Overview

- **Why is teen drinking important?**
- Effects in adolescents
 - Neurocognitive
 - Brain volume
 - White matter integrity
 - Brain function
- Conclusions

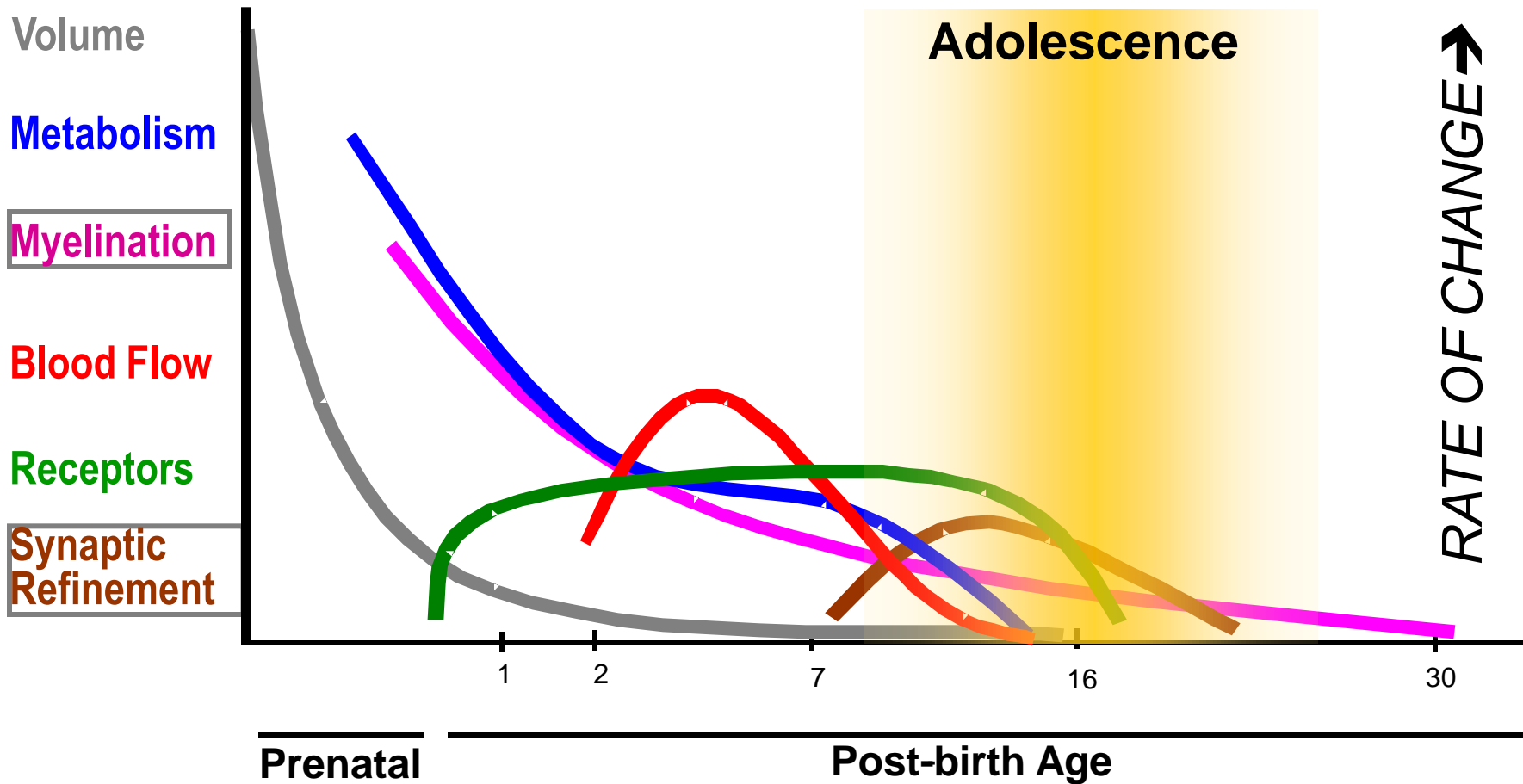


Teen Drinking Rates

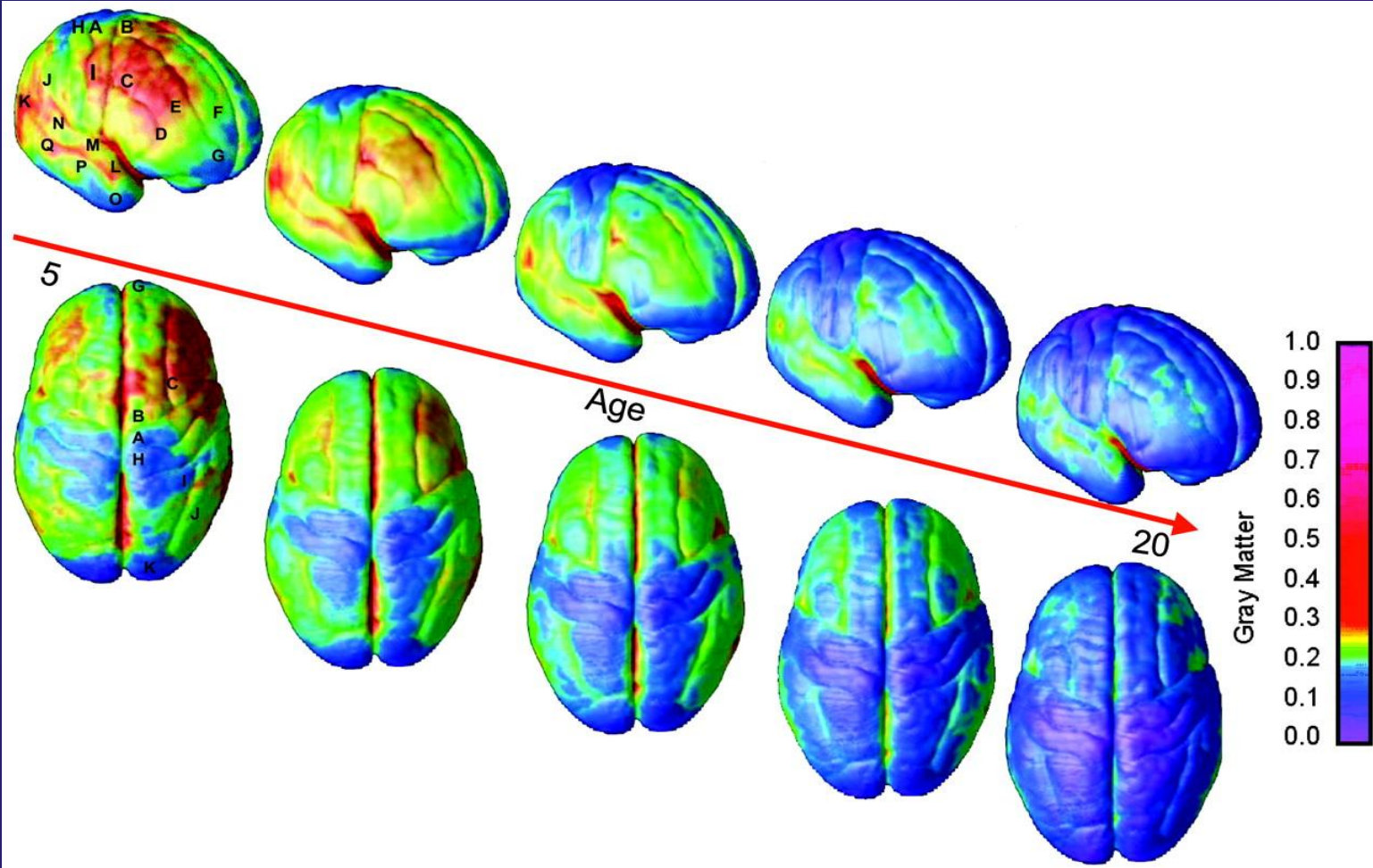


- Alcohol use disorder (AUD)
- Binge, past 2 weeks
- Ever got drunk
- Any alcohol use ever

Adolescent Brain Development



Gray Matter Development



White Matter Change

- Fiber improvement

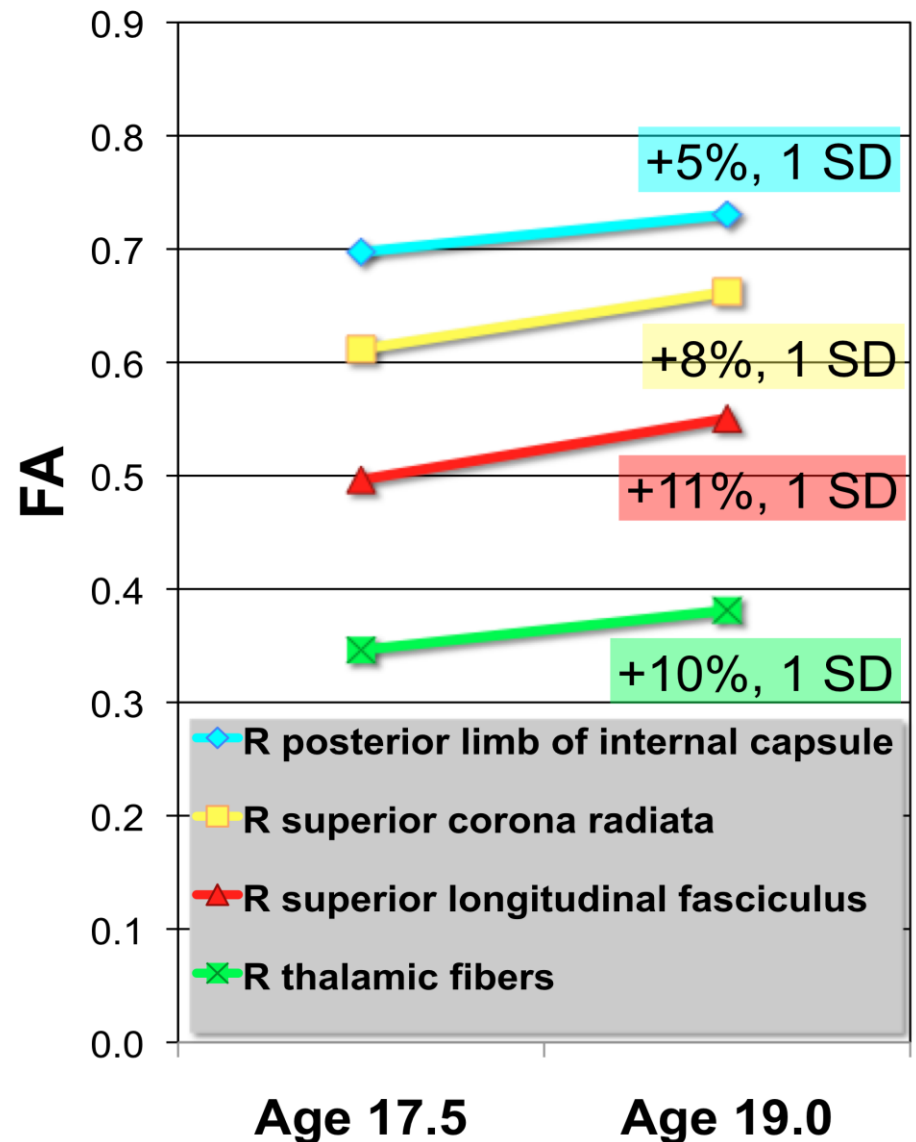
- FA

- MD

- RD

- $N=22$

- $\geq 153 \mu\text{l}$, $p < .01$



Effects of Heavy Drinking in Adults

- Cognition

- ↻ ↓ Visuospatial, executive functioning

- ↻ ↓ Memory, working memory

- Brain structure

- ↻ ↓ volume reduction

- ↻ ↓ white matter integrity

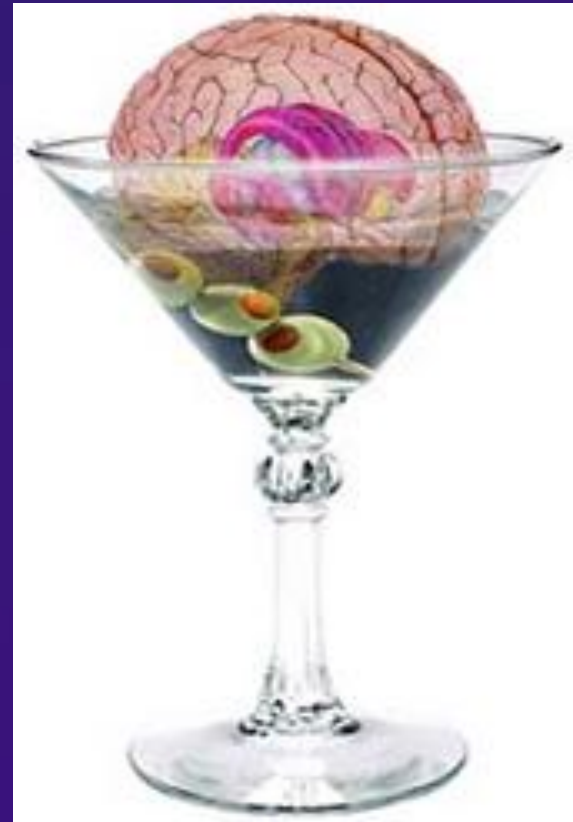
- Brain function

- ↻ ↓ EEG power, sleep

- ↻ ↓ perfusion, fMRI response

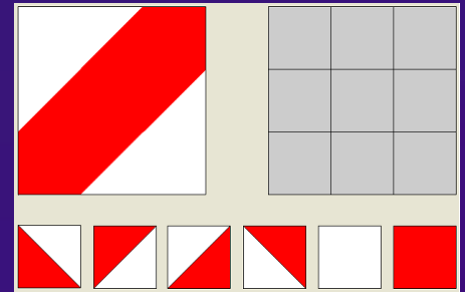
Effects of Drinking on Brain

- When do problems become apparent?

