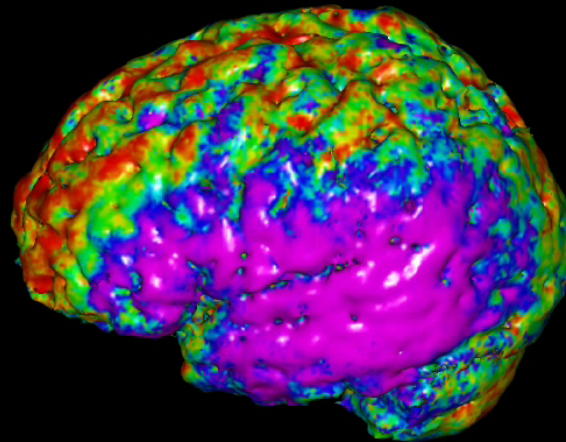


# **Who's been paying attention? What's known & unknown about ADHD**

**Jonathan Posner, MD**

**Assistant Professor of Clinical Psychiatry  
Columbia College of Physicians & Surgeons  
New York State Psychiatric Institute**



# Outline

- What is ADHD?
- Why treat ADHD?
- What causes ADHD?
- Neurobiological Understanding of ADHD
- Recent Controversies in ADHD

PLEASE ASK QUESTIONS

# What is ADHD?

- Collection of symptoms (syndrome) including difficulty staying focused, difficulty controlling behavior, and hyperactivity (over-activity).
- Symptoms cause difficulty in school, social and family interactions.

NIMH, 2015

# Attention Deficit Hyperactive Disorder

Must meet **at least 6** of the criteria within A1 and/or A2, and have experienced for at least the past 6 months.

## A1: Inattention

- a. Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or during other activities (e.g., overlooks or misses details, work is inaccurate).
- b. Often has difficulty sustaining attention in tasks or play activities (e.g., has difficulty remaining focused during lectures, conversations, or reading lengthy writings).
- c. Often does not seem to listen when spoken to directly (e.g., mind seems elsewhere, even in the absence of any obvious distraction).
- d. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (e.g., starts tasks but quickly loses focus and is easily sidetracked; fails to finish schoolwork, household chores, or tasks in the workplace).
- e. Often has difficulty organizing tasks and activities (e.g., difficulty managing sequential tasks; difficulty keeping materials and belongings in order; messy, disorganized, work; poor time management; tends to fail to meet deadlines).
- f. Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (e.g., schoolwork or homework; for older adolescents and adults, preparing reports, completing forms, or reviewing lengthy papers).
- g. Often loses things necessary for tasks or activities (e.g., school materials, pencils, books, tools, wallets, keys, paperwork, eyeglasses, or mobile telephones).
- h. Is often easily distracted by extraneous stimuli (for older adolescents and adults, may include unrelated thoughts).
- i. Is often forgetful in daily activities (e.g., chores, running errands; for older adolescents and adults, returning calls, paying bills, keeping appointments).

## A2: Hyperactivity and Impulsivity

- a. Often fidgets with or taps hands or feet or squirms in seat.
- b. Often leaves seat in situations when remaining seated is expected (e.g., leaves his or her place in the classroom, office or other workplace, or in other situations that require remaining seated).
- c. Often runs about or climbs in situations where it is inappropriate. (In adolescents or adults, may be limited to feeling restless).
- d. Often unable to play or engage in leisure activities quietly.
- e. Is often "on the go," acting as if "driven by a motor" (e.g., is unable or uncomfortable being still for an extended time, as in restaurants, meetings, etc; may be experienced by others as being restless and difficult to keep up with).
- f. Often talks excessively.
- g. Often blurts out an answer before a question has been completed (e.g., completes people's sentences and "jumps the gun" in conversations, cannot wait for next turn in conversation).
- h. Often has difficulty waiting his or her turn (e.g., while waiting in line).
- i. Often interrupts or intrudes on others (e.g., butts into conversations, games, or activities; may start using other people's things without asking or receiving permission, adolescents or adults may intrude into or take over what others are doing).

B. Several inattentive or hyperactive-impulsive symptoms were present prior to age 12.

C. Criteria for the disorder are met in two or more settings (e.g., at home, school or work, with friends or relatives, or in other activities).

D. There must be clear evidence that the symptoms interfere with or reduce the quality of social, academic, or occupational functioning.

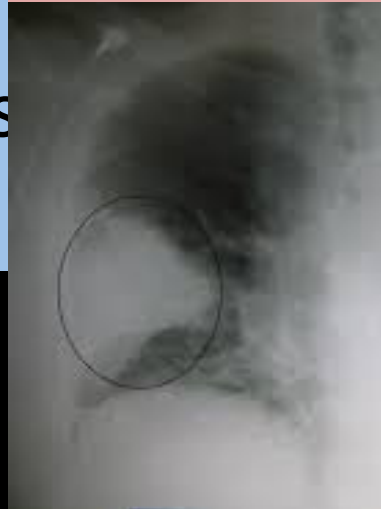
E. The symptoms do not occur exclusively during the course of schizophrenia or another psychotic disorder and are not better accounted for by another mental disorder (e.g., mood disorder, anxiety disorder, dissociative disorder, or a personality disorder).

# Bacterial Pneumonia

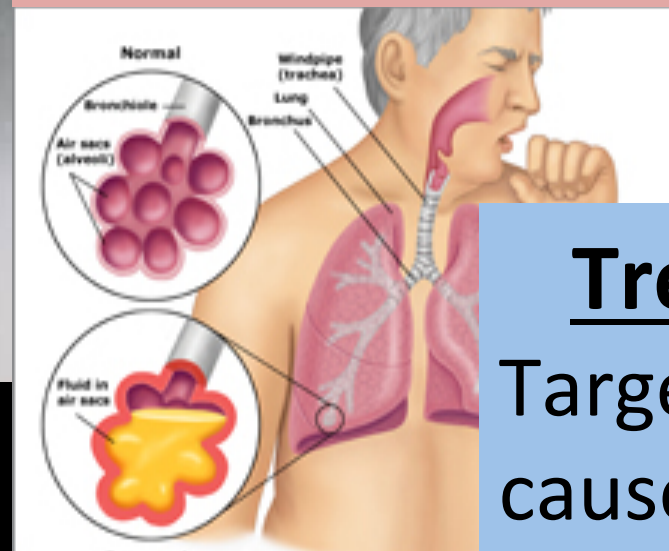
## Symptoms

- Fever
- Cough
- Shortness of breath

## Diagnostic Test



## Pathophysiology



## Treatment

Targeting the cause alleviates symptoms

# Do symptoms alone constitute a disorder?



# Reliability vs. Validity

## Reliability

1. Classification system in which different clinicians can arrive at the same conclusion

## Validity

1. Underlying cause of a disease is known.
2. Remove the underlying cause & symptoms resolve

# Treatment & Validity

- Without claims of diagnostic validity, are we just “creating” disorders?
- Should treatment still be provided?



# Why treat ADHD?

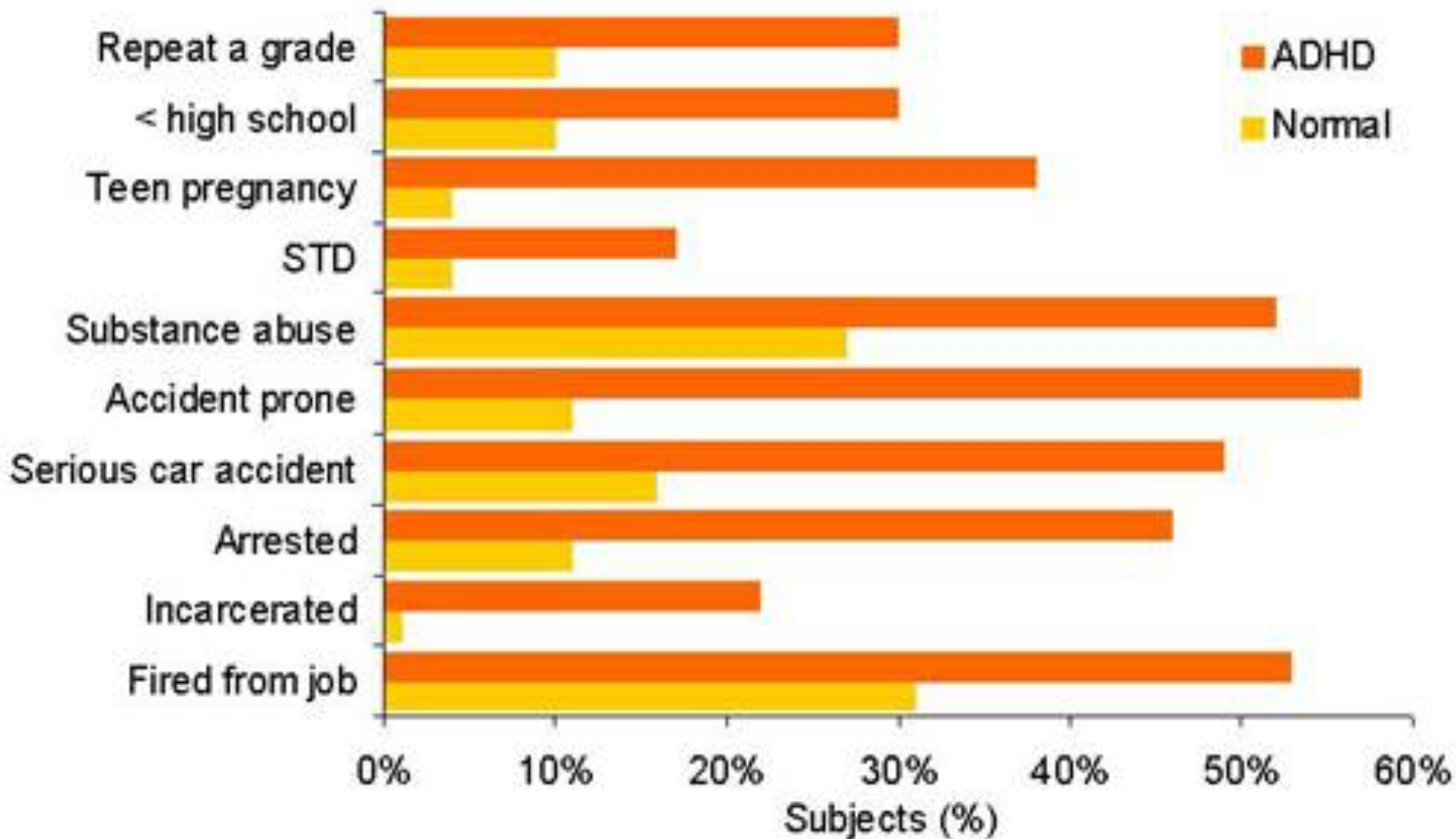
- Cluster of symptoms (syndrome):
  - Can be detected and reliably diagnosed
  - Are associated with significant negative outcomes
  - Improvement with treatment

