

# New Understandings of ADHD:

## Executive Function Impairments

Thomas E. Brown, PhD

Associate Director,  
Yale Clinic for Attention and Related Disorders  
Department of Psychiatry  
Yale Medical School



# Thomas E. Brown, Ph.D.

## Disclosure Statement

---

### **Consultant:**

Eli Lilly, Shire

### **Speaker:**

Eli Lilly, Shire

### **Publication royalties:**

PsychCorp/Pearson, Yale University Press,  
American Psychiatric Press, Routledge, Wiley

### **Research Support:**

Eli Lilly, Shire

# Overview

---

1. What is the essential problem in ADHD?
2. Brain differences that underlie ADHD
3. Mystery of ADHD: Role of Emotions
4. Working memory “googles” emotions
5. ADHD WM problems bias emotions

# What is essential problem in ADHD?

- ◆ **Old:** behavior problems & not listening
- ◆ **New:** developmental impairment of the brain's management system: EF
- ◆ Aspects of brain's EF don't come online in usual time frame.
- ◆ And don't work consistently

# Executive Functions

- ◆ Wide range of **central control processes** of the brain
- ◆ **Connect, prioritize, and integrate** cognitive functions—moment by moment
- ◆ Like conductor of a symphony orchestra

# “Will you do it and, if so, how and when?”

(Lezak, 2004)

---

Will you do it?

Motivation/Activation

How will you do it?

Planning/Organizing

When?

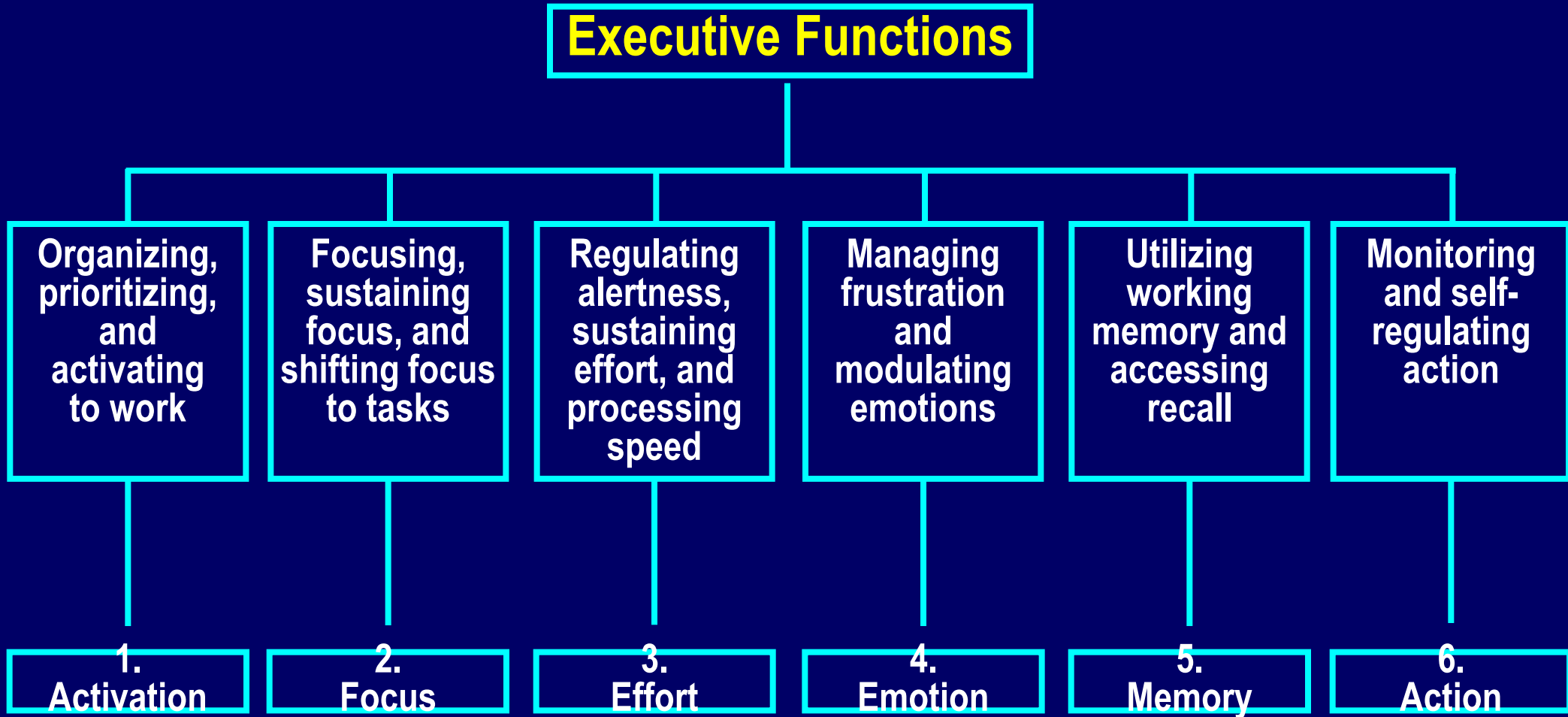
Timing/Remembering

# Characteristics of ADHD Symptoms

- ◆ **Dimensional, not “all-or-nothing”**
  - Everyone sometimes has some impairments in these functions;  
in ADHD: chronic, severe impairment
- ◆ **Situational variability: “If I’m interested”**
  - Most persons with ADHD have a few activities where ADHD impairments are absent

ADHD looks like willpower problem, but it isn't!