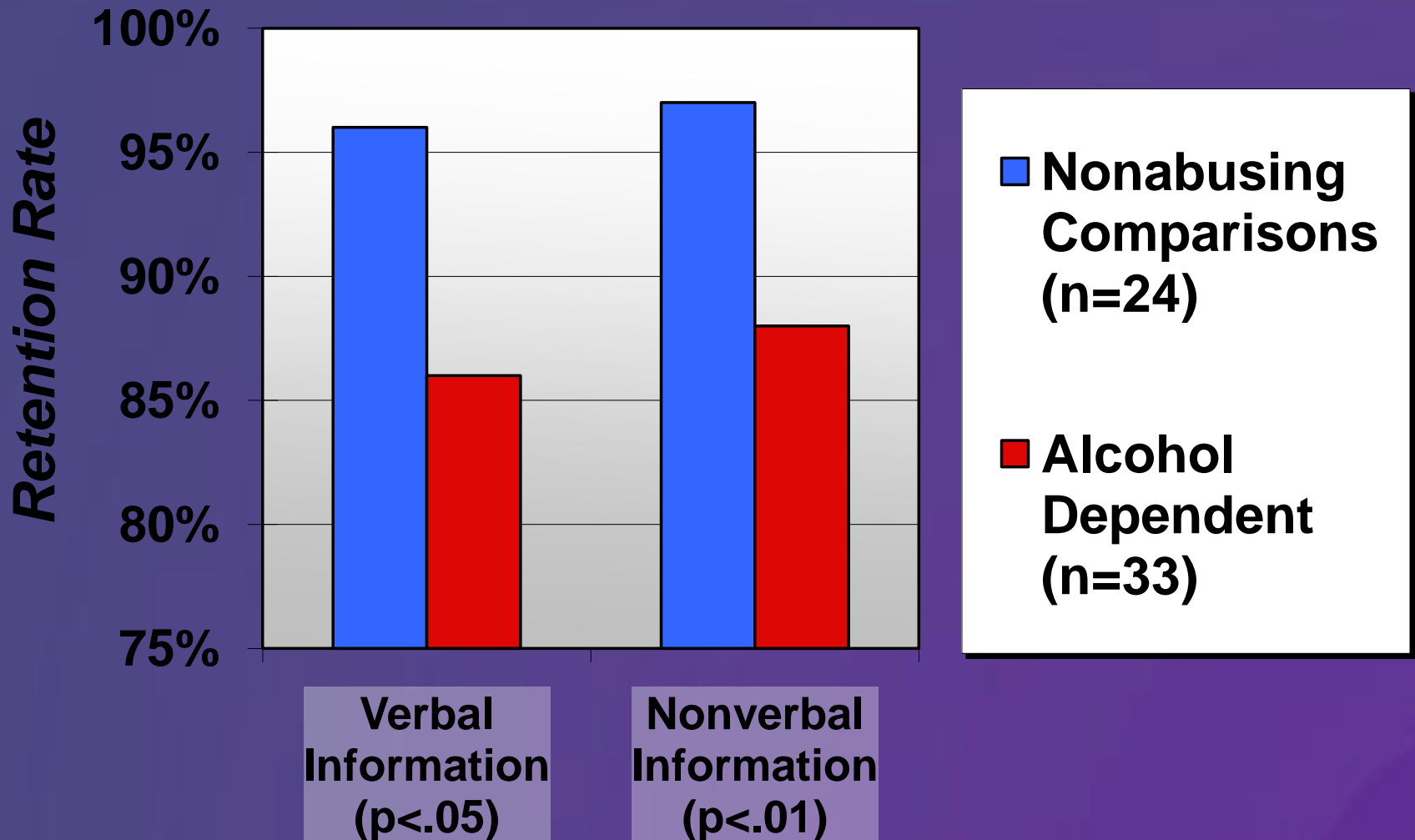


Overview

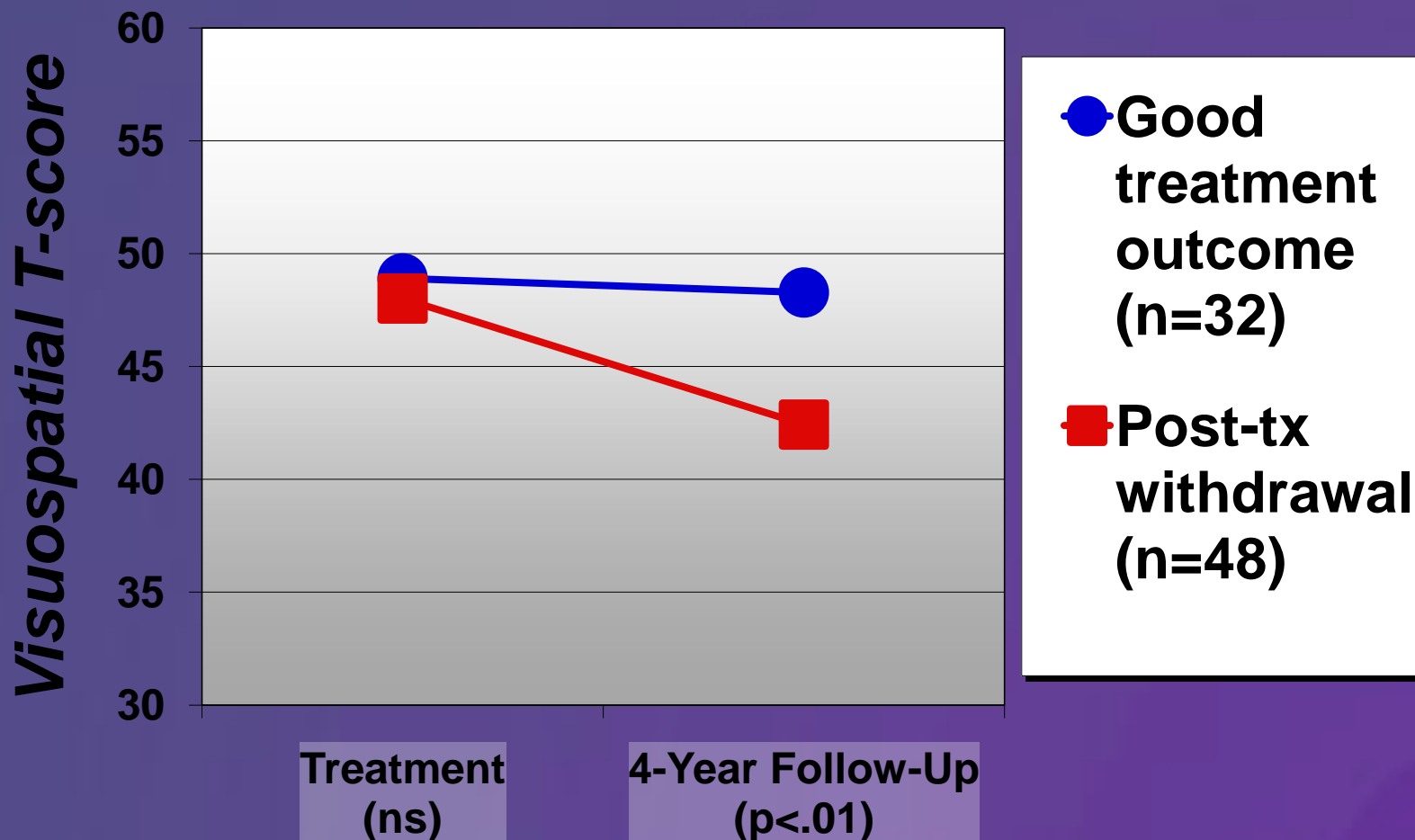
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Detoxified Teens

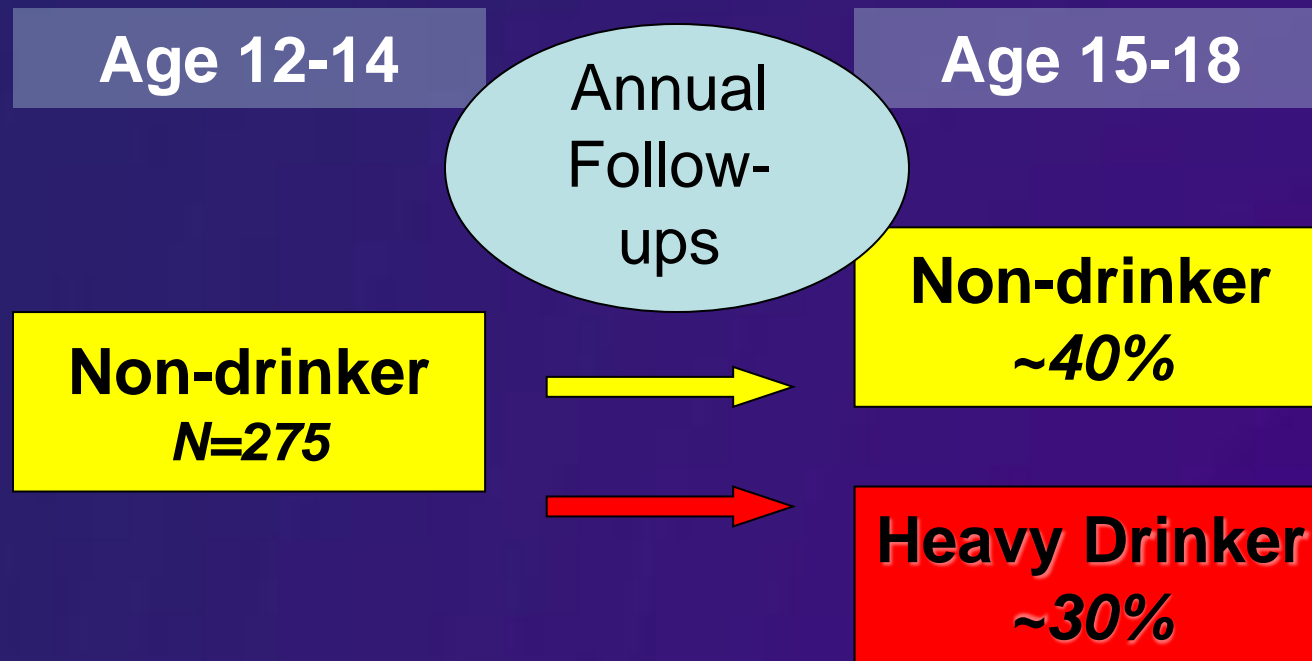


Longitudinal Study of Youth Treated for SUD



Longitudinal Study of Initiation

- Recruited from schools
- Followed annually: NP, imaging, interviews

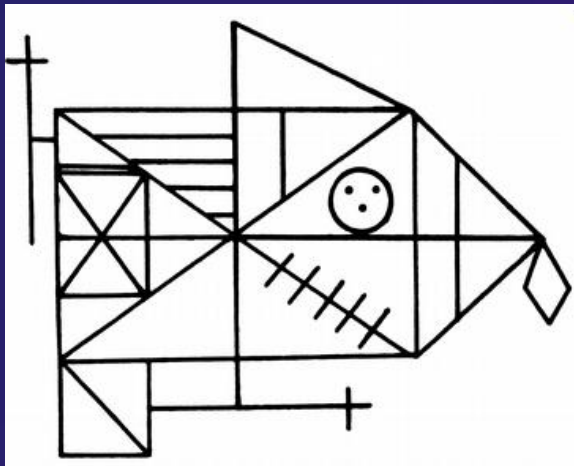


Exclusions

- Prenatal alcohol or drug use
- Birth <35 weeks
- Parent hx of severe mental illness
- Hx serious medical or neurological illness
- Hx loss of consciousness >2 minutes
- Hx psych disorder other than CD or ODD
- Hx learning disability
- Non-correctable vision or hearing problem
- Left handedness
- Current use of medication affecting brain

