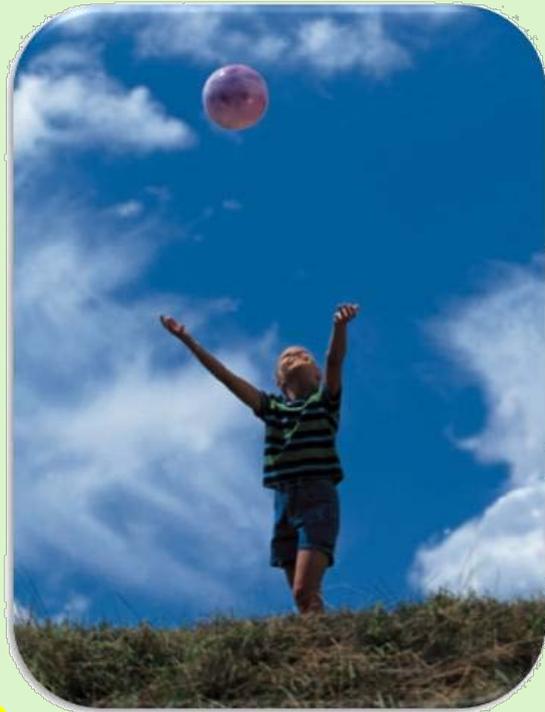




Ohio Chapter



# Toxic Stress and the Science of Early Brain and Child Development

**August 28, 2013**





# Building Bridges Series

## Building Bridges Part I; Toxic Stress and the Science of Early Brain and Child Development

– Sponsored by:

- Healthy Child Care America
- *Building Bridges Among Health & Early Childhood Systems*

## Building Bridges Part II; Purposeful Parenting and the Primary Prevention of Toxic Stress

– Sponsored by:

- Ohio Chapter, American Academy of Pediatrics
- Webinar Date: October 23, 2013
- Contact [hsouthworth@ohioaap.org](mailto:hsouthworth@ohioaap.org) for registration information





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LEARNING COLLABORATIVE

## **BUILDING BRIDGES Part I:**

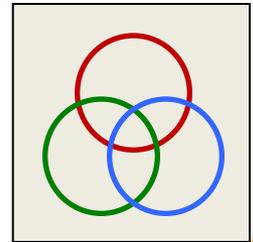
# **Toxic Stress and the Science of Early Brain and Child Development**

**Andrew Garner, MD, PhD, FAAP**

**Chair, American Academy of Pediatrics Early Brain and Child  
Development Leadership Workgroup**

# 3 Objectives For Part 1:

- Provide a **general overview** of advances in developmental science
- Present an organizing, integrated, **ecobiodevelopmental** framework
- Define **toxic stress** and discuss its potentially **lifelong consequences**



# *Critical Concept #1*

**Childhood Adversity has  
Lifelong Consequences.**

Significant adversity in childhood is  
strongly **associated** with  
unhealthy **lifestyles** and  
poor **health** decades later.

# ACE Categories



	Women (n=9,367)	Men (n=7,970)	Total (17,337)
<b>Abuse</b>			
– Emotional	13.1%	7.6%	10.6%
– Physical	27.0%	29.9%	28.3% <b>1:4!</b>
– Sexual	24.7%	16.0%	20.7% ←
<b>Household Dysfunction</b>			
– Mother Treated Violently	13.7%	11.5%	12.7%
– Household Substance Abuse	29.5%	23.8%	26.9% <b>1:4!</b>
– Household Mental Illness	23.3%	14.8%	19.4% ←
– Parental Separation or Divorce	24.5%	21.8%	23.3% ←
– Incarcerated Household Member	5.2%	4.1%	4.7%
<b>Neglect*</b>			
– Emotional	16.7%	12.4%	14.8%
– Physical	9.2%	10.7%	9.9%

\* Wave 2 data only (n=8,667)

Data from:

[www.cdc.gov/nccdphp/ace/demographics](http://www.cdc.gov/nccdphp/ace/demographics)