# Brown's Model of Executive Functions Impaired in ADHD





# 1. Organize, Prioritize, and Activate

---

- ◆ Difficulty organizing tasks, materials
- ◆ Difficulty estimating time, prioritizing tasks
- ◆ Trouble getting started on work

## 2. Focus, Shift, and Sustain Attention

---

- ◆ Loses focus when trying to listen or plan
- ◆ Easily distracted—internal/external
- ◆ Forgets what was read, needs to re-read

# 3. Regulating Alertness, Effort, and Processing Speed

- ◆ Difficulty regulating sleep and alertness
- ◆ Quickly loses interest in task, especially longer projects; doesn't sustain effort
- ◆ Difficult to complete task on time, especially in writing—"slow modem"

## 4. Manage Frustration, Modulate Emotion

(Not included in DSM-IV criteria)

- ◆ Emotions impact thoughts, actions too much
- ◆ Frustration, irritations, hurts, desires, worries, etc., experienced “like computer virus”
- ◆ “Can’t put it to the back of my mind”

## 5. Utilize Working Memory, Access Recall

- ◆ Difficulty holding one or several things “on line” while attending to other tasks
- ◆ Difficulty “remembering to remember”
- ◆ Inadequate “search engine” for activating stored memories, integrating these with current info to guide current thoughts and actions

T.Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)

# 6. Monitor and Self-Regulate Action

(Not just hyperactive/impulsive behavior)

- ◆ Difficulty controlling actions, slowing self and/or speeding up as needed for tasks
- ◆ Doesn't size up ongoing situations carefully
- ◆ Hard to monitor and modify own actions to fit situation/aims

# Executive Functions are complex and operate in dynamic, integrated ways

---

For example, EF of “focus”

- Does not mean
  - as in holding the camera still to take a photo of an unmoving object
- Does mean
  - as in focusing on the task of driving a car

# Executive Functions: Development and Demands

- ◆ EF capacity develops through childhood, into adolescence, and beyond; **it is not fully present in early childhood**
- ◆ Environmental **demands for EF increase with age**, from preschool through adulthood
- ◆ EF impairments **often are not noticeable by age 12 yrs!**



# When Are ADHD Impairments Noticeable?

- ◆ Some are obvious very early and are noticeable in **preschool years**
- ◆ Some are not noticeable until middle elementary or **junior high**
- ◆ Some are not apparent until child leaves home to go to **college or later**

# Sean

## 18 years old-college freshman

---

- ◆ On meds for ADHD 8<sup>th</sup> grade thru 12<sup>th</sup>
- ◆ Honor student in competitive high school
- ◆ Varsity athlete, shy in social activities
- ◆ No meds in college; fell behind early
- ◆ Excessive alcohol, marijuana, computer
- ◆ Missed many classes and assignments  
“Just their being around...”

## 2. Brain differences underlying ADHD (temporary and/or longer term)

---

1. Delay in unfolding of **brain development** that supports executive functions
2. Impaired white matter **connections between brain regions**
3. Impaired control of **oscillations that coordinate** brain region communications
4. Inadequate **release/reloading of transmitter chemicals** at synapses

# Cortex Maturation in ADHD vs NC

- ◆ MRI studies of **40K cortex sites** in 223 youths with ADHD vs matched controls
- ◆ Brain maturation was **delayed ~3yrs in specific regions** in ADHD youths vs NC
- ◆ Frontal areas of cortex **slower in ADHD**
- ◆ **Medial PFC** developed **lagged 5 yrs**

(Shaw, et al, PNAS, Nov, 2007)

# Is ADHD Brain Wired Differently?

- ◆ New model shifts focus from regional brain abnormalities to dysfunction in distributed network organization.
- ◆ DTI shows converging evidence for white matter pathology & disrupted anatomical connectivity in ADHD

(Konrad & Eickhoff, Human Brain Mapping, 2010)

# Structural & Functional Connectivity in ADHD

- ◆ fMRI and DTI (diffusion tensor imaging) show connectivity between brain regions is impaired in ADHD
- ◆ Shown in default mode network at rest and in failure to attenuate DMN during active task performance
- ◆ Overall white matter volume is reduced in children & adolescents with ADHD