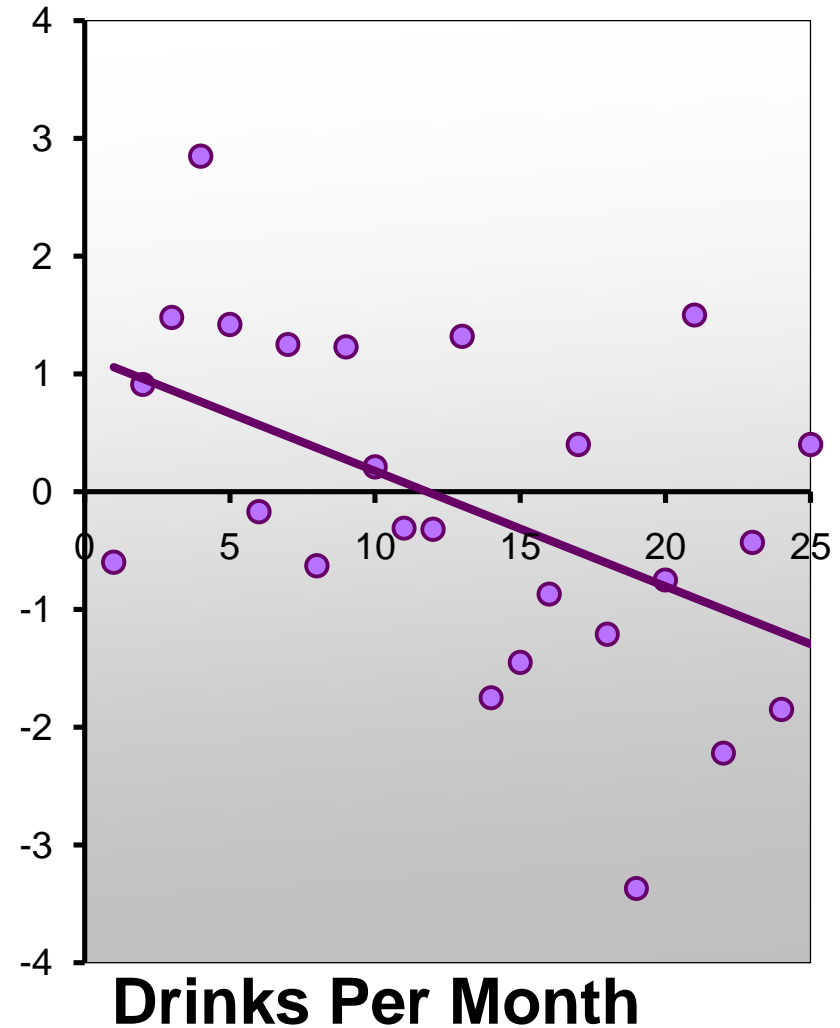
Initiation of Drinking: Girls

↑drinks →
↓figural memory



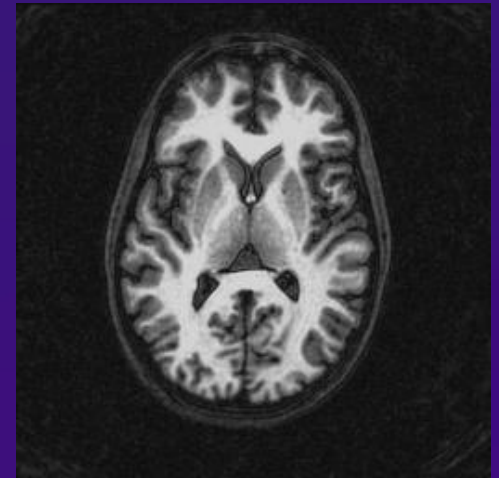
$R^2\Delta = 8\%$, $\beta = -.32$, $p < .05$

Z-Score Change
← Worse - Better →



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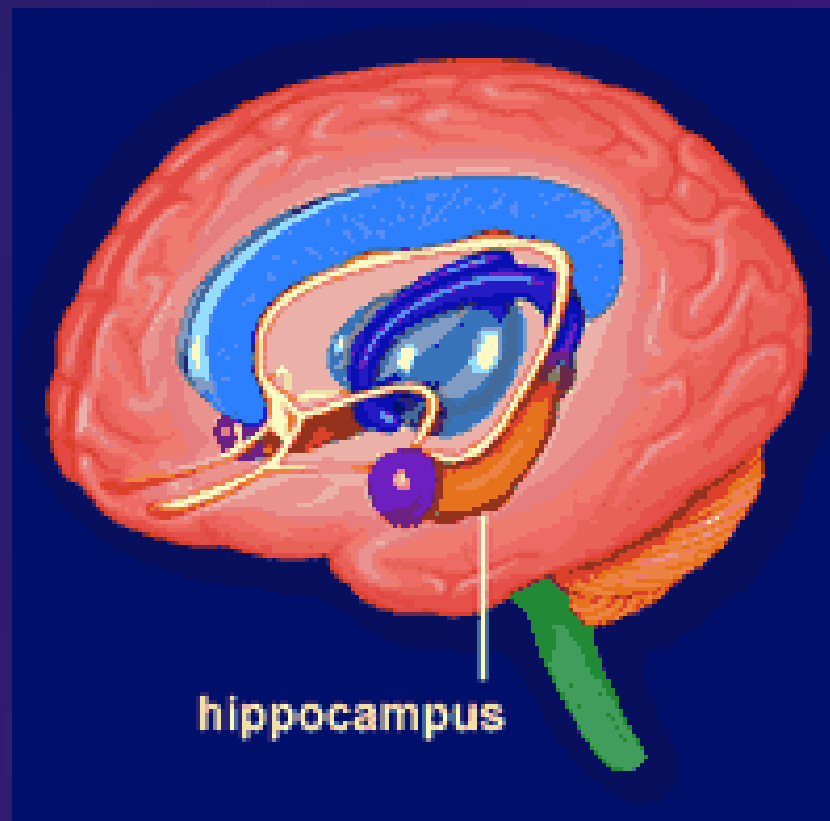
MRI

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

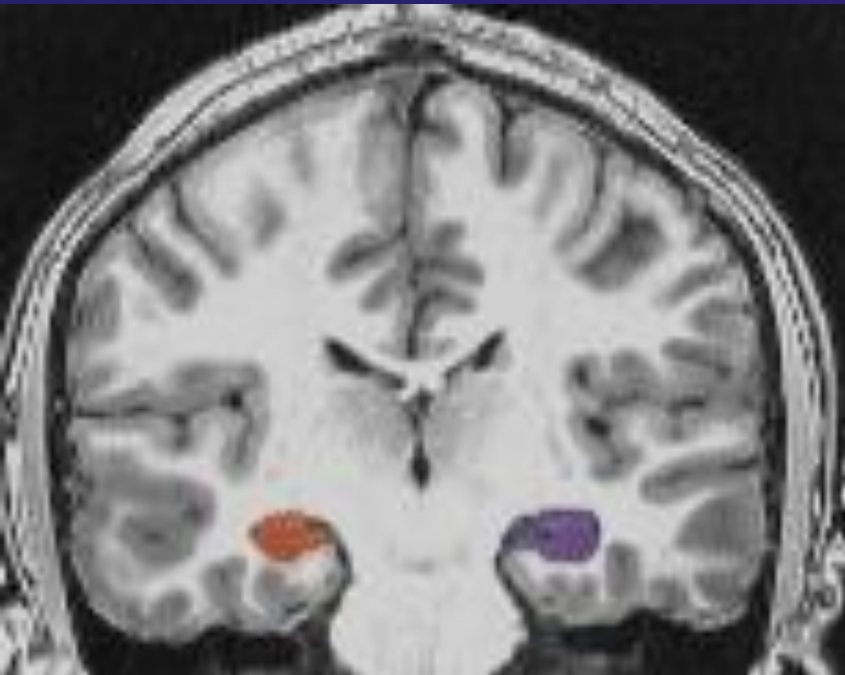


Alcohol & Hippocampus

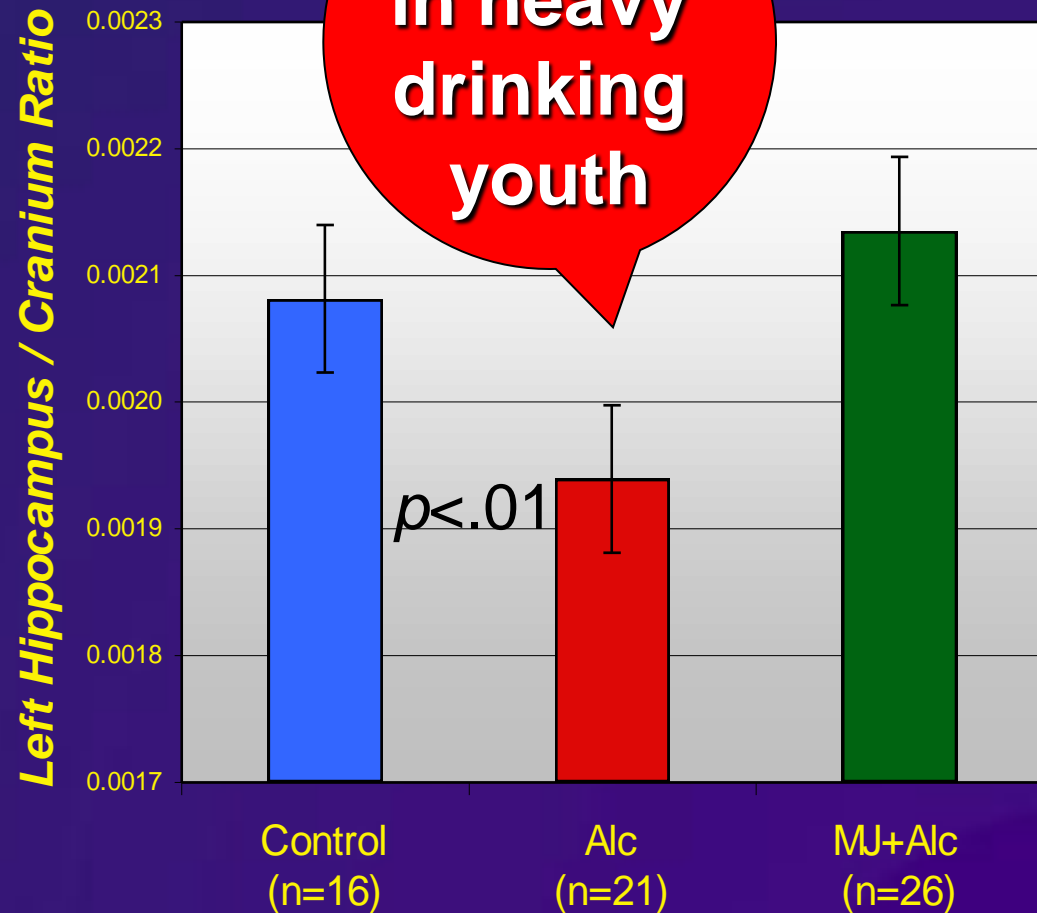
- Critical brain part for learning new info
- Vulnerable during adolescence