# Is the diagnosis reliable?

- Established by “field trials”
  - Over 2246 patients interviewed for DSM-5
  - Reliability (kappa statistic) measured as diagnostic agreement between 2 independent clinicians.
  - Kappa  $\sim 0.6$  (substantial agreement)

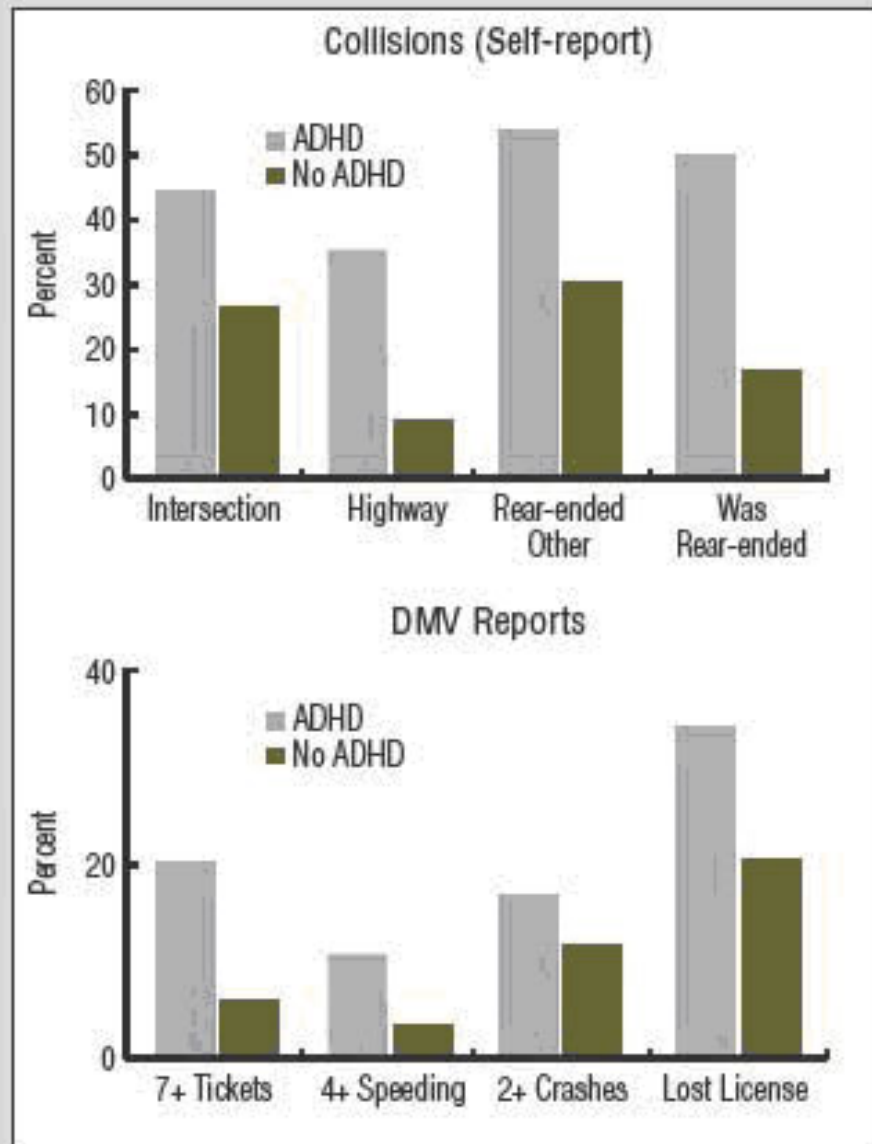
# Is the diagnosis impairing?

## Functional Impairment in Patients with ADHD



# Motor Vehicle Accidents

FIGURE 1  
ADHD AND DRIVING RISKS



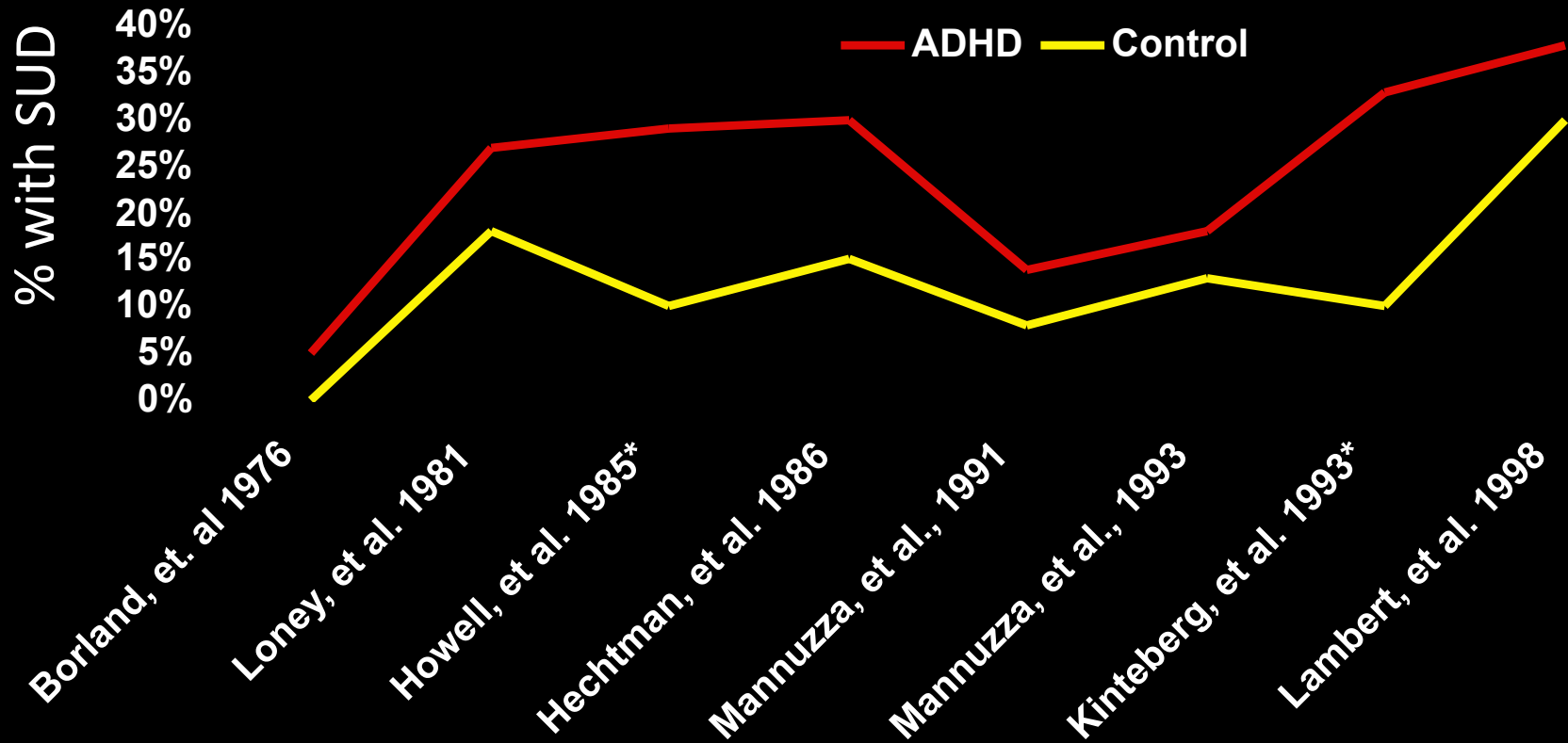
ADHD, attention-deficit/hyperactivity disorder; DMV, Department of Motor Vehicles.