Konrad & Eickhoff (2010); Nagel, Bathula, Herting, et al, (2011)

# Chemical Dynamics of Brain also contribute to impairments of ADHD

- ◆ **Not** due to overall “imbalance of chemicals” (not too much/too little salt in soup)
- ◆ But to **inadequate release and/or reloading** of transmitter chemicals in countless **infinitesimal network junctions**
- ◆ **Except for** “messages” re priority interests or fear of imminent unpleasantness

# A Chemical Problem

---

- ◆ ADHD is fundamentally a chemical problem
- ◆ Most effective treatment is to change the chemistry with medication
- ◆ Unless the problematic chemistry is changed, other interventions are not likely to be very effective



# In the Human Brain

---

- ◆ 100 billion neurons
- ◆ each one linked to >1000 others
- ◆ in complex sub-systems
- ◆ that have to “talk to each other”
- ◆ using low voltage electrical impulses
- ◆ that have to jump across gaps
- ◆ so fast that 12 can cross in 1/1000 sec.

# The Jungle





Neuron

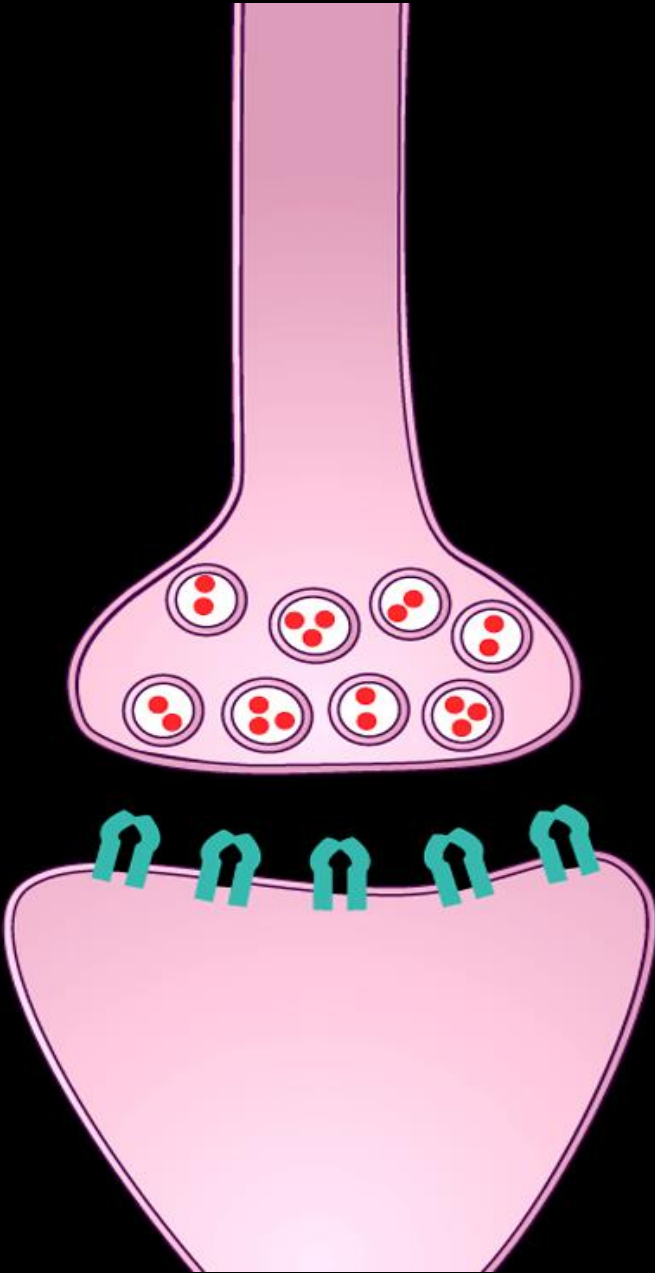
Synapse

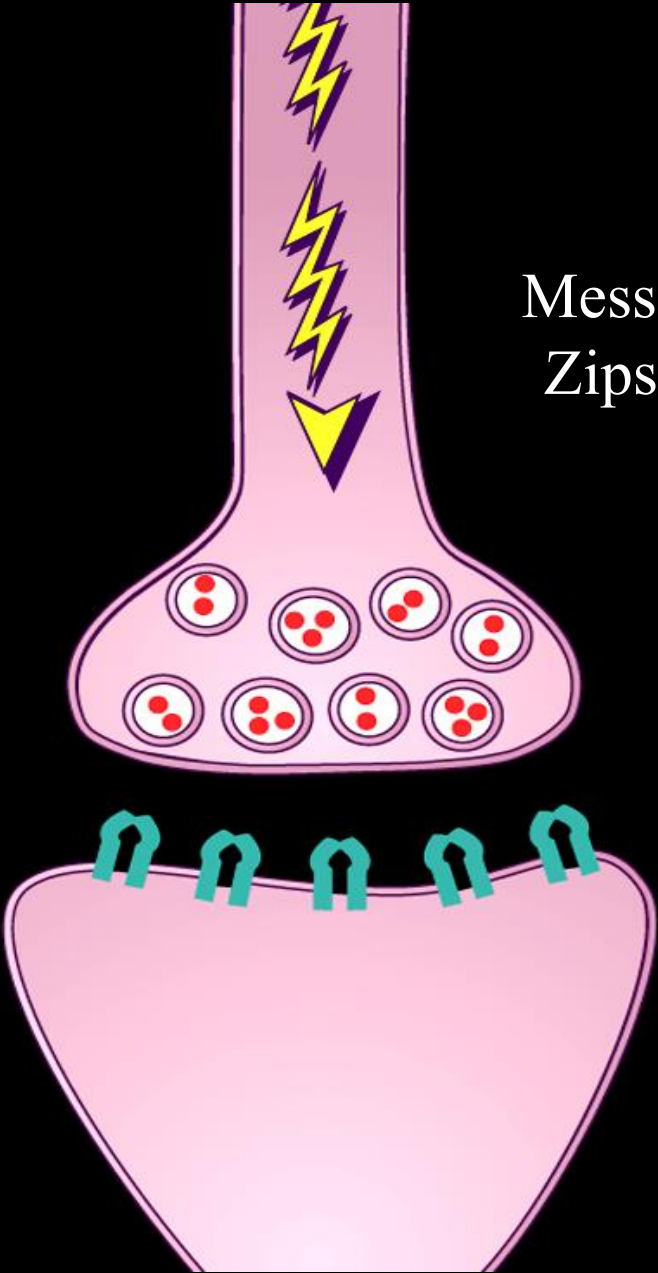


Intertwined  
neurons

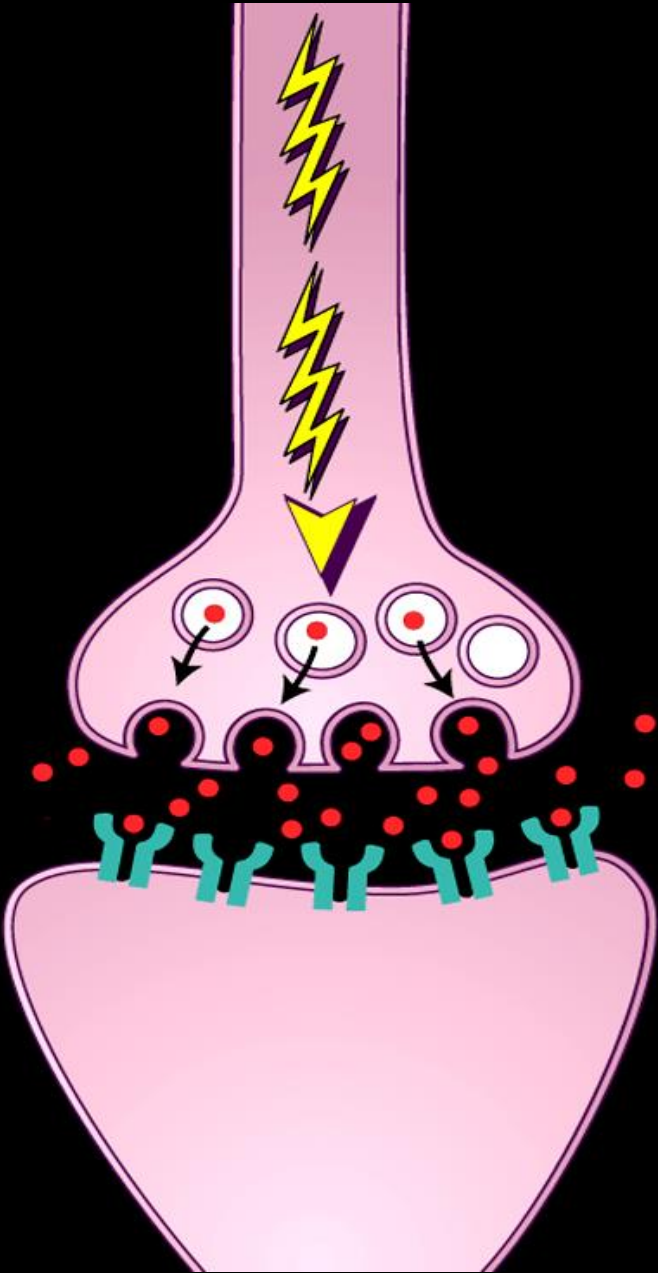
# Chemicals Jump the Gaps

- ◆ Inside brain >50 different chemicals are continuously made
- ◆ every neuron system uses 1 of them
- ◆ stored in little vesicles near tip of neuron
- ◆ when electrical impulse comes, mini-dots of that chemical are released,
- ◆ cross the gap, fire next neuron, then reload in fractions of a second