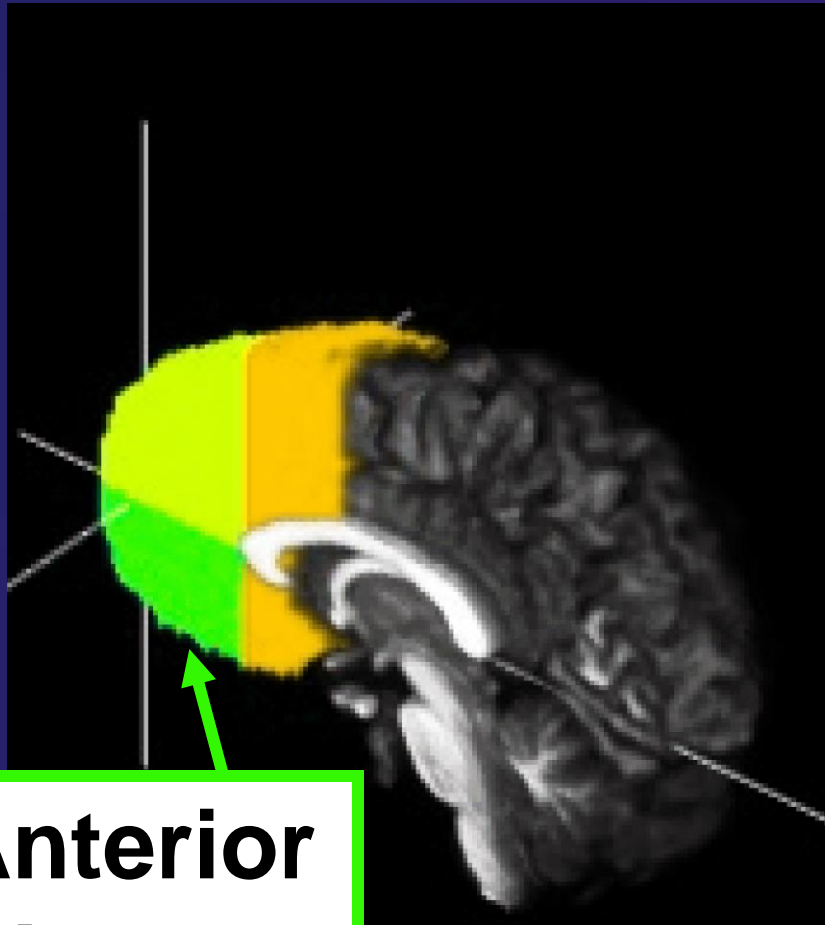
Hippocampal Volume



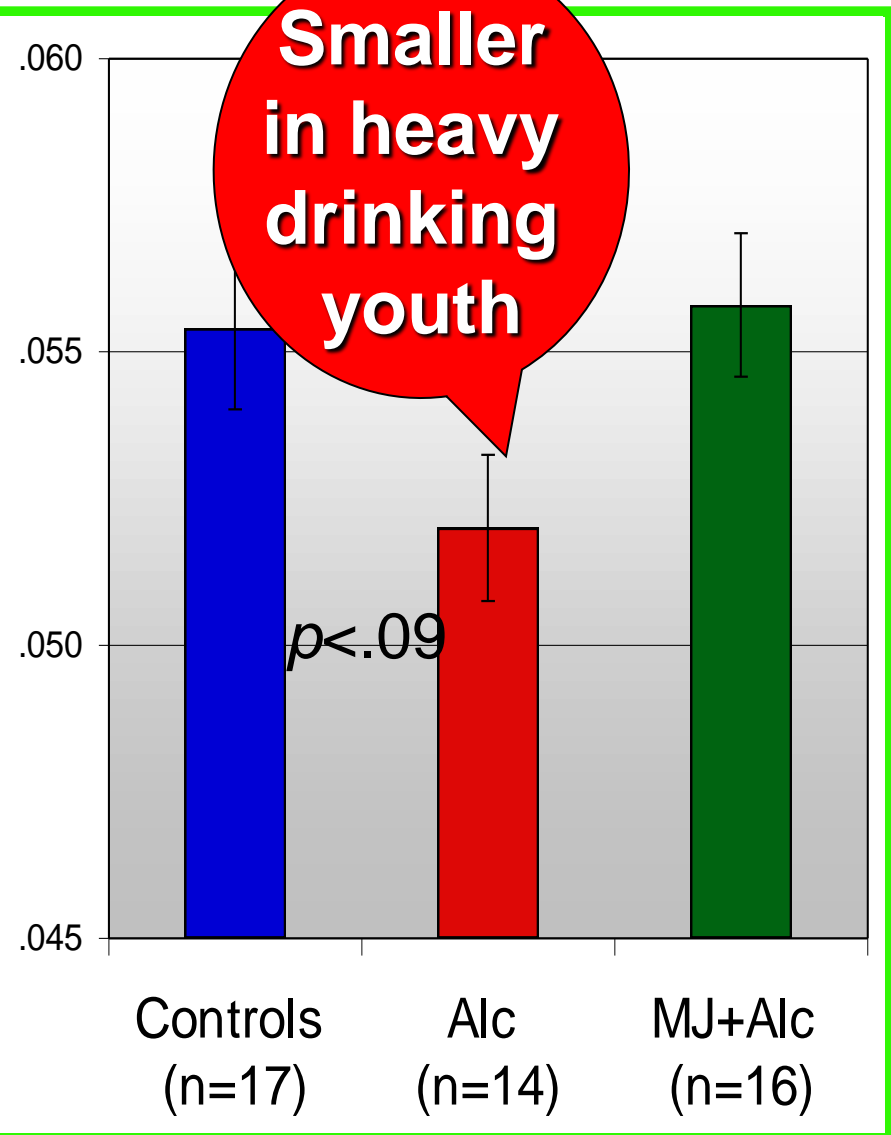
Right / Left



Prefrontal Cortex Volume

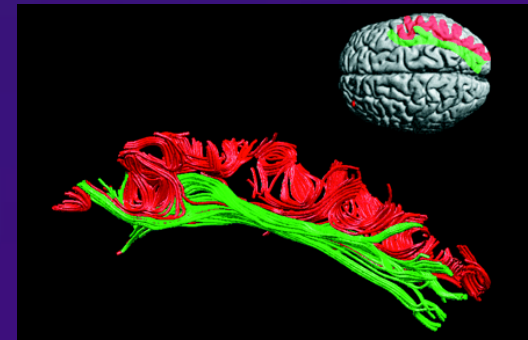


**Anterior
Ventral**



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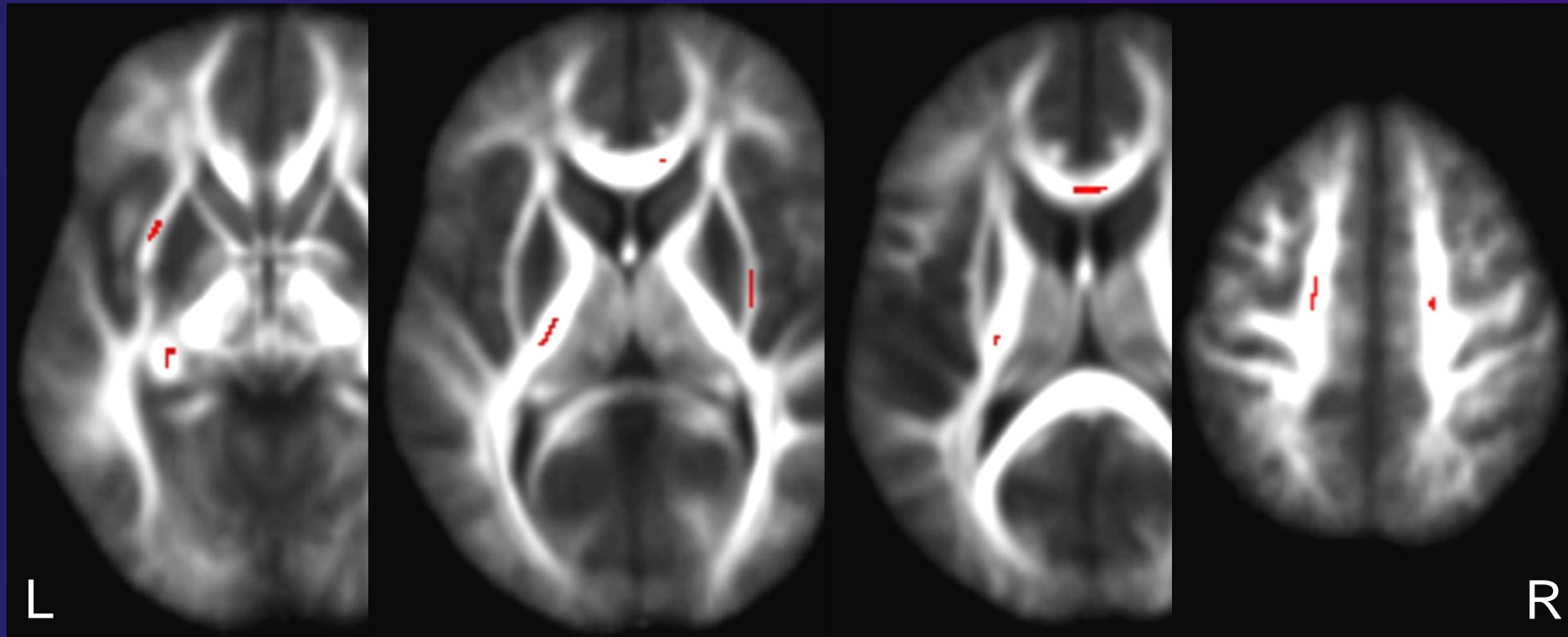
Binge Drinkers

	14 Binge Drinkers	14 Controls
Age	18.0 ±0.8	17.9 ±0.9
Female	14%	14%
Family history negative	92%	92%
Annual parent income	\$118K ±72	\$103K ±83
WASI Vocabulary T-score	56 ±10	56 ±8
Lifetime drink episodes**	55 ±48	1.3 ±3
Drinks/occas, past 3 mo**	10 ±5	0 ±0

** $p < .001$

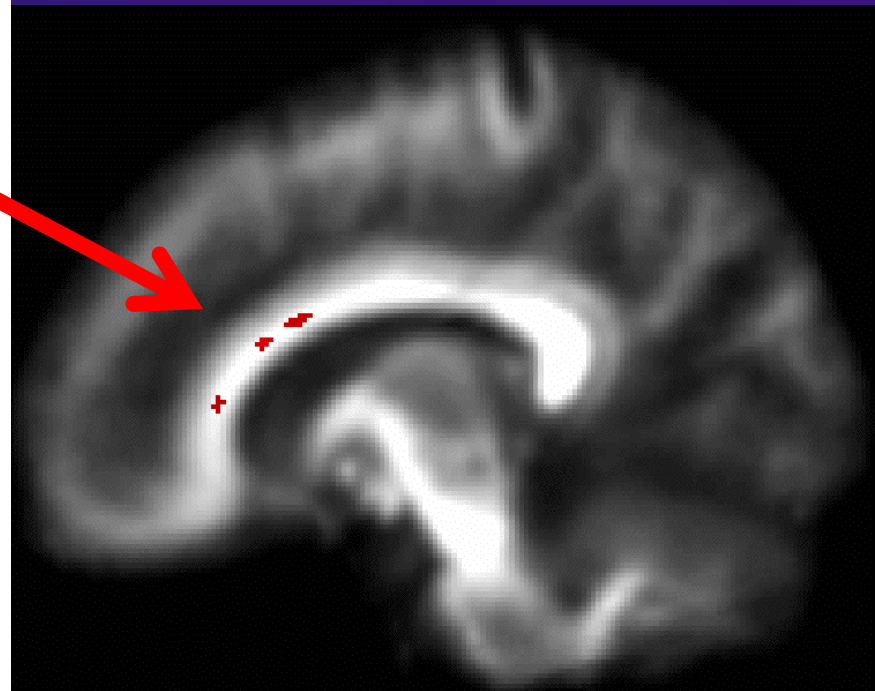
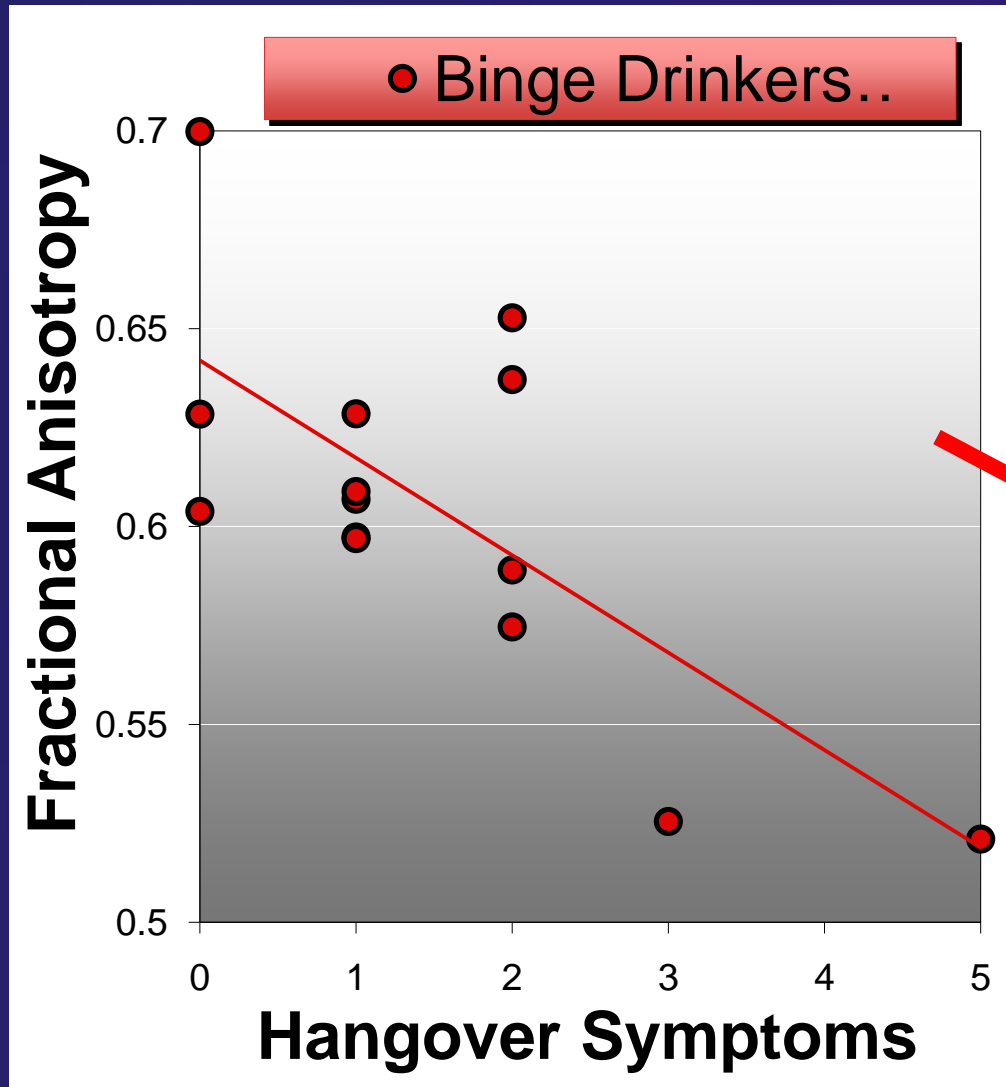
FA in Binge Drinkers