# Lifetime Rates of SUD

## in Controlled Longitudinal Studies of ADHD Adults

Mean age range at follow-up: 18-26 years

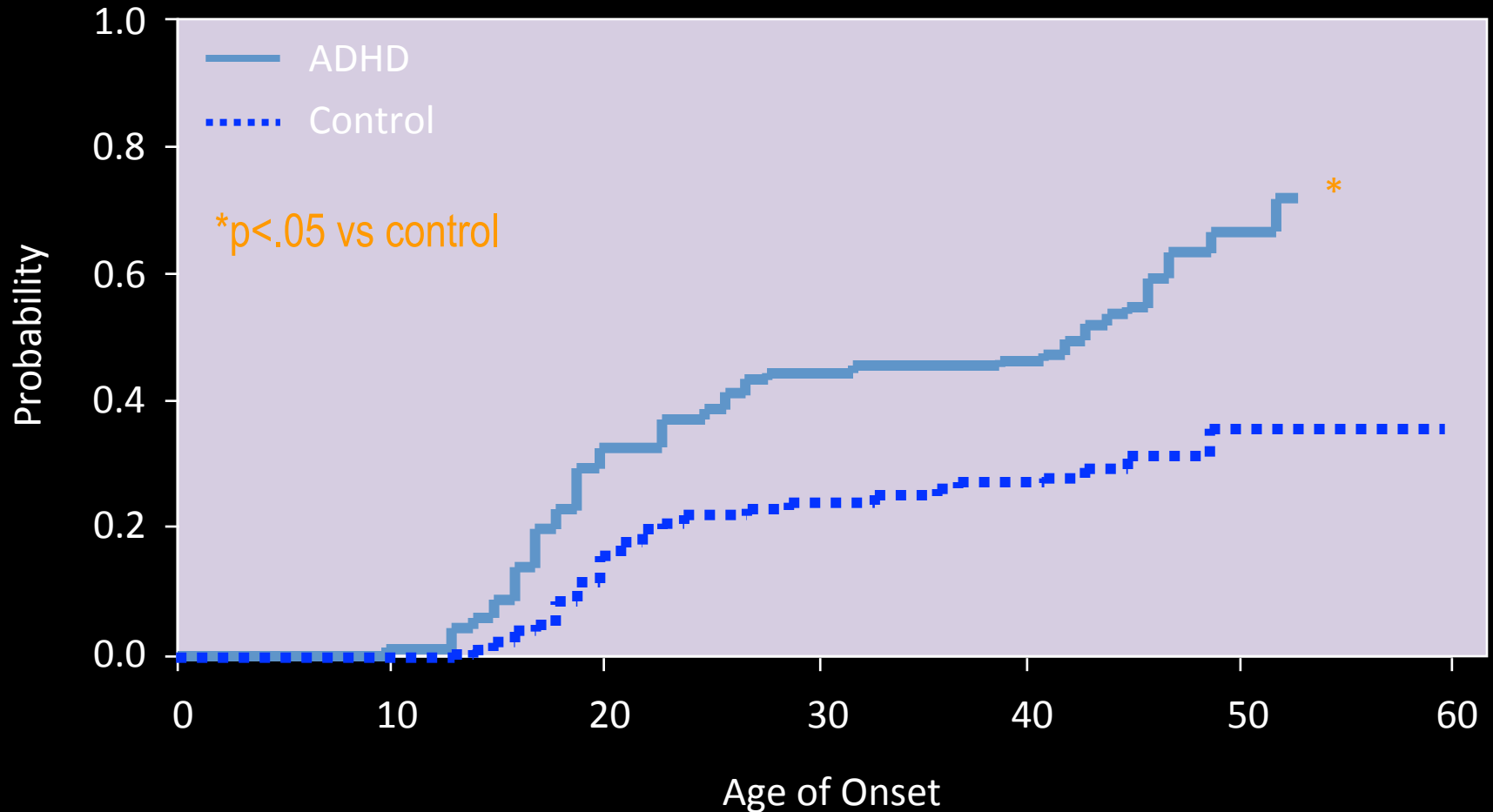
Total ADHD N=845, total Control N=1085



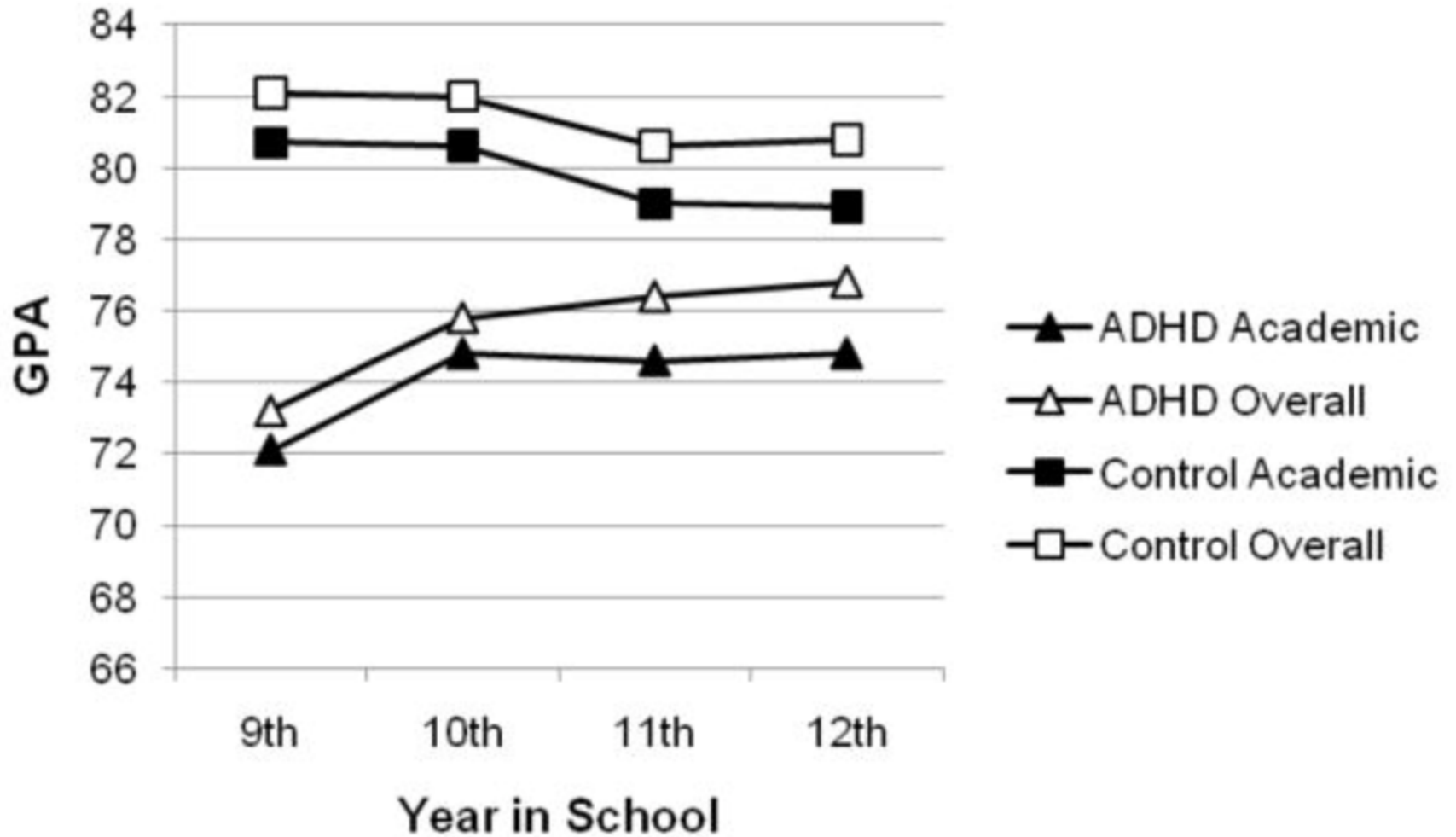
( from Wilens et al., Psych Clin N Am: 2004)

# Onset of Substance Abuse in ADHD Adults

(Retrospectively Derived)



# High School Academics



# High School Dropout Rates

**Table 2.** Details of Multivariate Model Predicting Repeated Grade/High School Dropout

Predictor	Odds ratio, 95% confidence interval	z statistic	p value
ADHD	3.13 [1.79, 5.48]	4.00	<.001
Low socioeconomic status	2.20 [1.37, 3.53]	3.25	.001
IQ < 100	2.94 [1.84, 4.69]	4.52	<.001
Disruptive disorders	1.51 [0.90, 2.52]	1.57	.12
Mood disorders	1.31 [0.79, 2.17]	1.06	.29
Anxiety disorders	0.73 [0.43, 1.22]	-1.19	.23
Substance use disorders	0.78 [0.49, 1.22]	-1.09	.28
Learning disability	1.28 [0.75, 2.20]	0.90	.37

Note: Predictors are also included in the model: study of origin, sex, and age.



# Do treatments help?



- Over 250 controlled studies in children
- Response rate ~ 70%
- 90 ~ 95% will respond to one of the stimulants
- Effect size = 0.8

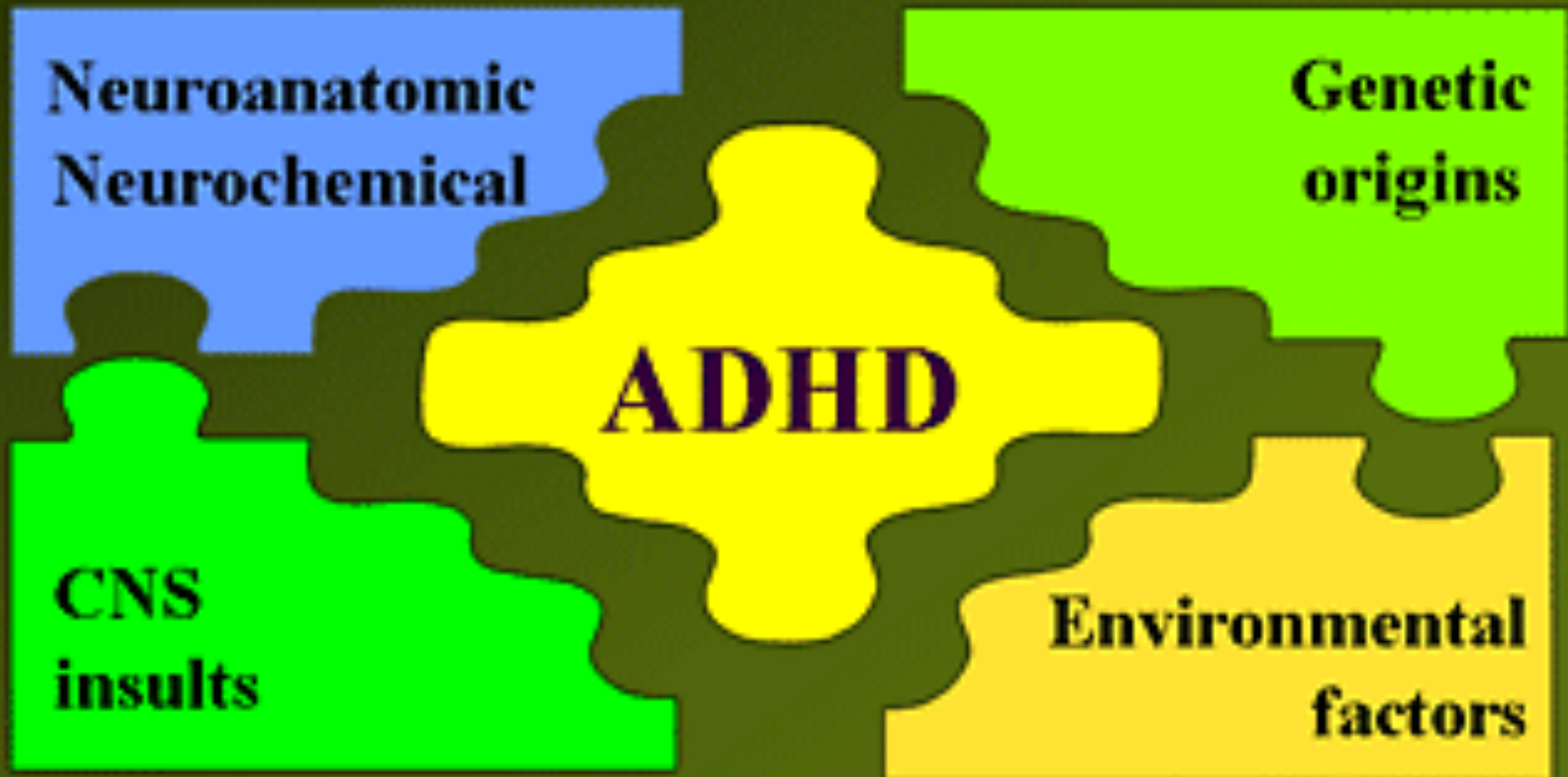
# Summary

- ADHD:
  - Can reliably be diagnosed
  - Confers risk for significant negative outcomes
  - Can be helped with treatment
- Should ADHD be treated? Is it a real disorder?