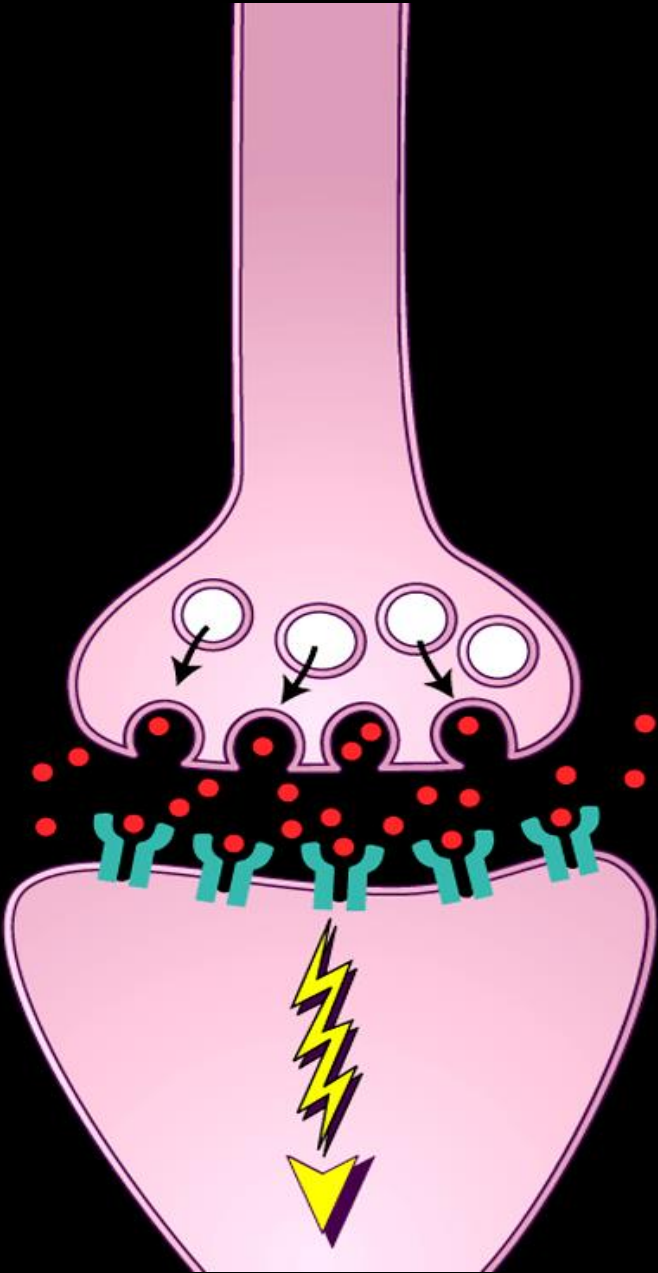




Message  
Zips in

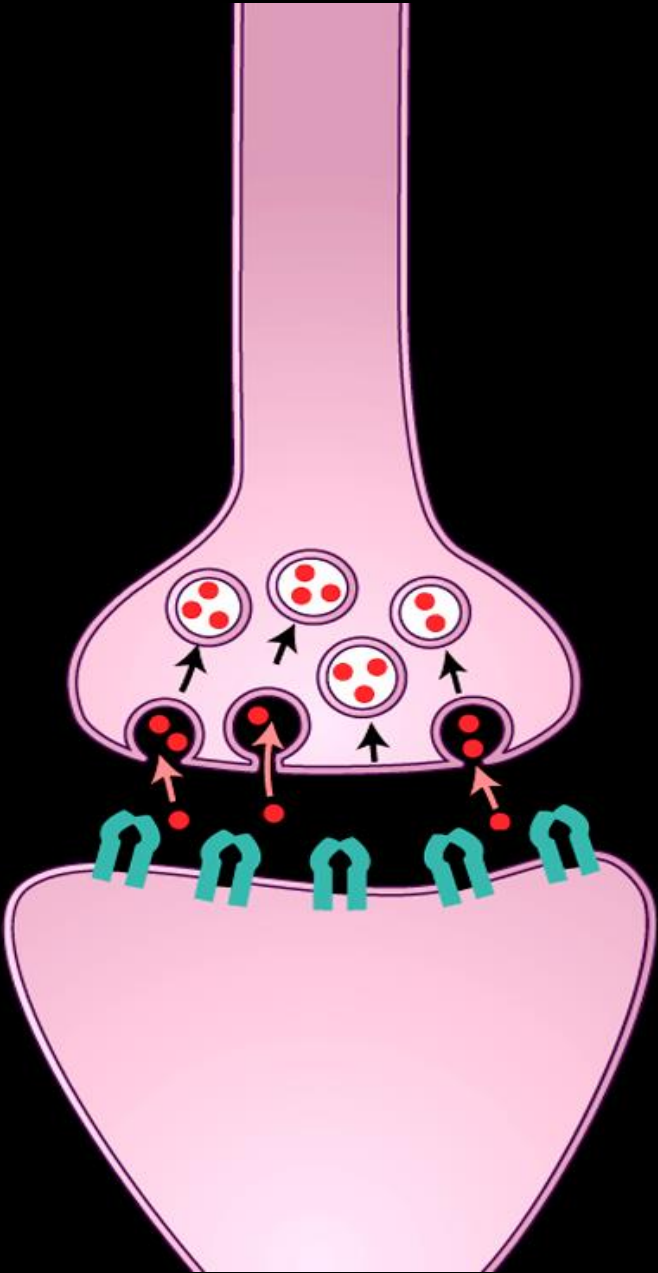


Releasing  
transmitter