- **Bingers** ($n=14$) lower than Controls ($n=14$), $p<.01$

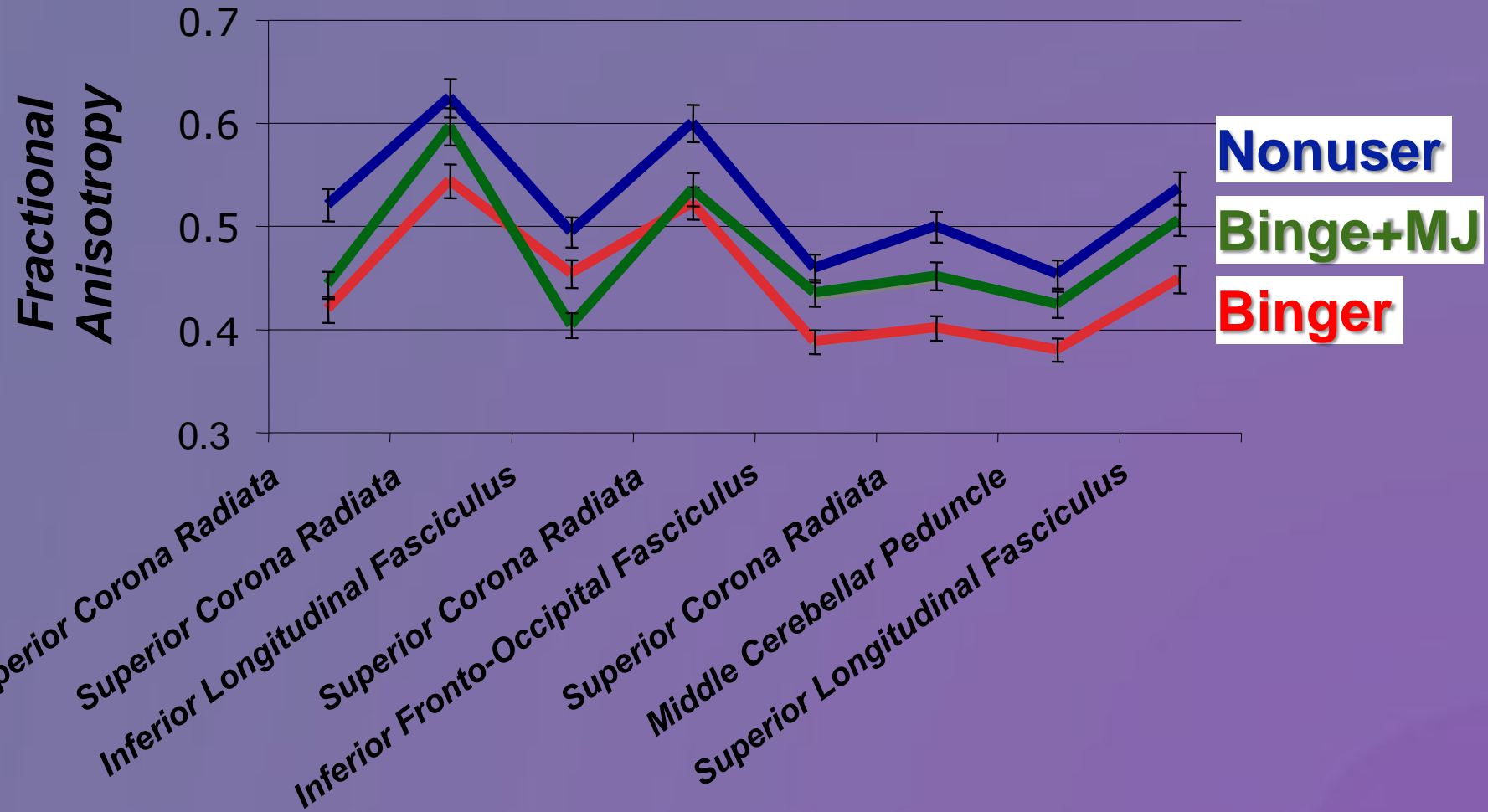


- Subtle insults → neurodevelopment

Hangover → Worse WM

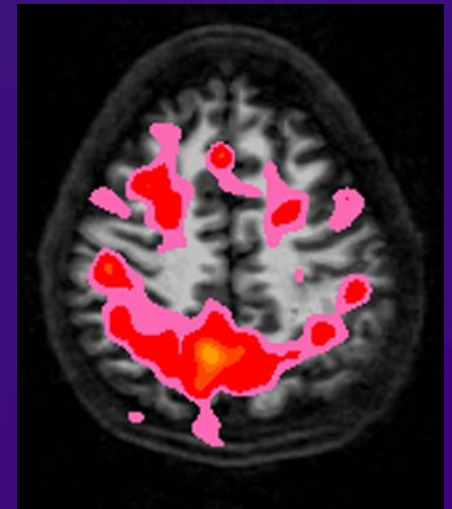


Alcohol and Marijuana



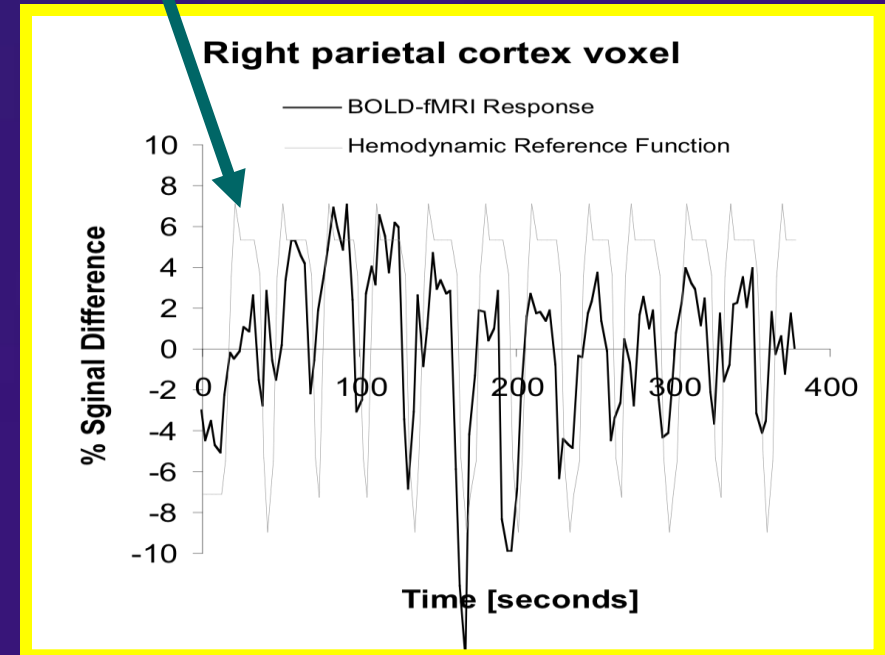
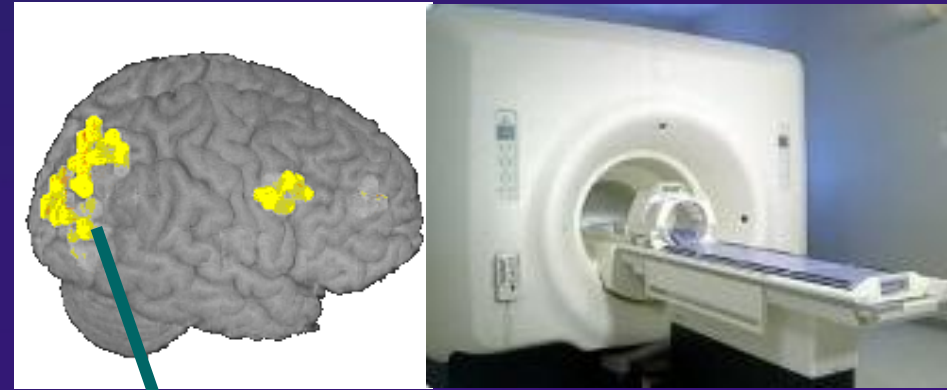
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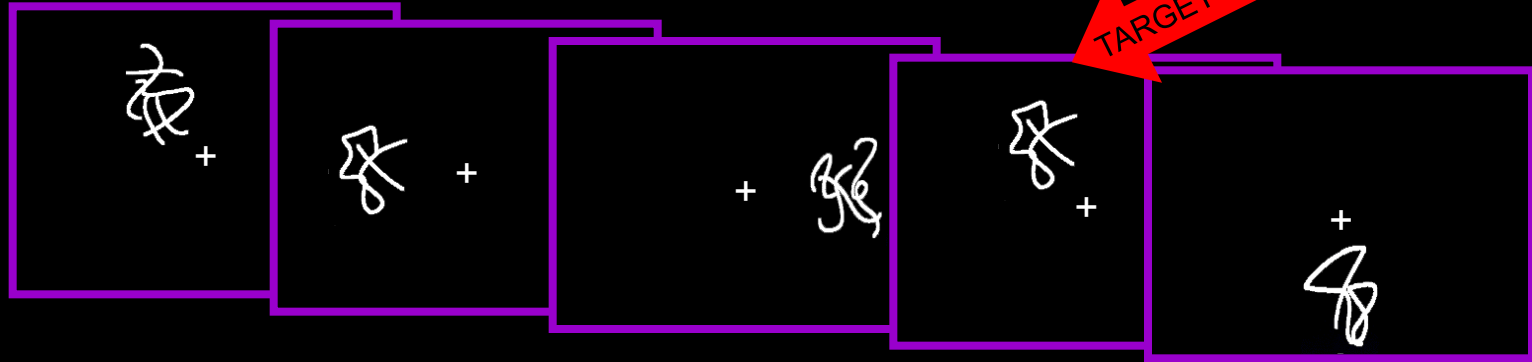
FMRI