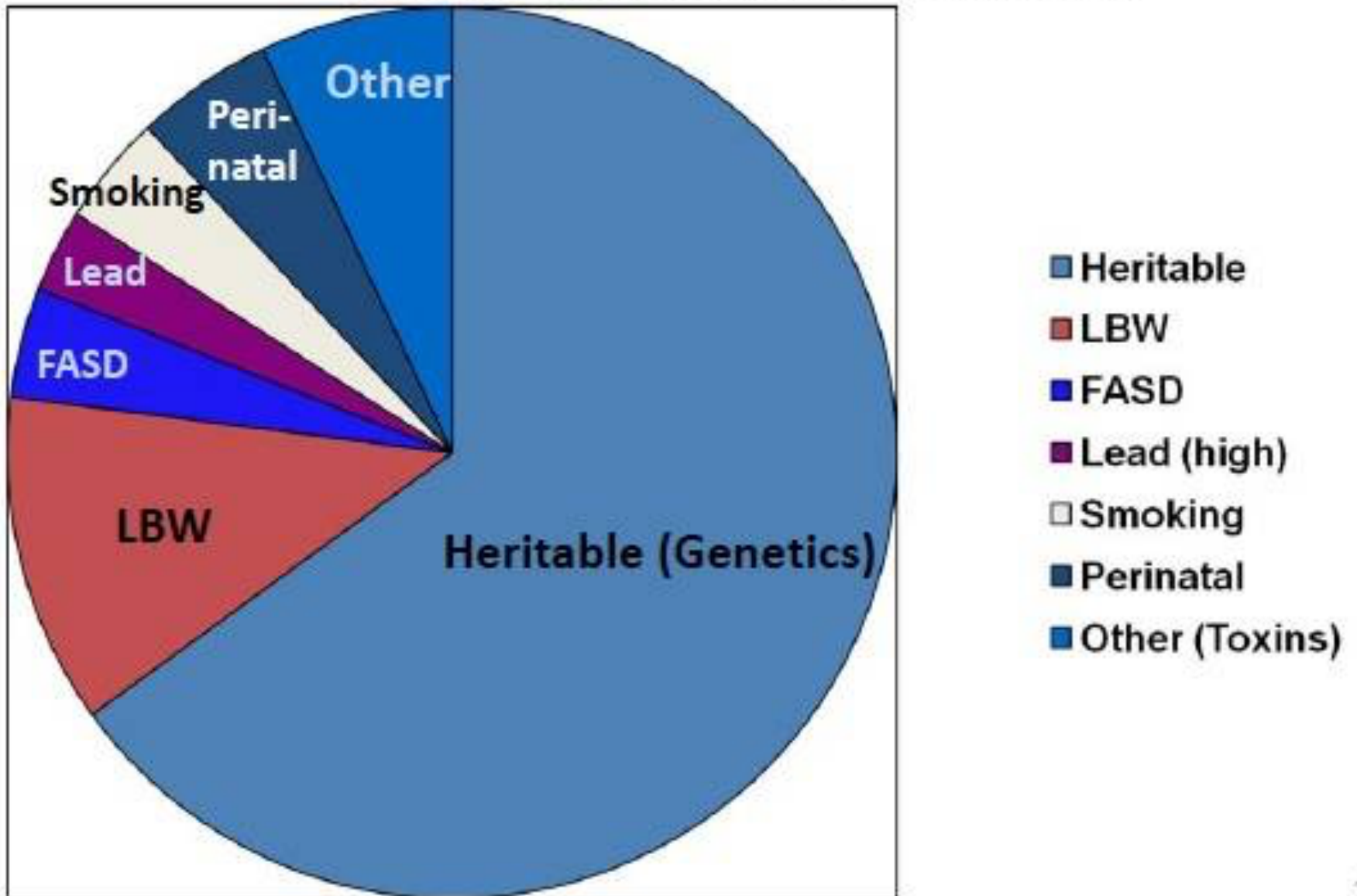
What causes ADHD?

# ADHD: Etiologies

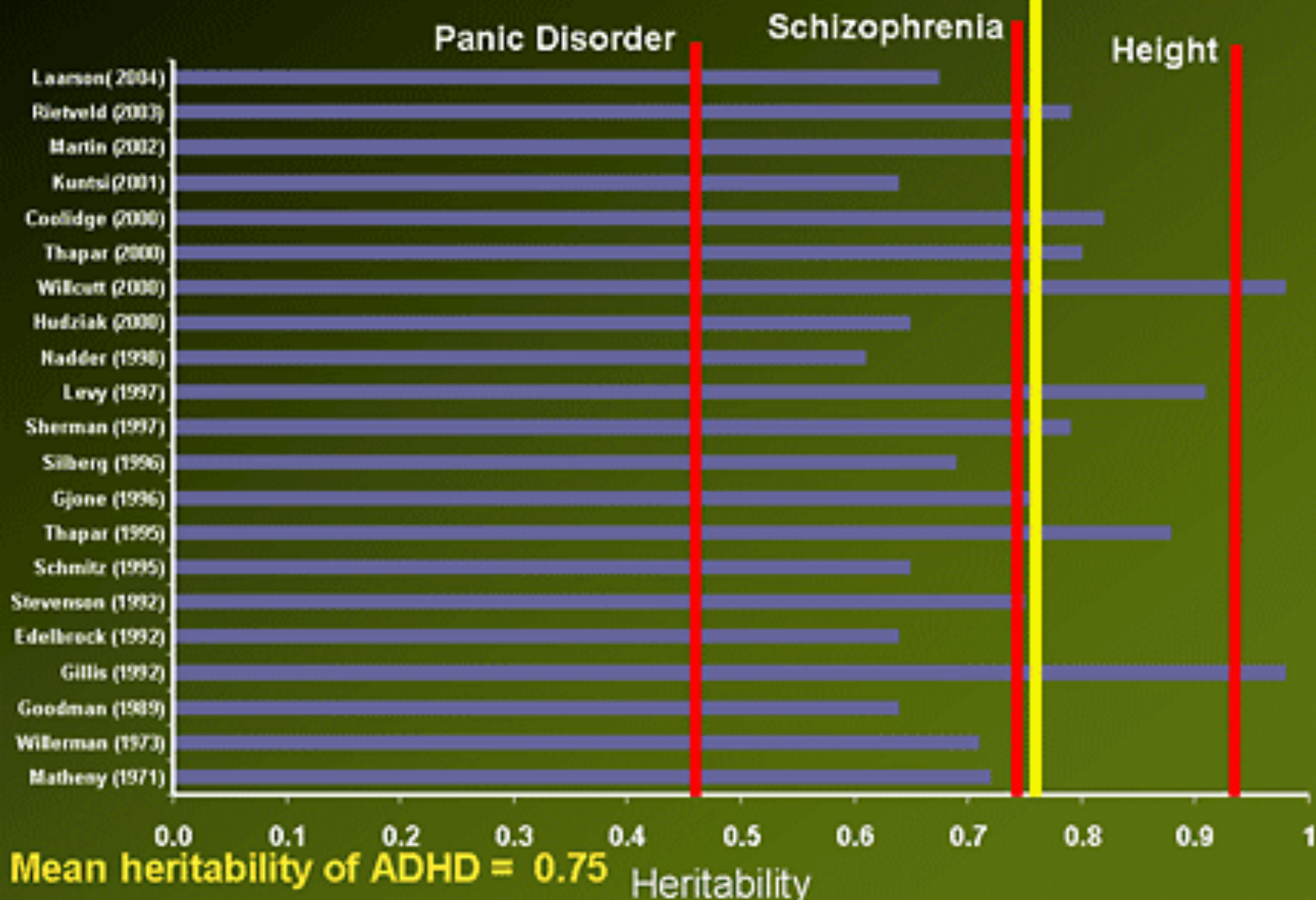
ADHD is a heterogeneous behavioral disorder with multiple possible etiologies.