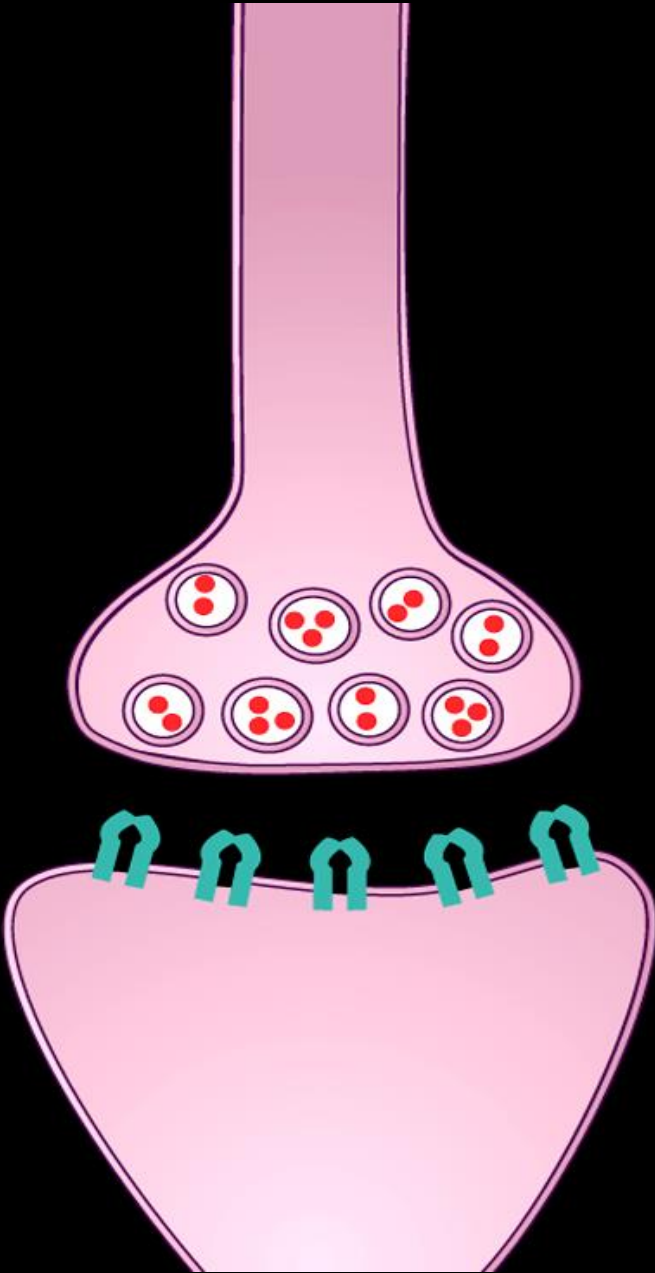


Message  
Zips on





Reloading  
transmitter

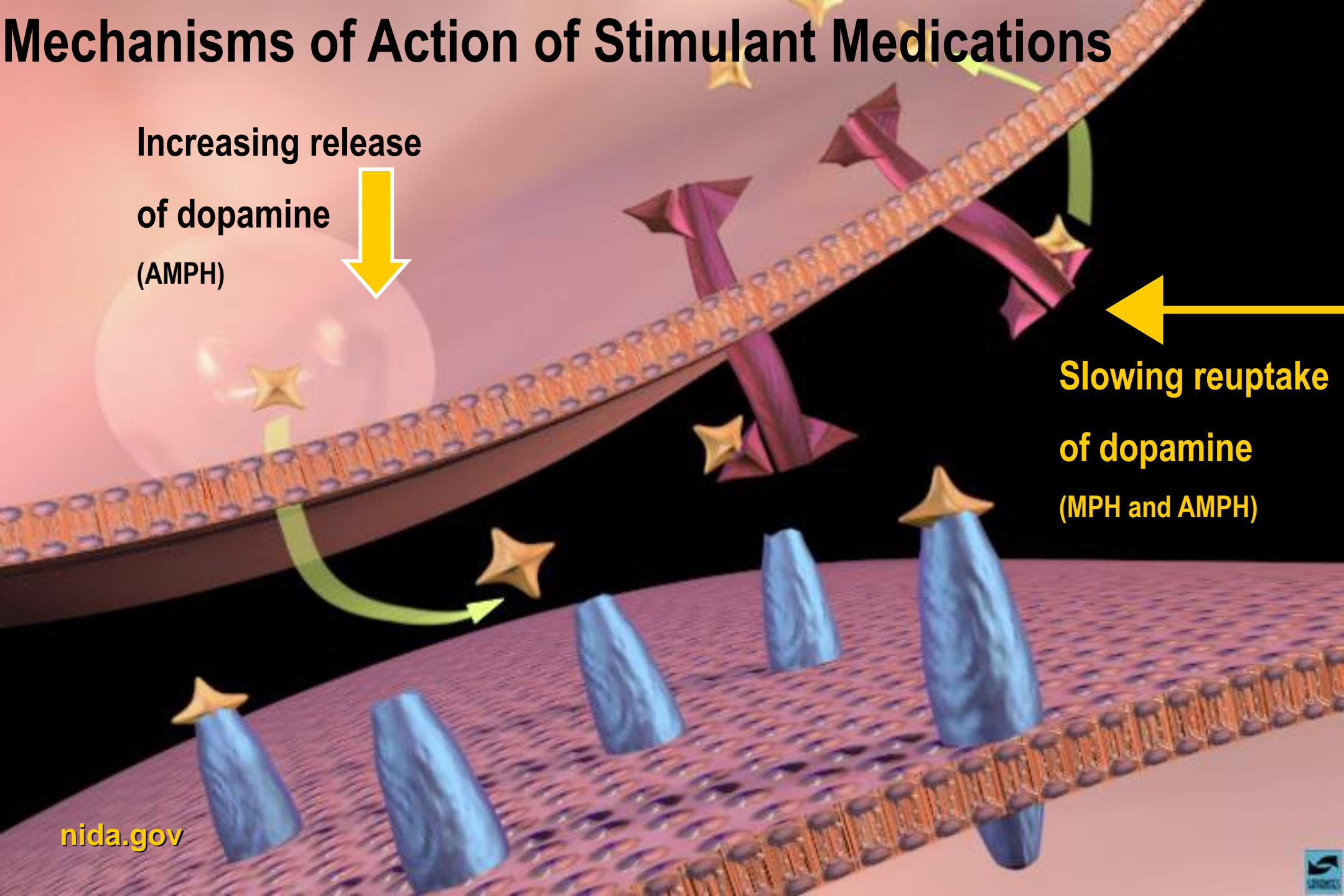


# Mechanisms of Action of Stimulant Medications

Increasing release  
of dopamine  
(AMPH)



Slowing reuptake  
of dopamine  
(MPH and AMPH)