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

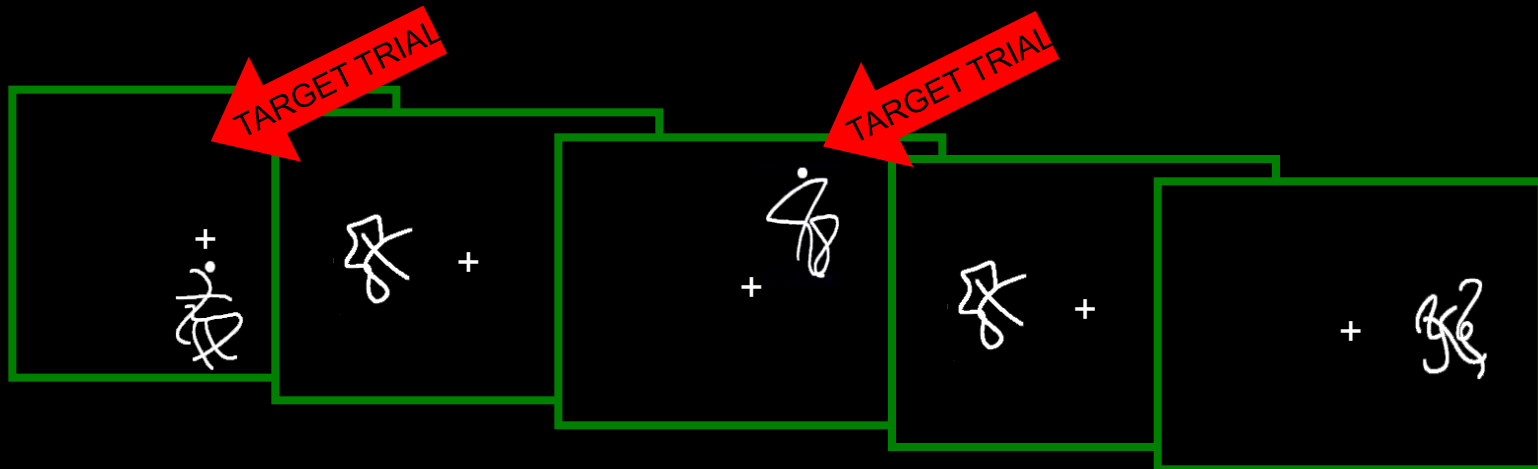


Spatial Working Memory Task

SPATIAL
WORKING
MEMORY



SIMPLE
ATTENTION



Age 15-17 with AUD

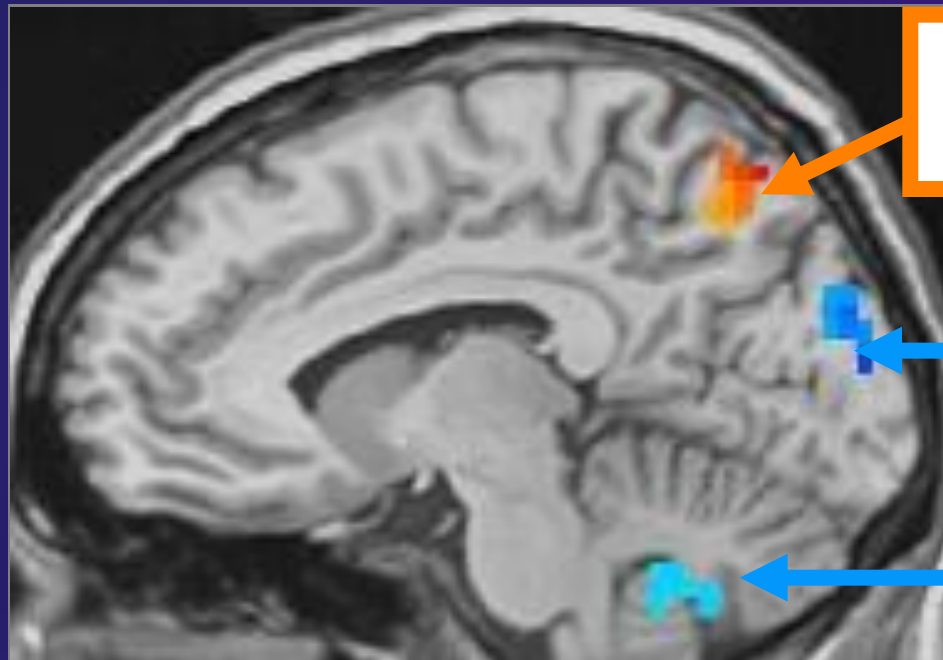
Task: SWM

19 Controls

88% accurate

15 Alcohol abuse/dep

90% accurate

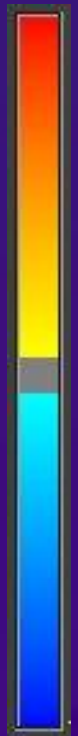


Parietal 7
AUD > Control

Occipital 18/19
AUD < Control

Tonsil
AUD < Control

$t=+4.4$



$t=-4.2$

Age 18-25 with AUD

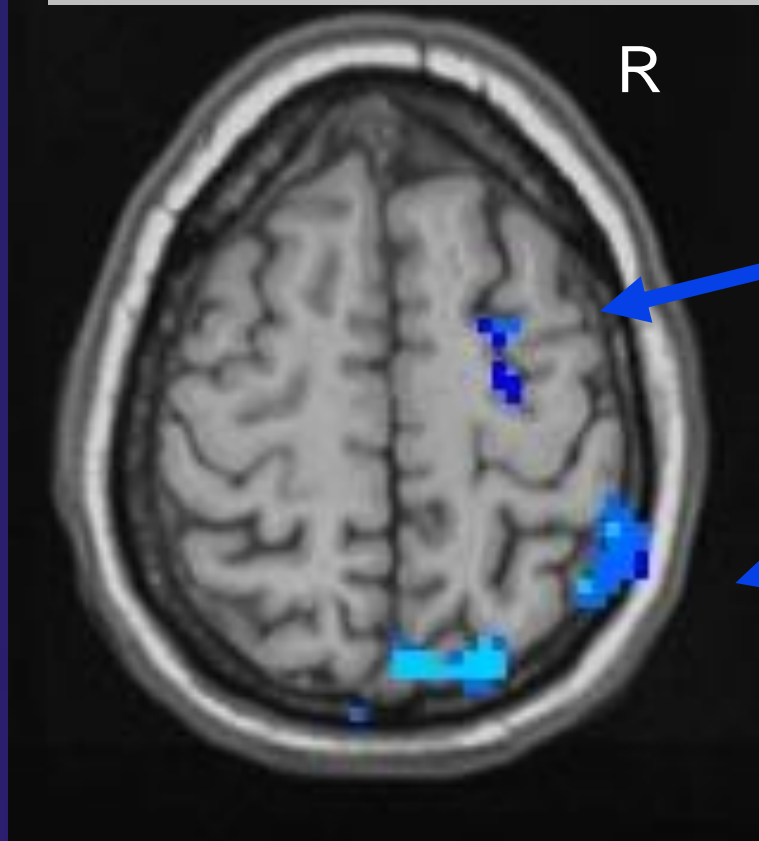
Task: SWM

10 Controls

91% accurate

10 Alcohol dependent

82% accurate



Middle Frontal
AUD < Controls

Sup & Inf Parietal
AUD < Controls



Post-Drinking Effects

- Performance related to post-drinking effects, but not alcohol quantity per se:

	Drinks per month	Post-drinking effects
Trails B time	-.12	.80 **
Digits Span total	.08	-.58 *
Spatial Working Memory accuracy	.27	-.52 *

* $p < .05$
** $p < .001$

Verbal Encoding

1. Before scan: learn 16 “old” word pairs
2. During scan: learn old and new word pairs
3. After scan: test recall of pairs

MERMAID

TAIL

TOAST

BREAD

SINK

DRAIN

Verbal Encoding in Bingers

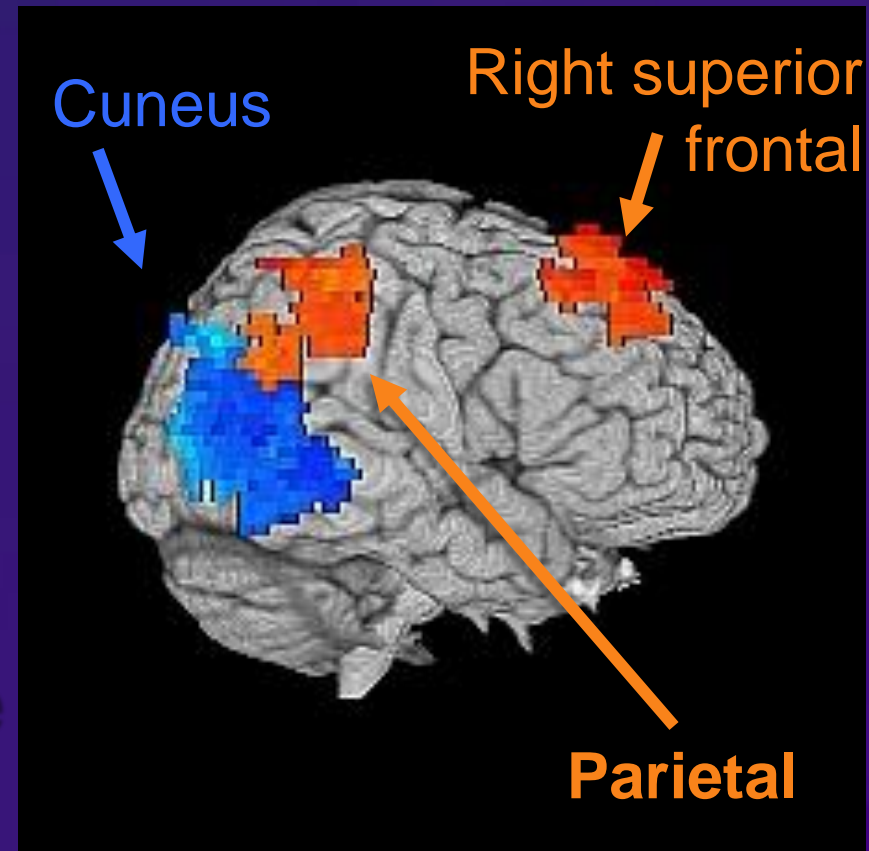
Binge drinkers (15-18):

- Lack of hippocampal response

⑩ ↓ occipital ($p < .001$) response

⑩ ↑ frontal ($p < .001$) & parietal ($p < .01$) response

- Poorer recall ($p = .07$)



Alcohol Cue Task

Alcohol Pictures



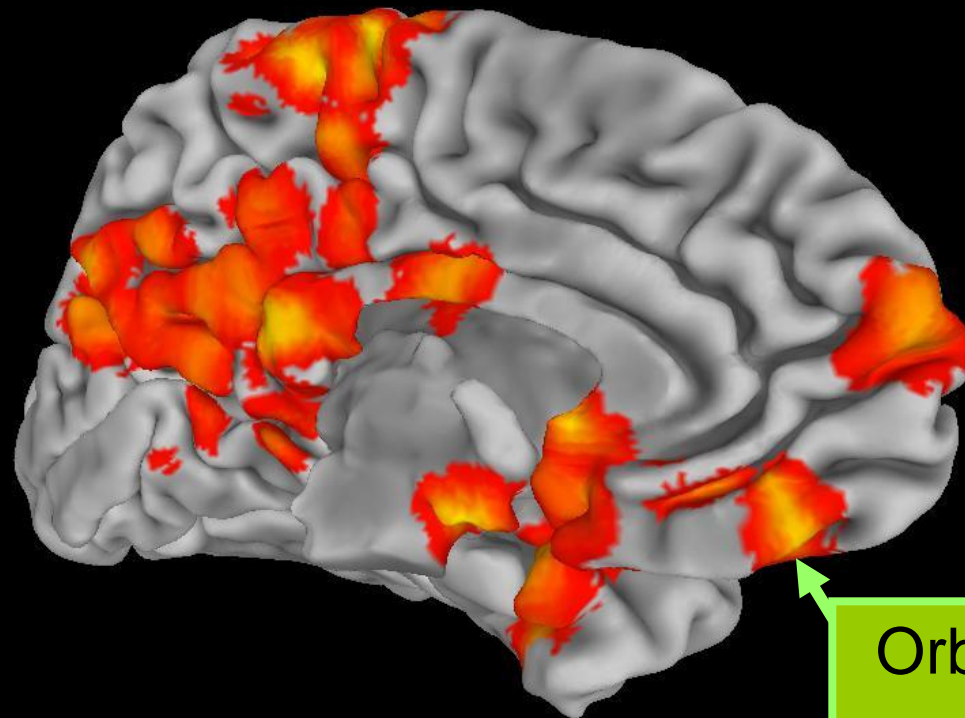
Non-Alcohol Pictures



Cue Reactivity: Adolescents

- Alcohol picture trials relative to non-alcohol beverage trials:

LEFT
HEMISPHERE



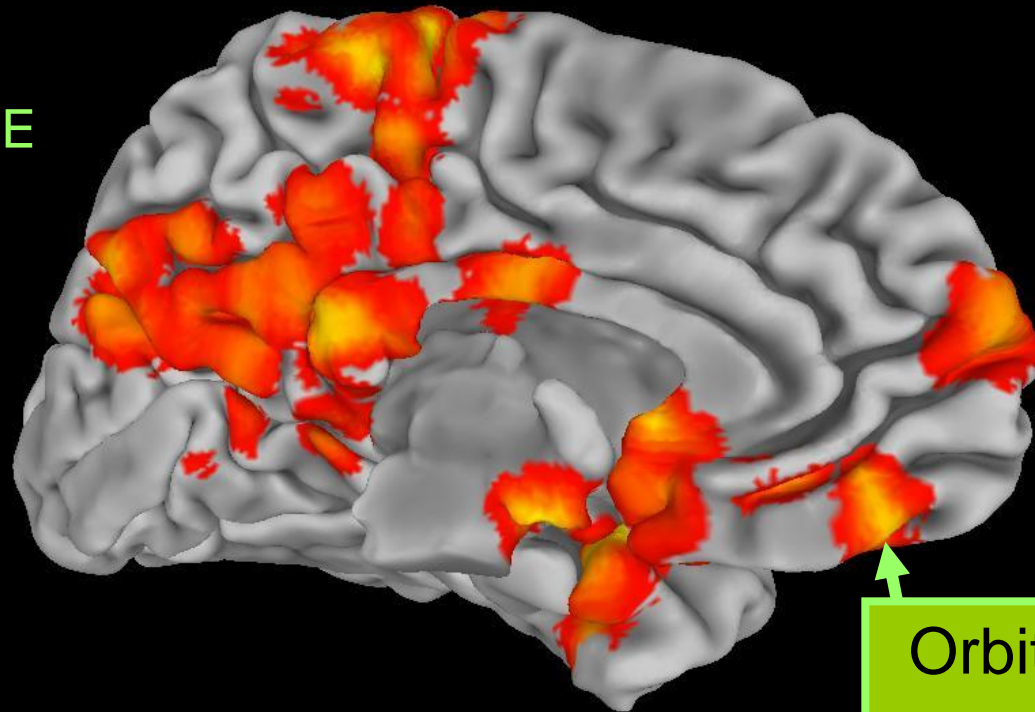
Orbital/prefrontal
(BA11)

Orange: AUD teens had more response to alcohol pictures
Blue: Controls had more response to alcohol pictures