# Causes of ADHD



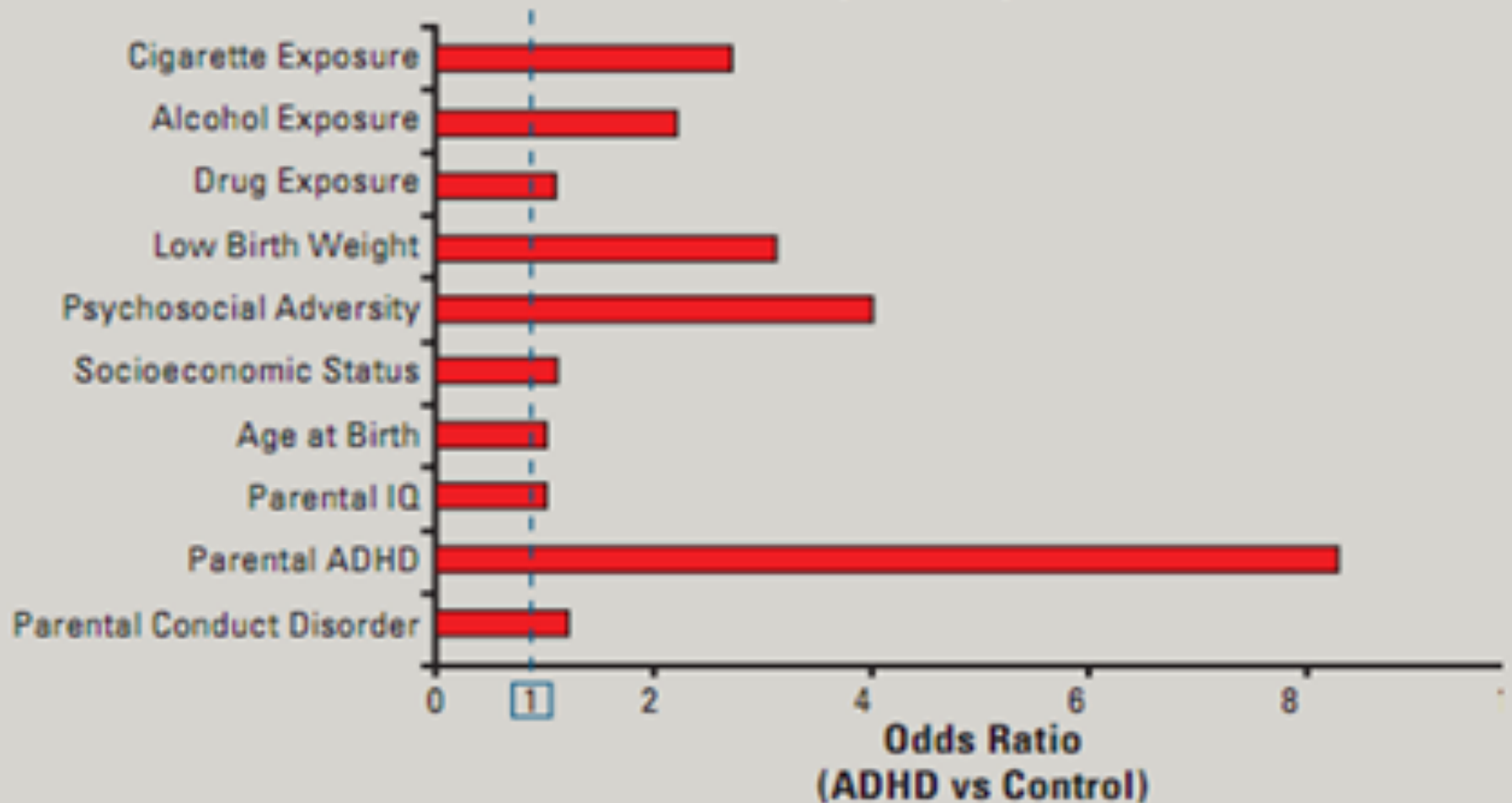
# Heritability of ADHD



# Relative Effects

## *Pre- and Perinatal Risk Factors for ADHD*

Results from Logistic Regression Model



# Parenting

- Misattributing cause & effect





# Neurobiological Models of ADHD

# SELF-REGULATORY CONTROL

The capacity to weigh prospects for pleasure in the present moment with potential, temporally more remote, adverse consequences of those actions —*i.e. self-regulation is needed to weigh cross-temporal contingencies of actions* —*as well as to monitor and update action plans on-line as they unfold*

# **ADHD is a Prototypical Disorder of Self-Regulatory Control**

- Distractibility
- Impulsivity

# Neurocognitive Models of Self-Regulation

- Top-down control
  - Impairments in inhibitory control
  - Impaired capacity to suppress responses elicited by stimuli (Barkley, 2007)
  - Problem with the “brakes”



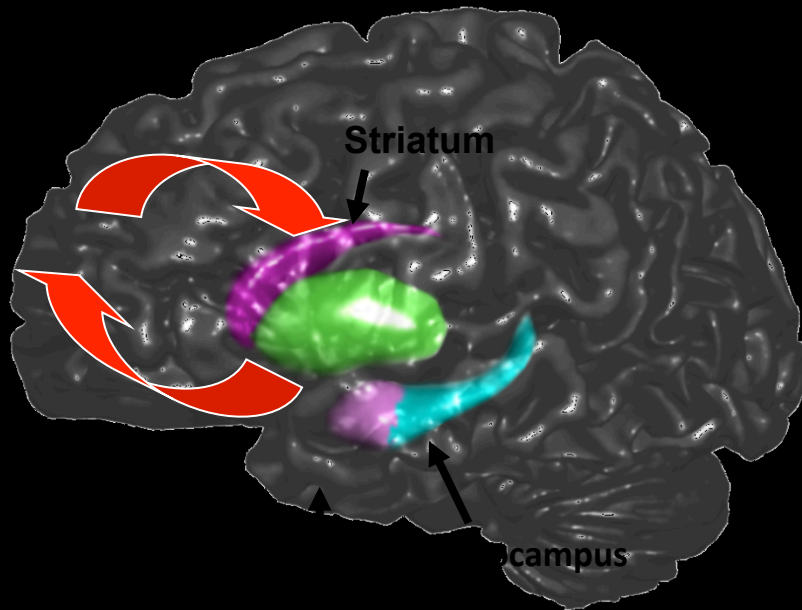
# Neurocognitive Models of Self-Regulation

- Bottom-up processing
  - Dysfunction in processing expected rewards
  - Unusually, strong responses to immediate vs. delayed rewards
  - Problem with the “gas”