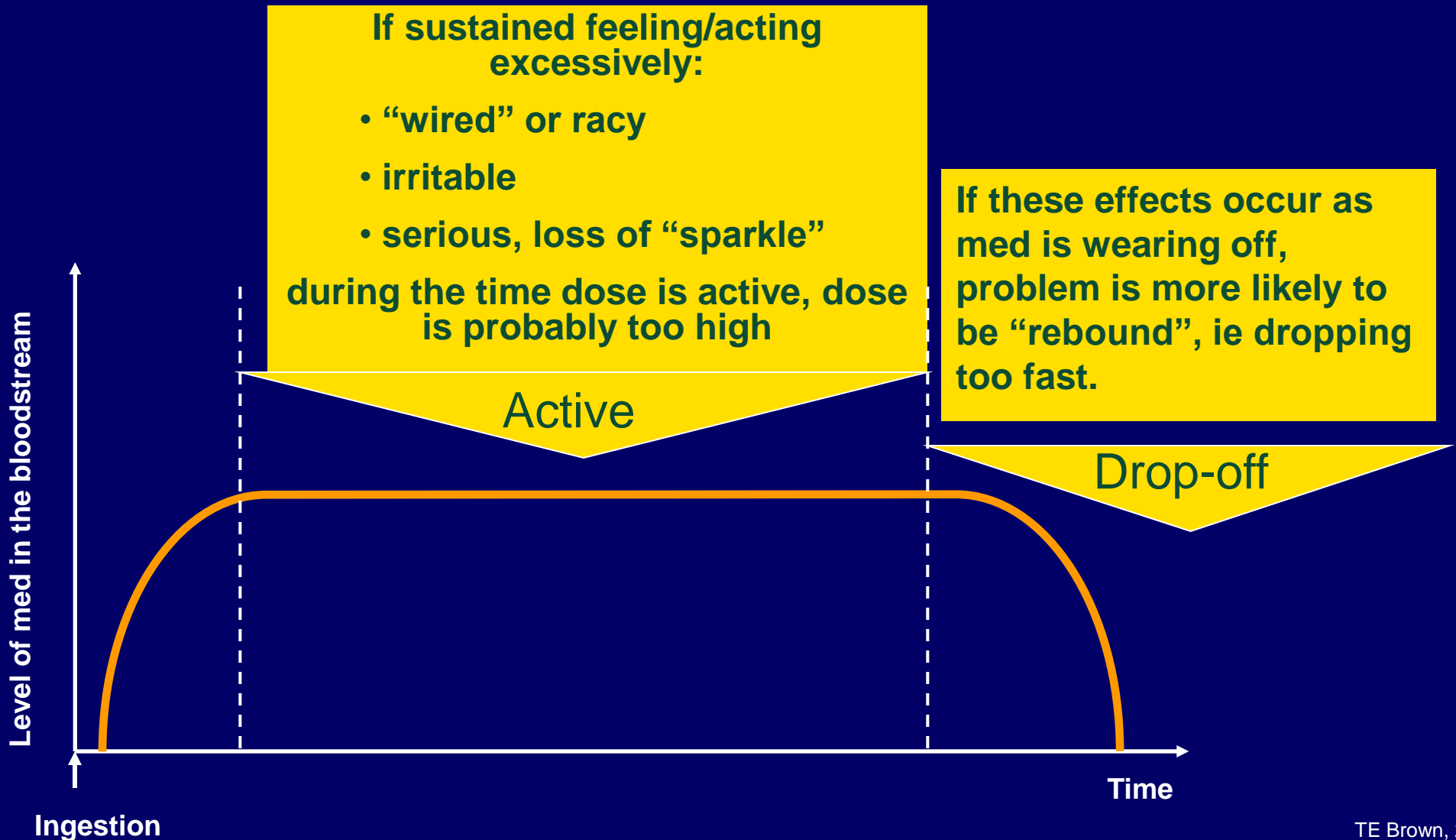
# How do ADHD Impairments of EF Usually Respond to Medication?

- ◆ This wide range of cognitive impairments **responds to medication treatment in 70-90%** of cases in children, adolescents and adults
- ◆ Symptom improvement varies from modest to very dramatic
- ◆ Adverse effects are usually transient, not significant

# Set Realistic Expectations for Tx Medications **do not cure ADHD!**

- ◆ Cannot realistically promise “there will be **no problematic effects**” for any medication for any disorder.
- ◆ Cannot realistically promise that medication will effectively treat ADHD.  
~**80% success rate** w/stims
- ◆ Close collaboration with prescriber is essential for “**fine-tuning**”

# Time Frames and Rebound



# Misuse of ADHD Medications

---

- ◆ Many students take meds without scrip
- ◆ May be helpful, but can cause trouble
- ◆ If you have prescribed meds, protect them from theft
- ◆ Protect yourself from “borrowers”

# Key Points

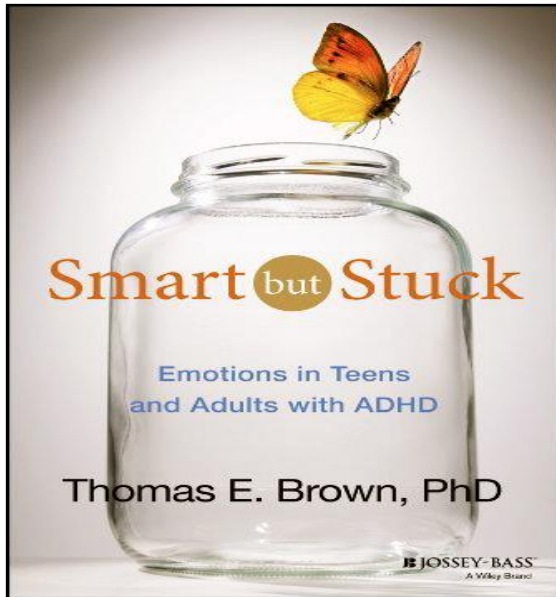
---

1. Essential problem in ADHD is developmental **impairment of EF**
2. Those with ADHD **usually can focus well for some tasks**
3. **Inherited brain differences** underlie ADHD.
4. **Tailored medication** treatment helps 80%



# Books by Thomas E. Brown, Ph.D.

([www.DrThomasEBrown.com](http://www.DrThomasEBrown.com))



- “**Smart but Stuck: Emotions in Teens and Adults with ADHD**” – 2014
- “**A New Understanding of ADHD in Children and Adults: Executive Function Impairments**” – 2013
- “**ADHD Comorbidities: Handbook for ADHD Complications in Children and Adults**” – 2009
- “**Attention Deficit Disorder: The Unfocused Mind in Children and Adults**” - 2005