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HEMISPHERE



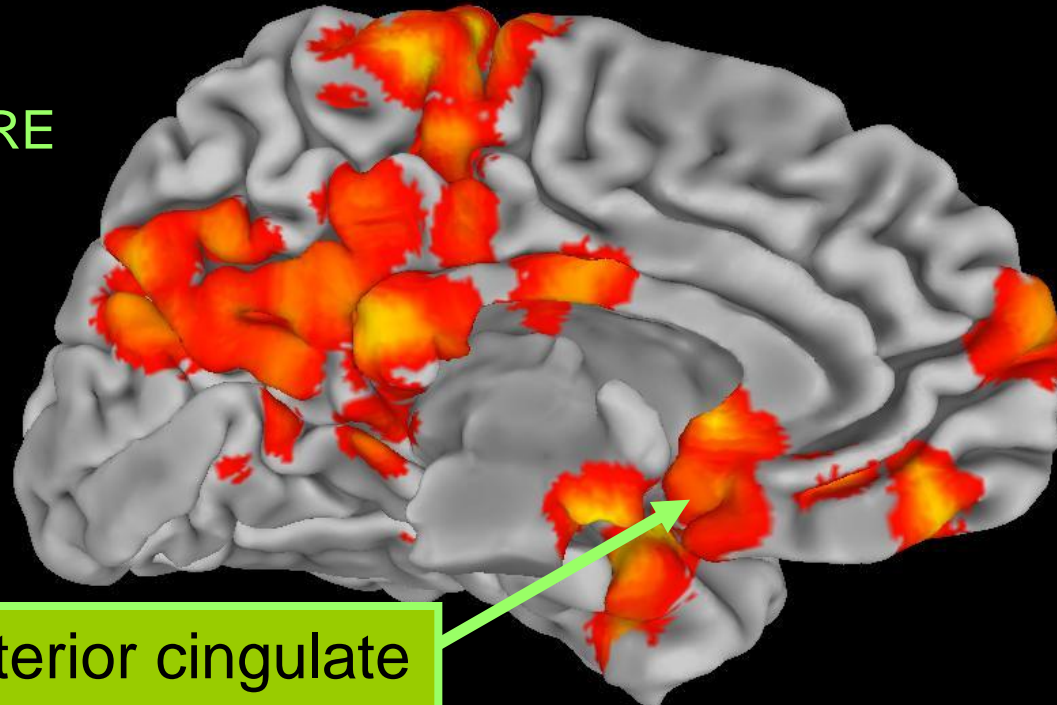
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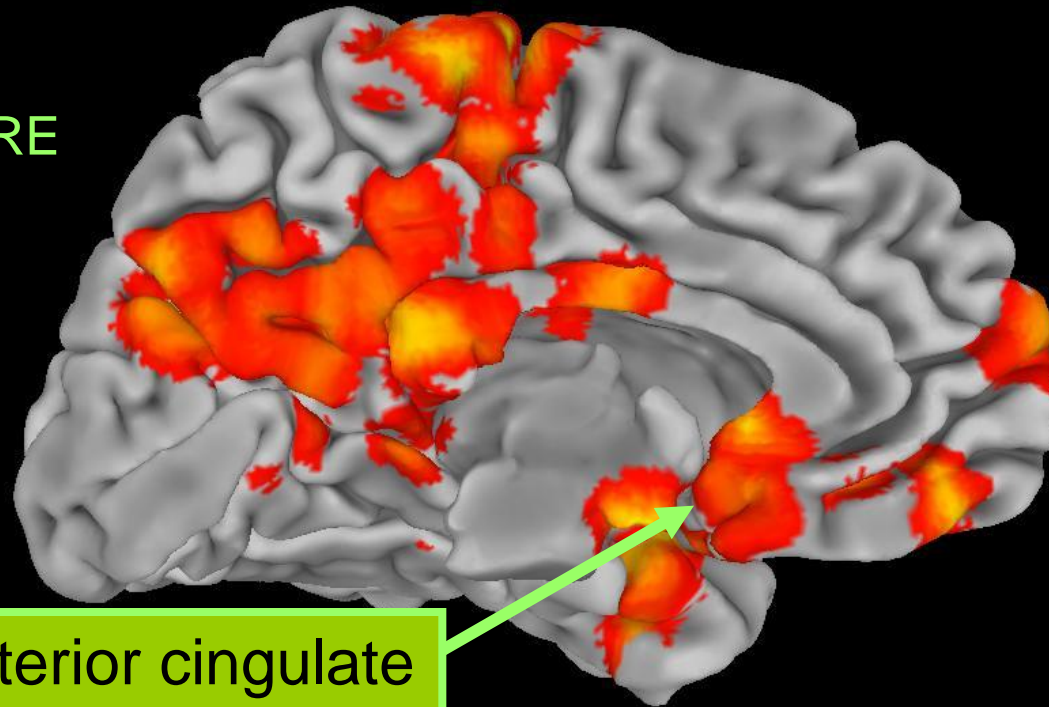
Anterior cingulate
& NAc

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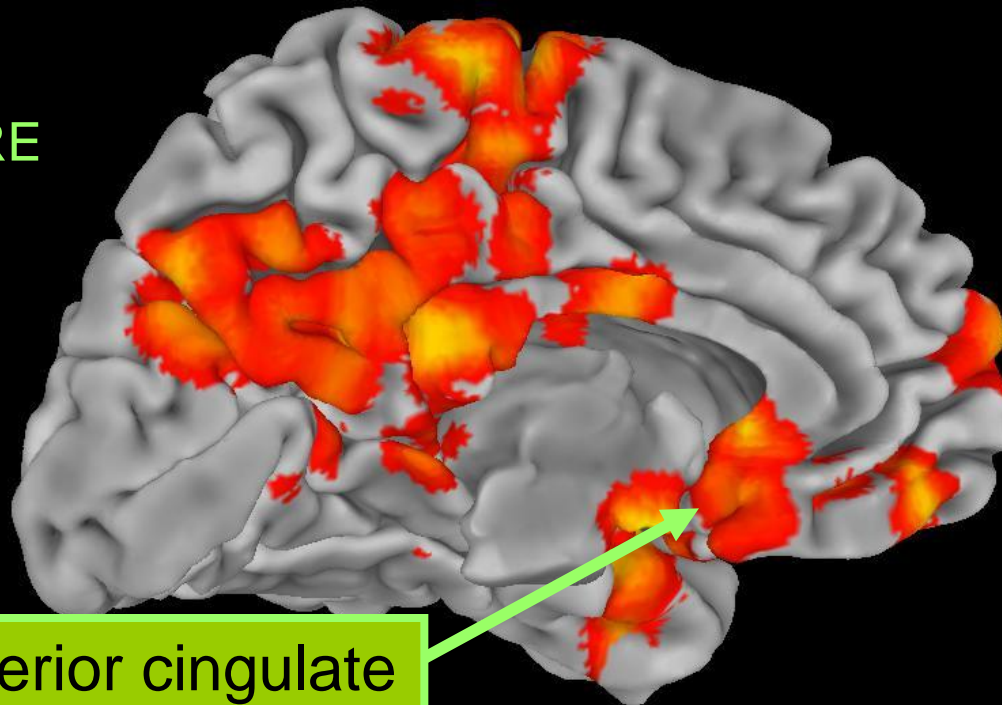
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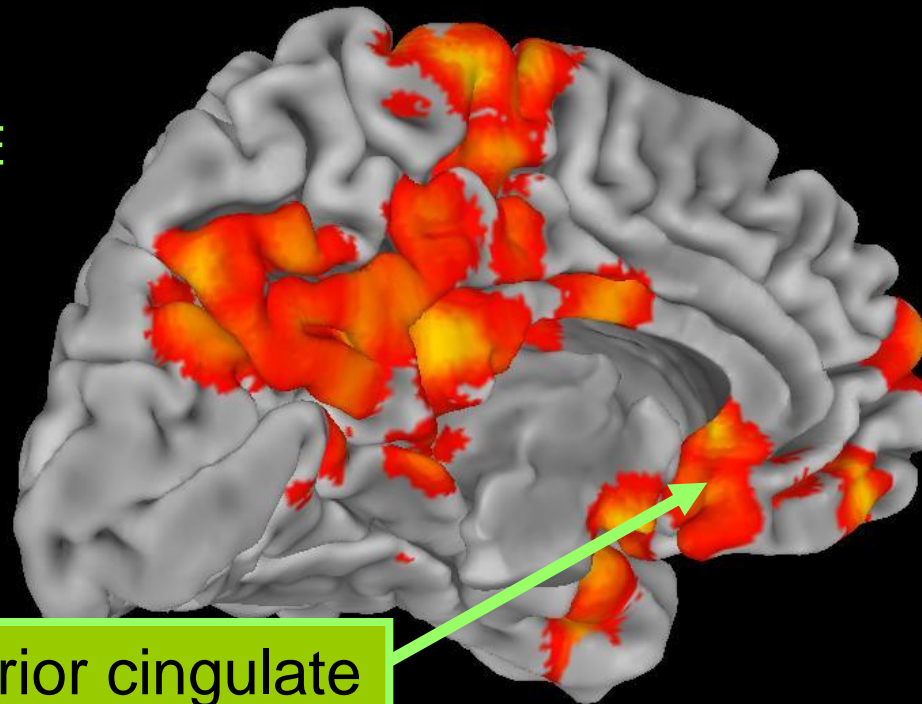
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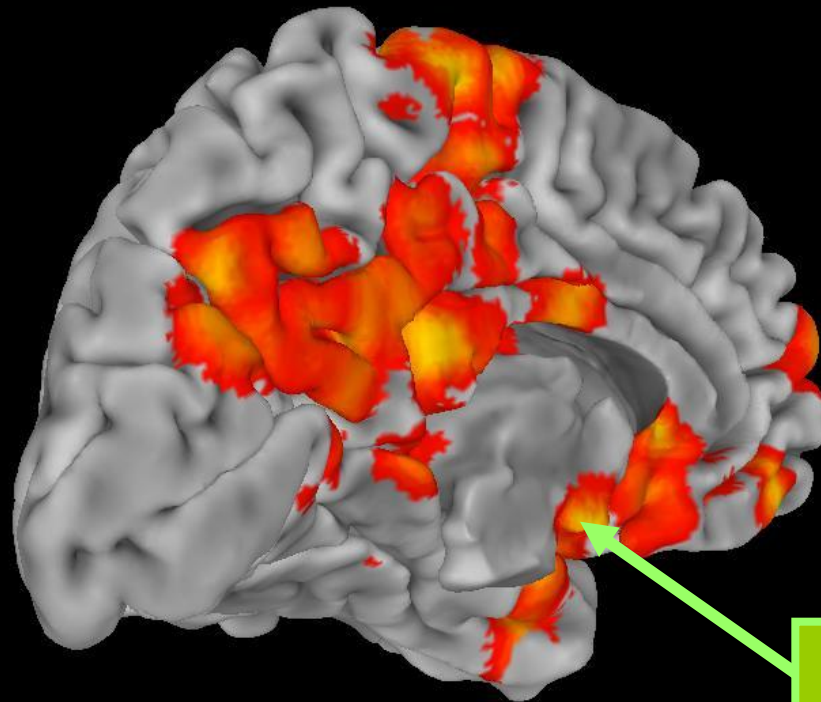
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HEMISPHERE



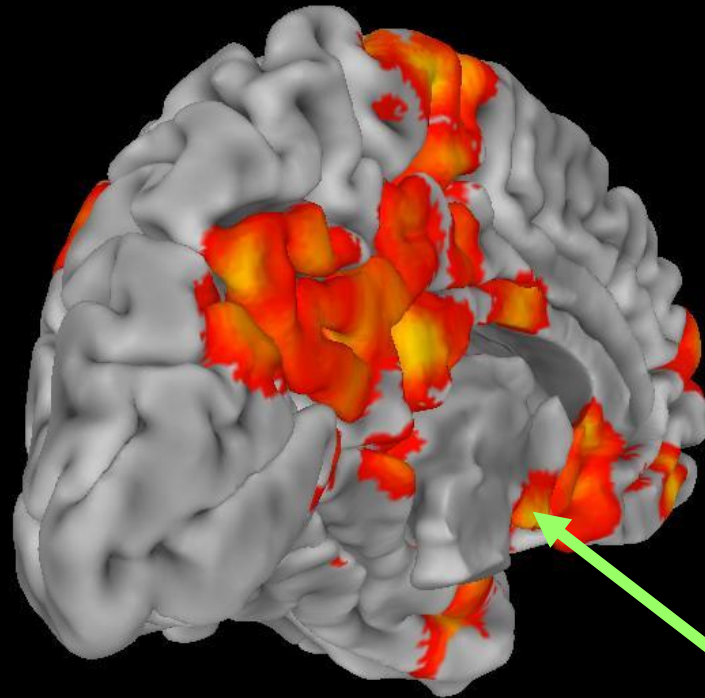
Hypothalamus

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LEFT
HEMISPHERE



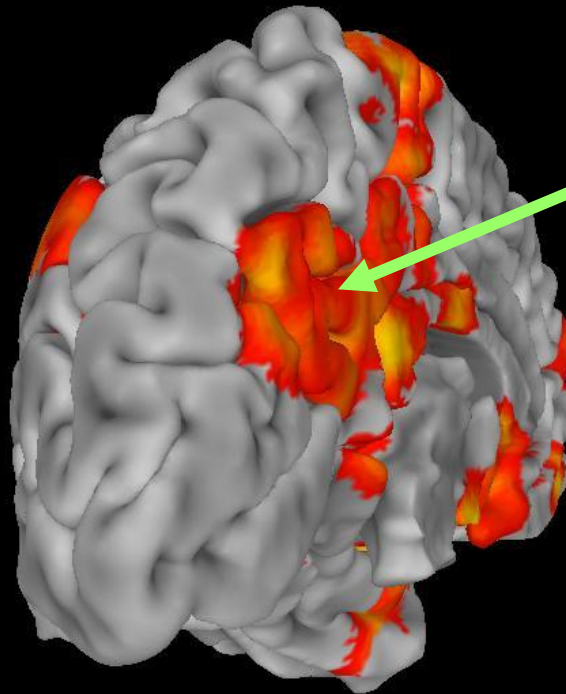
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LEFT
HEMISPHERE