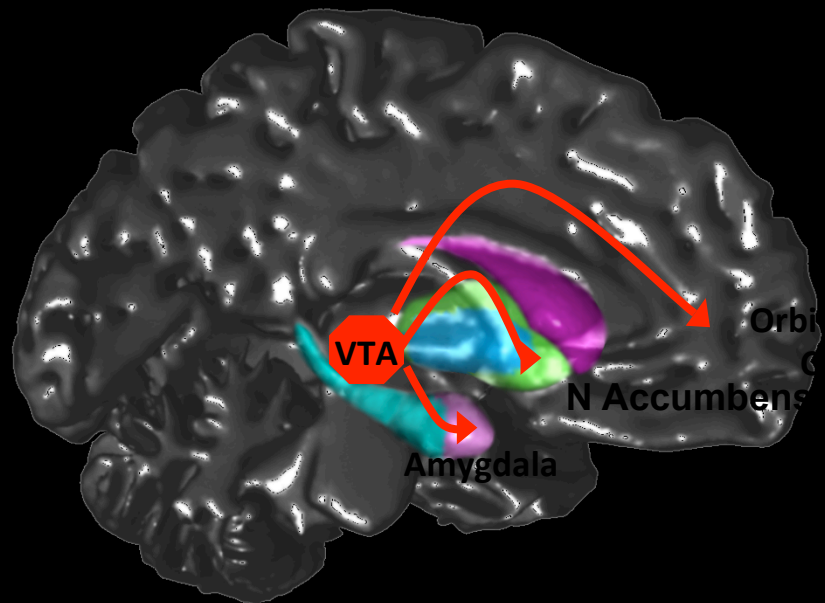


**Cortical-Subcortical Circuits  
Subserve Self-Regulatory Control**

**Frontostriatal  
Top-Down Control**



**Mesolimbic  
Bottom-Up Processing**



# Top Down Control

## Stroop Word-Color Interference

### Congruent

RED

BLUE

YELLOW

GREEN

### Incongruent

RED

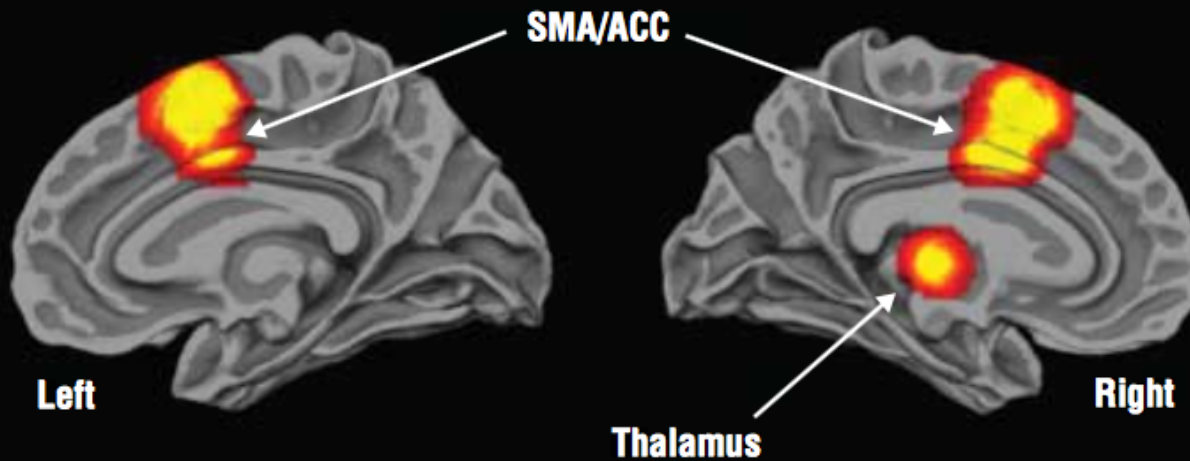
BLUE

YELLOW

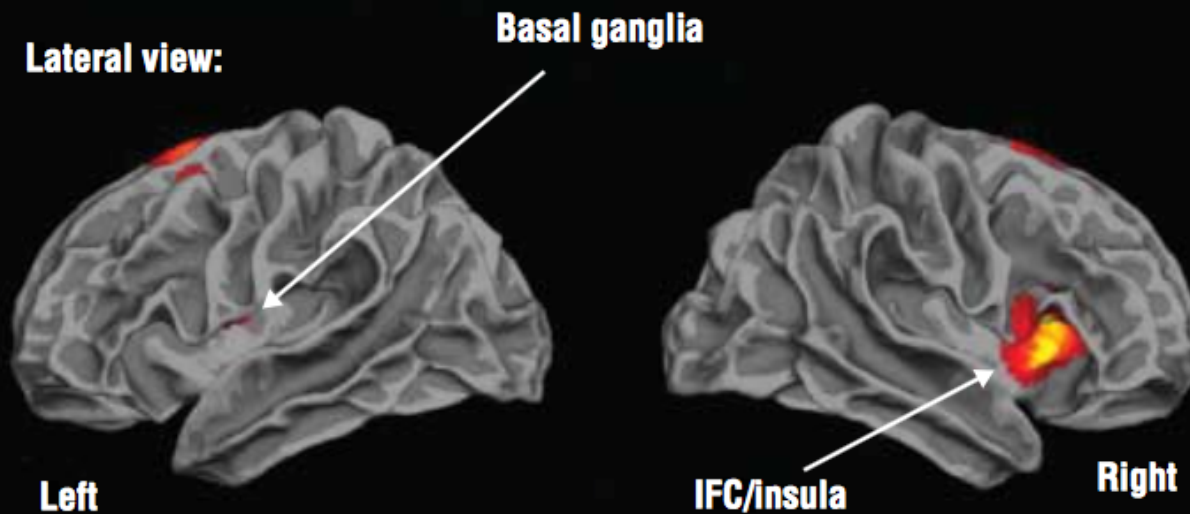
GREEN

# fMRI studies of top-down control

**Medial view:**



**Lateral view:**

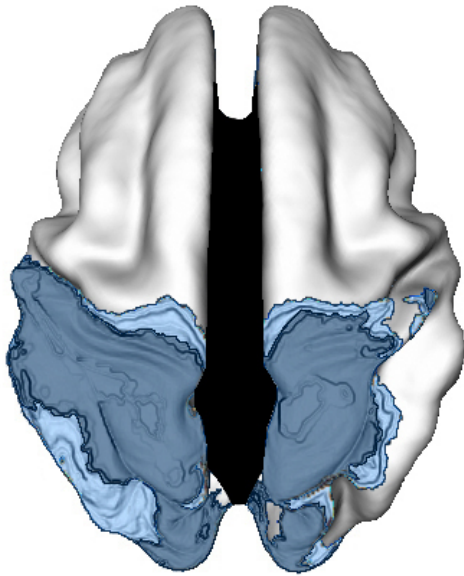




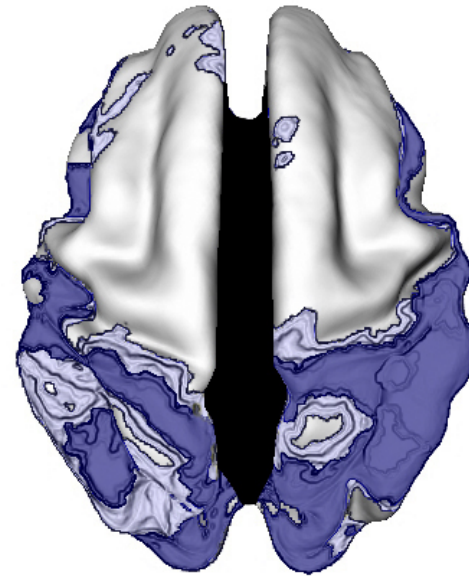
# Delay in Cortical Maturation in Children with ADHD

Shaw et al., *PNAS*, 2007

**AGE: 5**

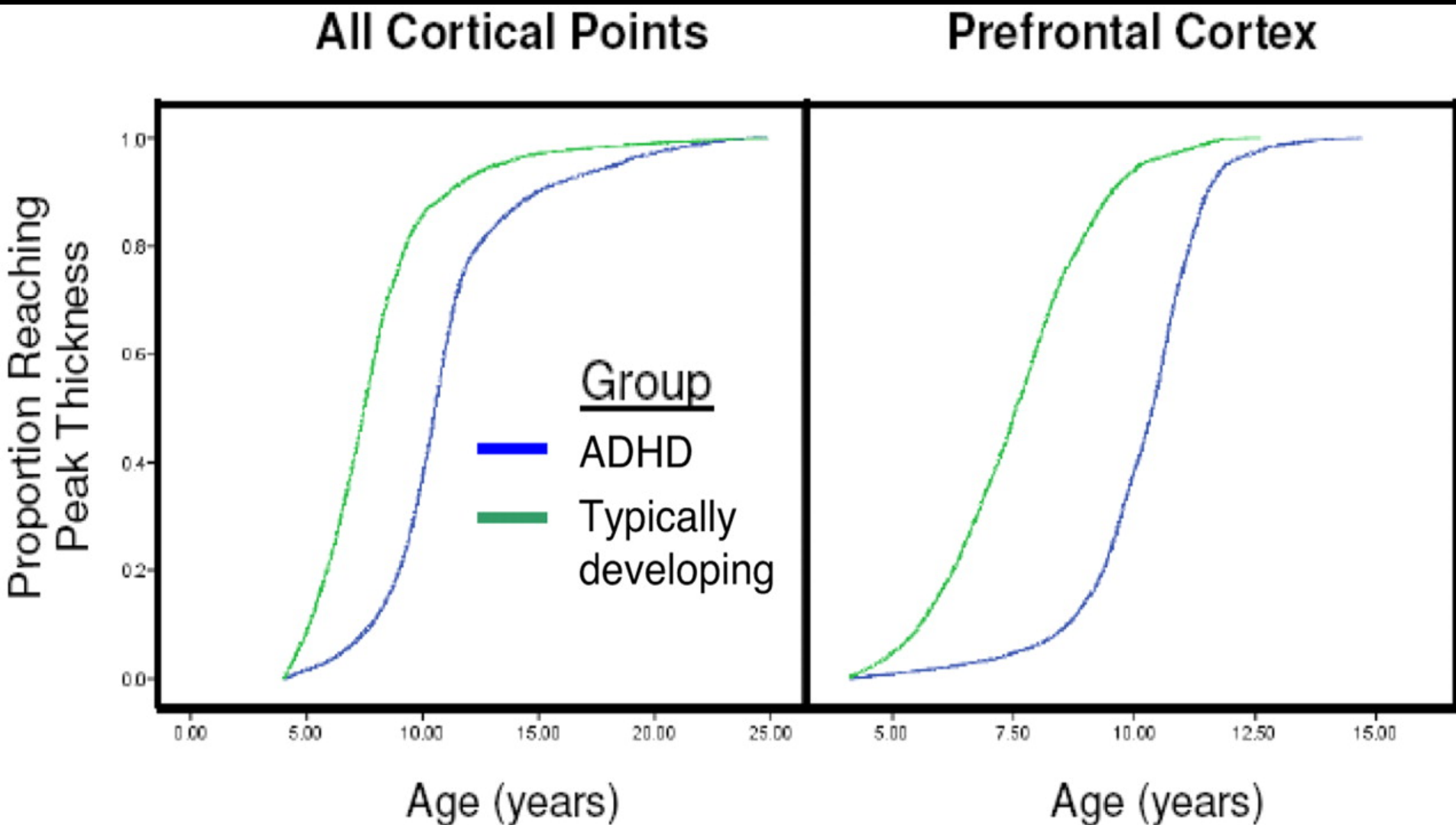


**ADHD**



**TYPICALLY DEVELOPING  
CONTROLS**

# Delay in Cortical Maturation in Children with ADHD



# Bottom-up Reward Processing

## Delayed Discounting

Which would you prefer?

\$10 today      \$11 in 6 months

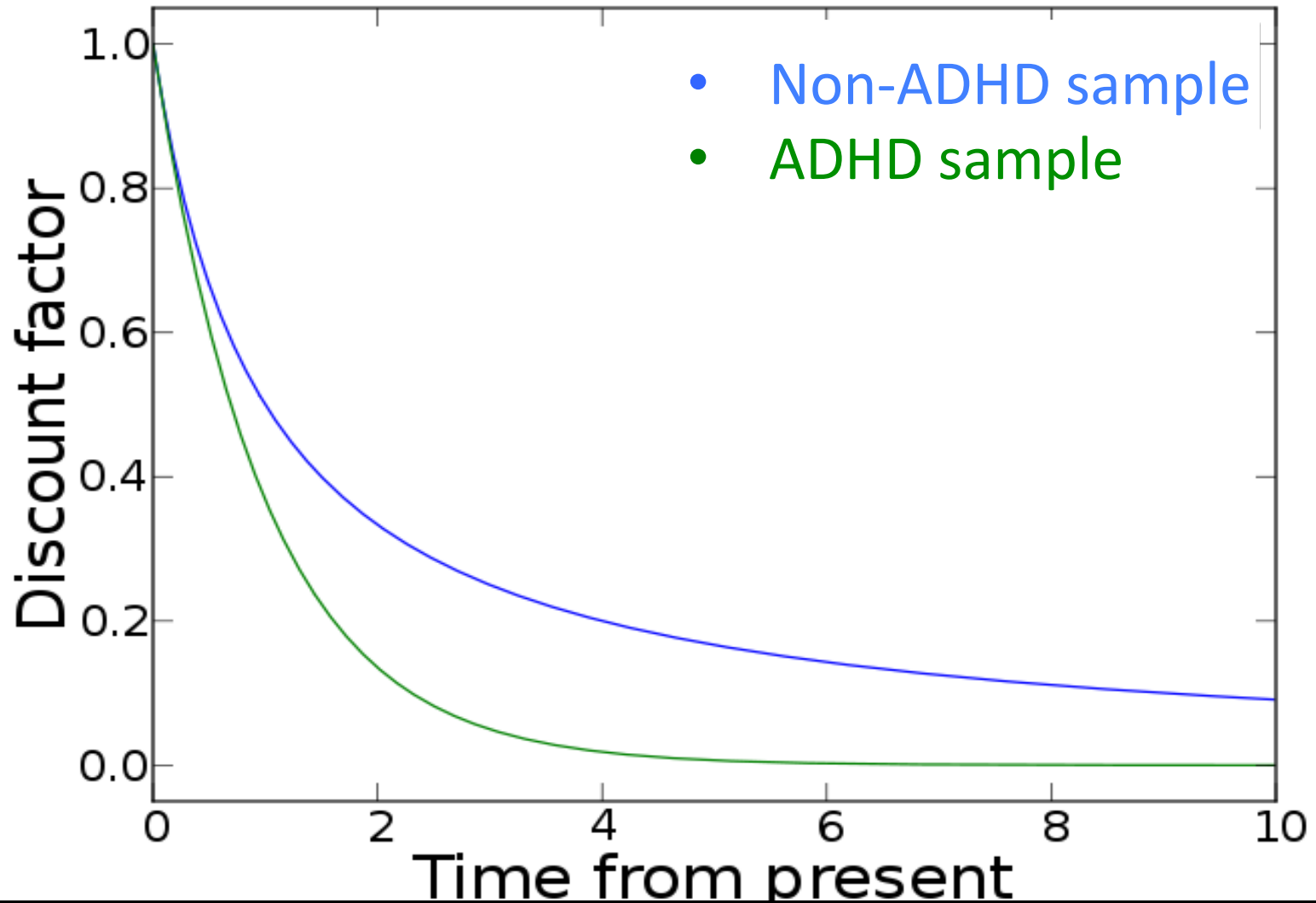
Which would you prefer?

\$10 in 1 month      \$11 in 6 months

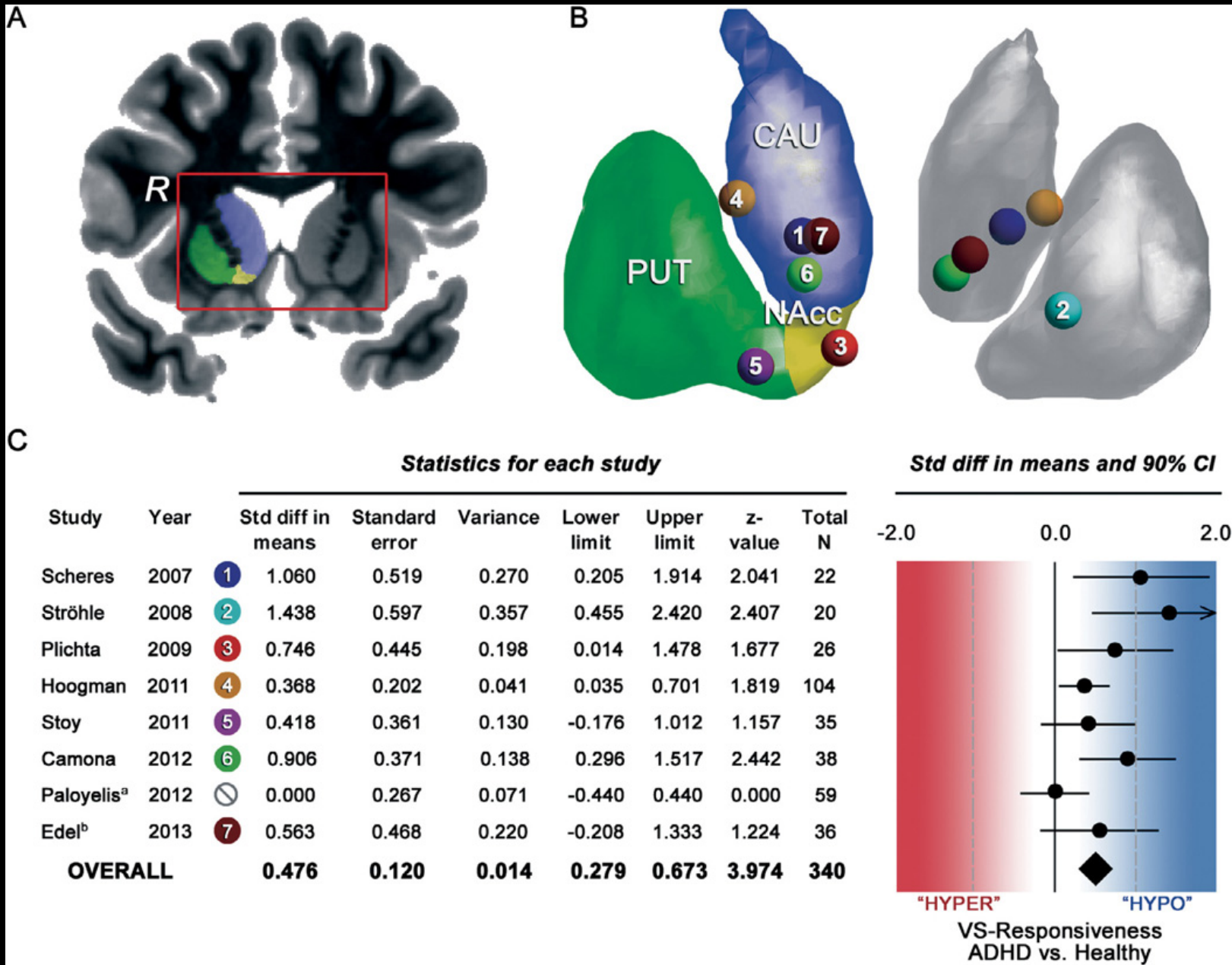
Which would you prefer?

\$15 in 2 weeks      \$25 in 1 year

# Steeper discounting curve



# fMRI studies of reward



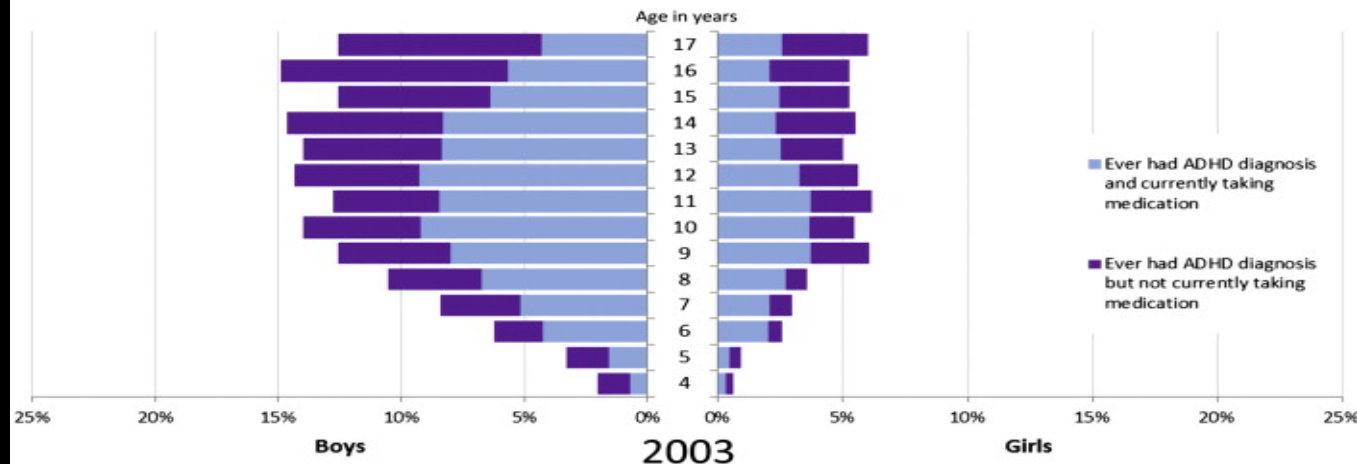
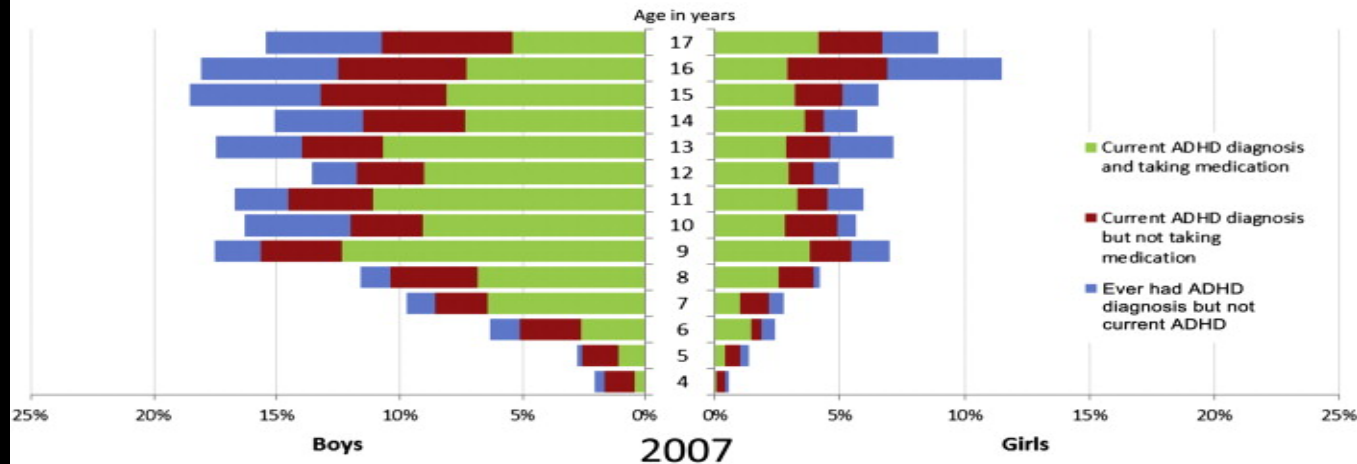
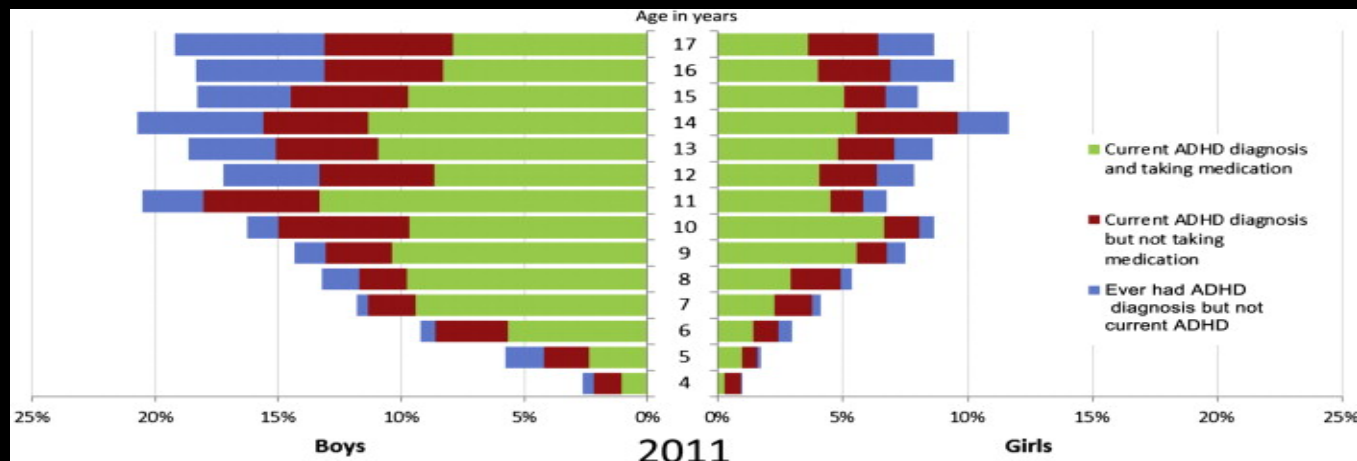
# Summary

- ADHD is biologically heterogeneous
- The development of top-down control systems may be delayed
- Bottom-up reward processing may over-value immediate rewards
- Disturbances in either system (or both) may lead to similar impulsive behaviors