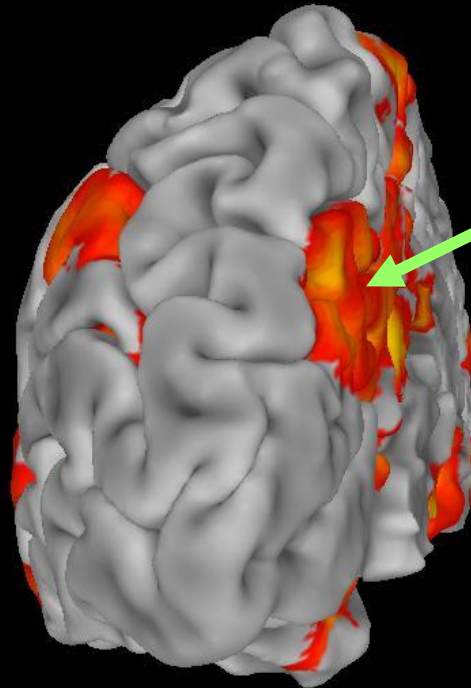
Posterior
cingulate/
Precuneus

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Cue Reactivity: Adolescents

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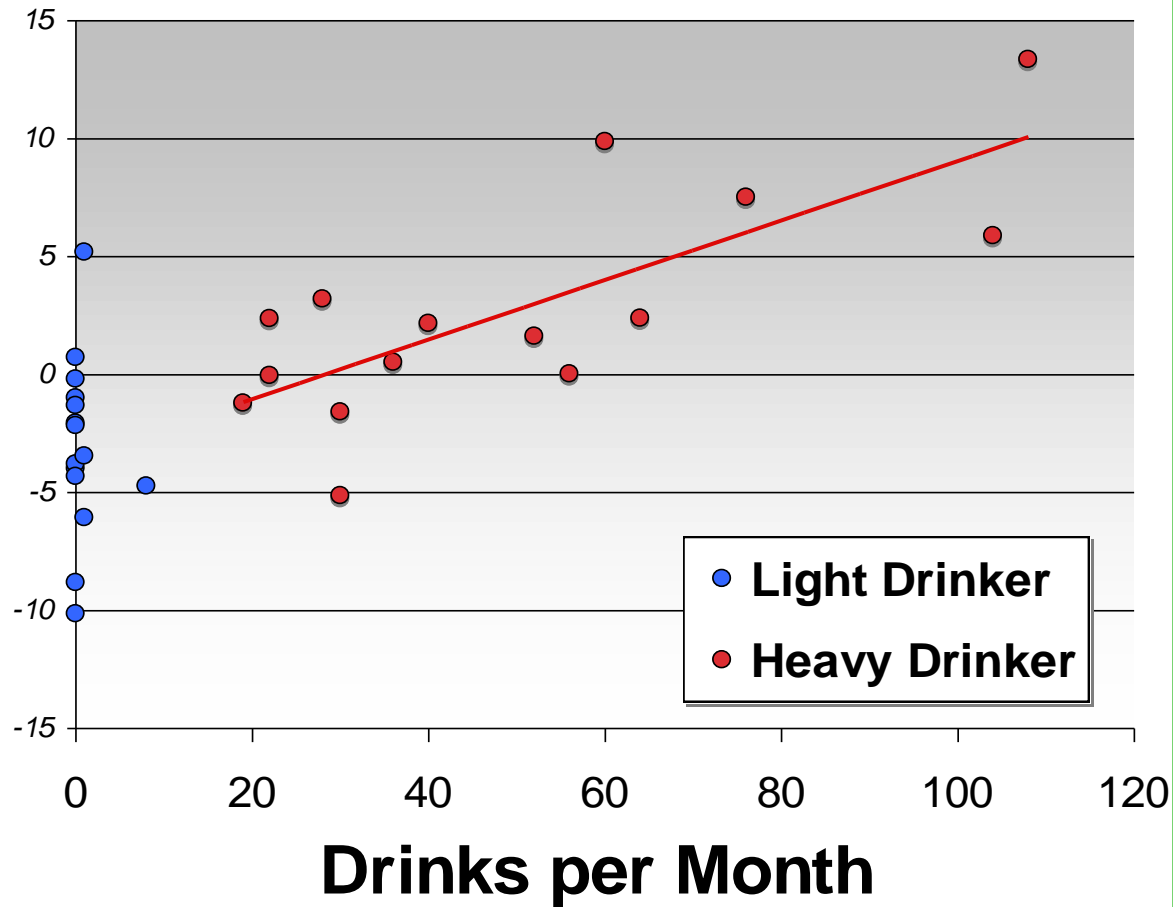
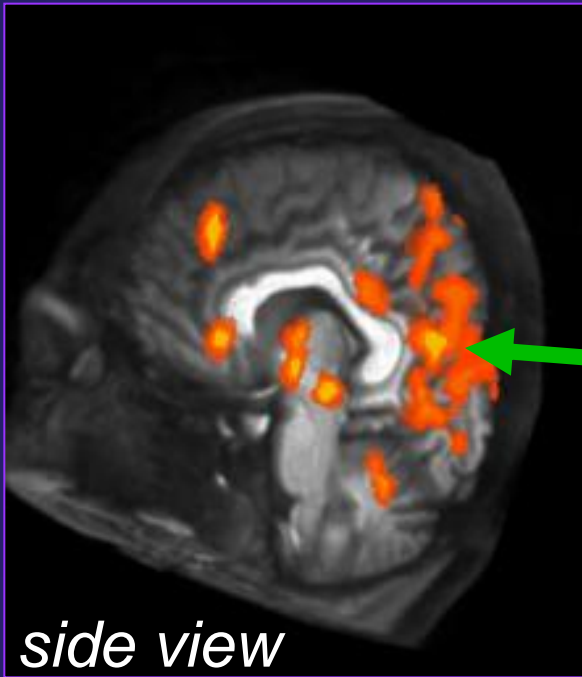
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HEMISPHERE



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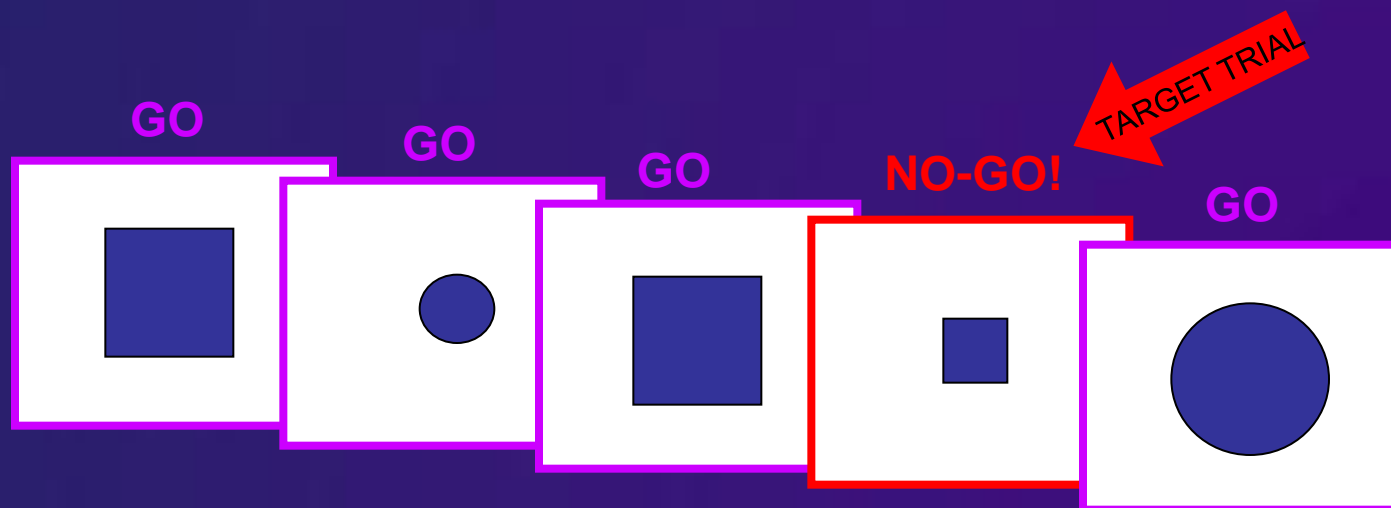
Youth Response to Alcohol Ads



Inhibition Task

Instructions:

- Press the button as soon as you see a blue shape **EXCEPT** the **SMALL** blue square
- Respond as **FAST** as you can!



Inhibition & Future Initiation

scan

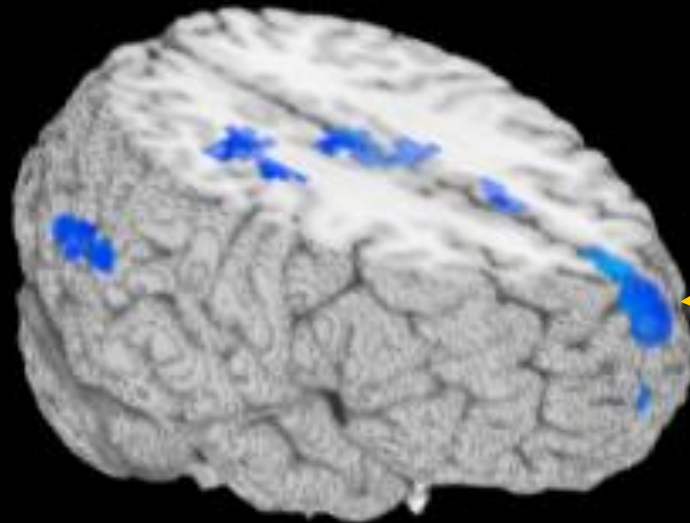
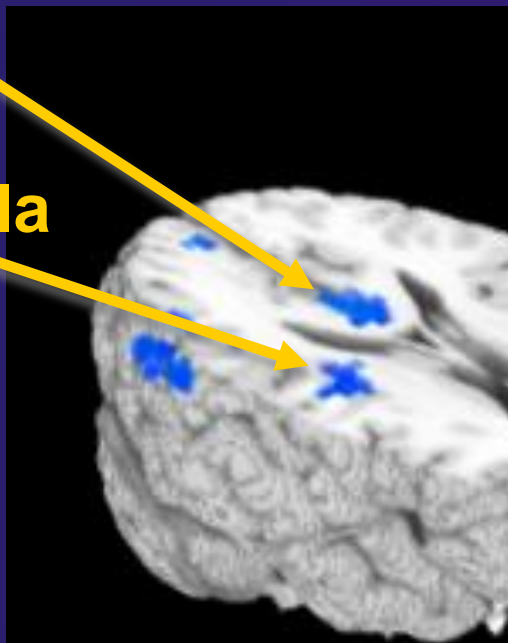
Non-Drinkers

Heavy Drinkers

Baseline 1yr 2yr 3yr 4yr 5yr→

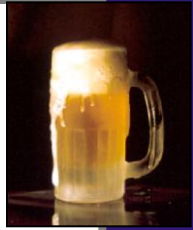
↓ No-go BOLD response predicted starting heavy drinking (N=38)

PCC
R Insula



clusters > 1358 μ l, $p < .05$

BOLD Response Summary



At-risk	↓inhibition response
Binge drinkers	↓hippocampal, occipital, & ↓recall ↑parietal compensation
AUD	↓occipital, cerebellar ↑parietal compensation
Continued AUD	↓↓SWM (frontal,parietal) ↓performance

Summary: Teen Heavy Drinking

↓ Neuropsychological performance

↓ Volume:

↓ Hippocampus

↓ Prefrontal cortex

↓ White matter quality

↑↓ Abnormal brain functioning

→ Multimodal, connectivity



THANKS TO... NIAAA & NIDA: R01 AA13419 & R01 DA021182 (Tapert)



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