# Controversies in ADHD

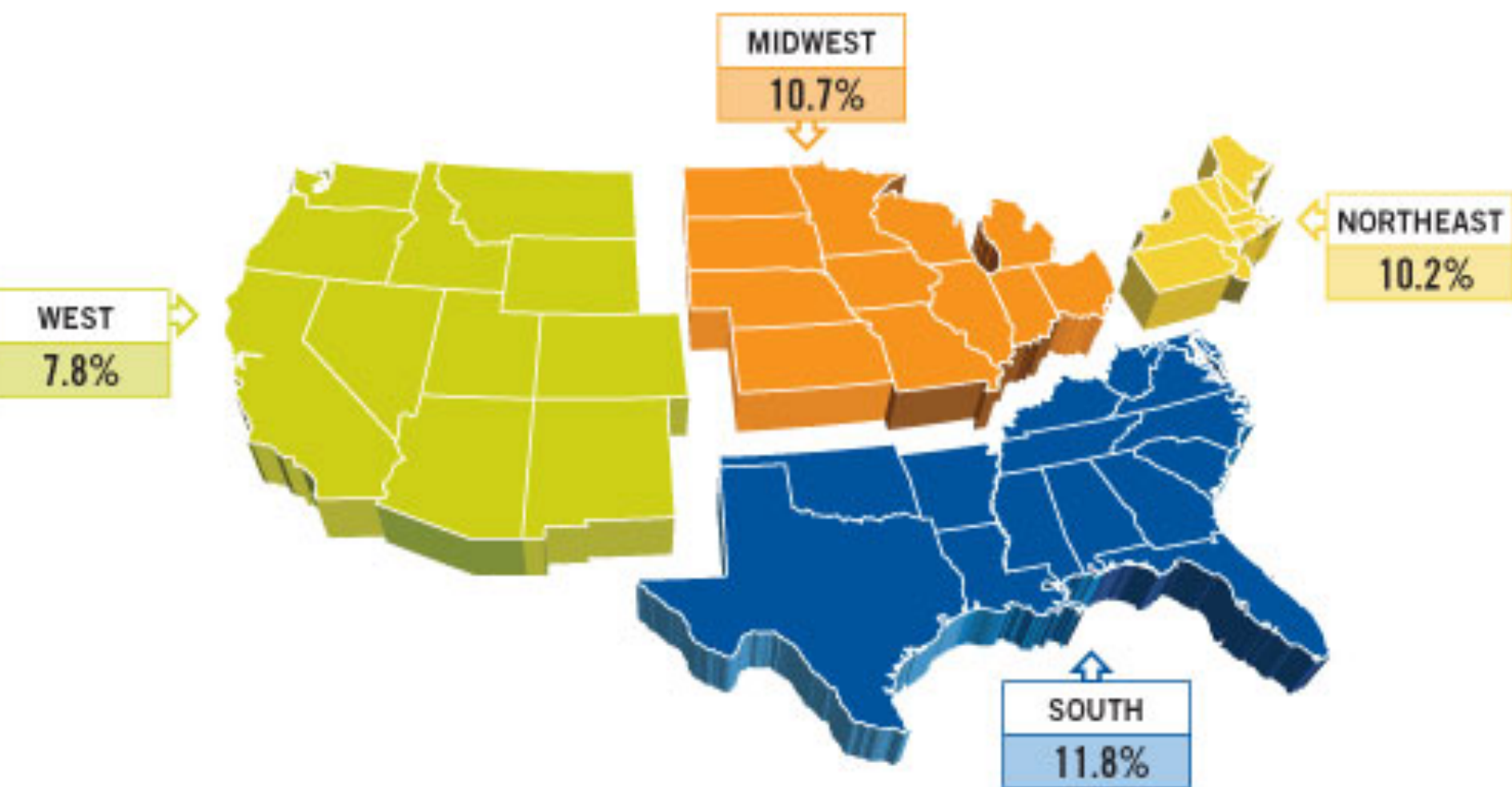
Why are diagnostic rates of ADHD increasing?

# 2013 CDC Report



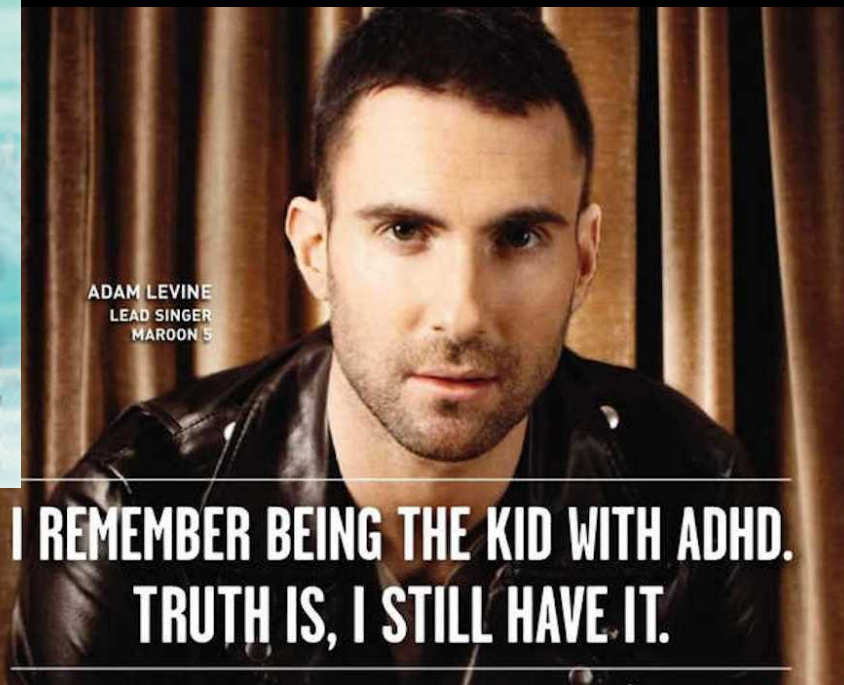


## Percentage of Children with ADHD Diagnosis, by U.S. Region (2010)



**SOURCE:** Express Scripts research based on additional data from the U.S. Census and the U.S. Centers for Disease Control.

# Reduced Stigma & Improved Access

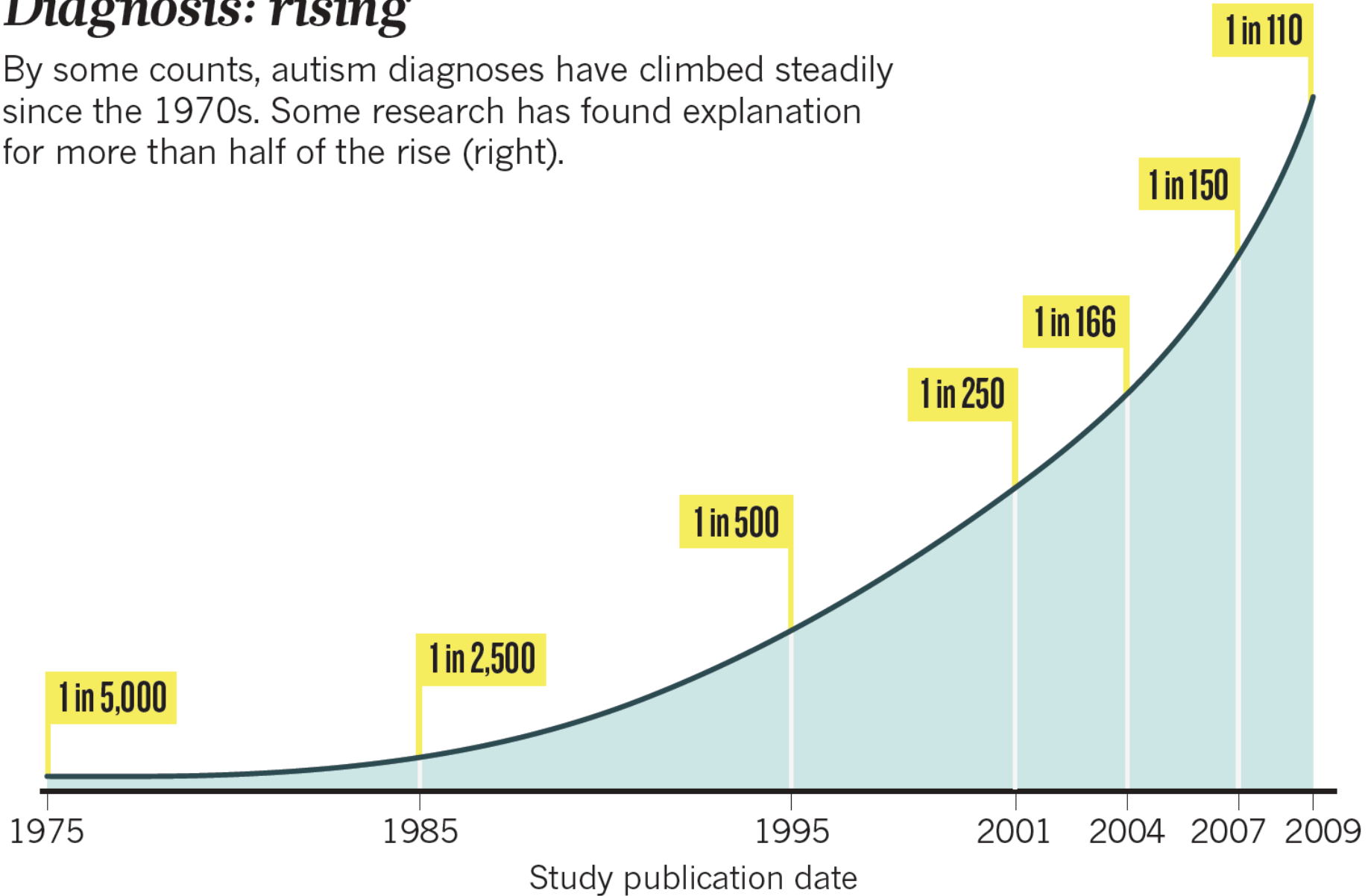


# Increasing Prevalence

- Perinatal complications
  - Preterm & low birth weight
- Environmental Toxins
- Media Effects (unlikely)

## *Diagnosis: rising*

By some counts, autism diagnoses have climbed steadily since the 1970s. Some research has found explanation for more than half of the rise (right).



# Diagnostic slide

- Diagnosis: 6 or 9 symptoms
  - What about 5 of 9? 4 of 9?
- “Ritalin is safe, safer than aspirin.”
  - Cognitive enhancement?

# Academic Standards

- Diagnostic rates differ from state to state
- Consequential accountability statutes
  - School funding contingent on the number of students who pass standardized tests
- States that enacted these measures early was ADHD diagnoses go up faster
- When schools are given financial incentives to improve student success rates, students are more likely to be diagnosed with ADHD

# Summary

- Increase in the diagnoses of ADHD
  - Progress
    - Less stigma
    - Better access & recognition
  - Increase in true prevalence
    - Toxic exposures, perinatal complications
  - Diagnostic slide
    - Treating sub-threshold, cognitive enhancement
    - School standards

# Acknowledgments



The Klingenstein Third Generation Foundation

The Edwin S. Webster Foundation