# ACE Scores



**Number of categories of adverse childhood experiences are summed ...**

<i>ACE score</i>	<i>Prevalence</i>
0	36%
1	26%
2	16%
3	9.5%
4 or more	12.5%

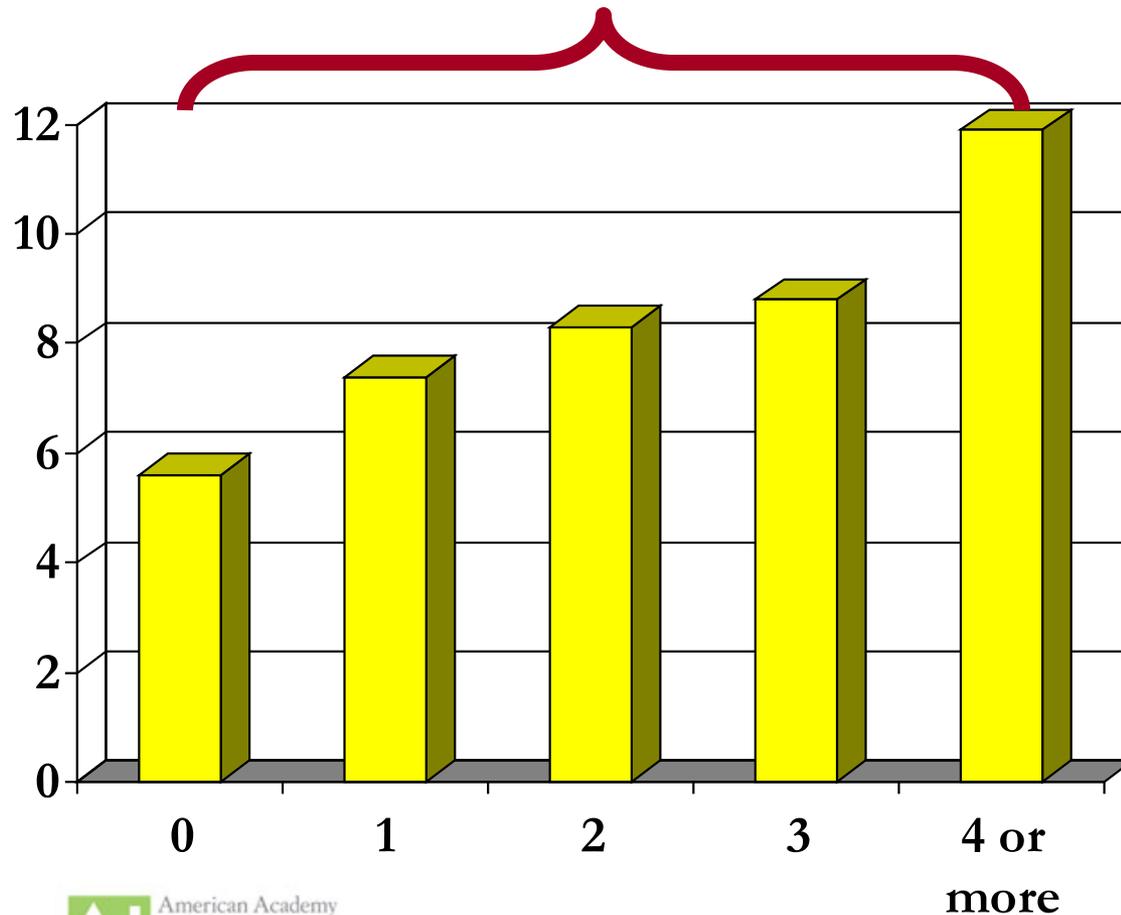


- ***More than half* (almost 2/3) have at least one ACE**
- ***1 in 8* have 4 or more ACEs**
- **Average pediatrician will see **2-4** children with an ACE score of **4 or more each day****

# ACEs and Obesity

AOR = 1.9 (1.6-2.2)

Prevalence  
(% with BMI >35)



ACE Score

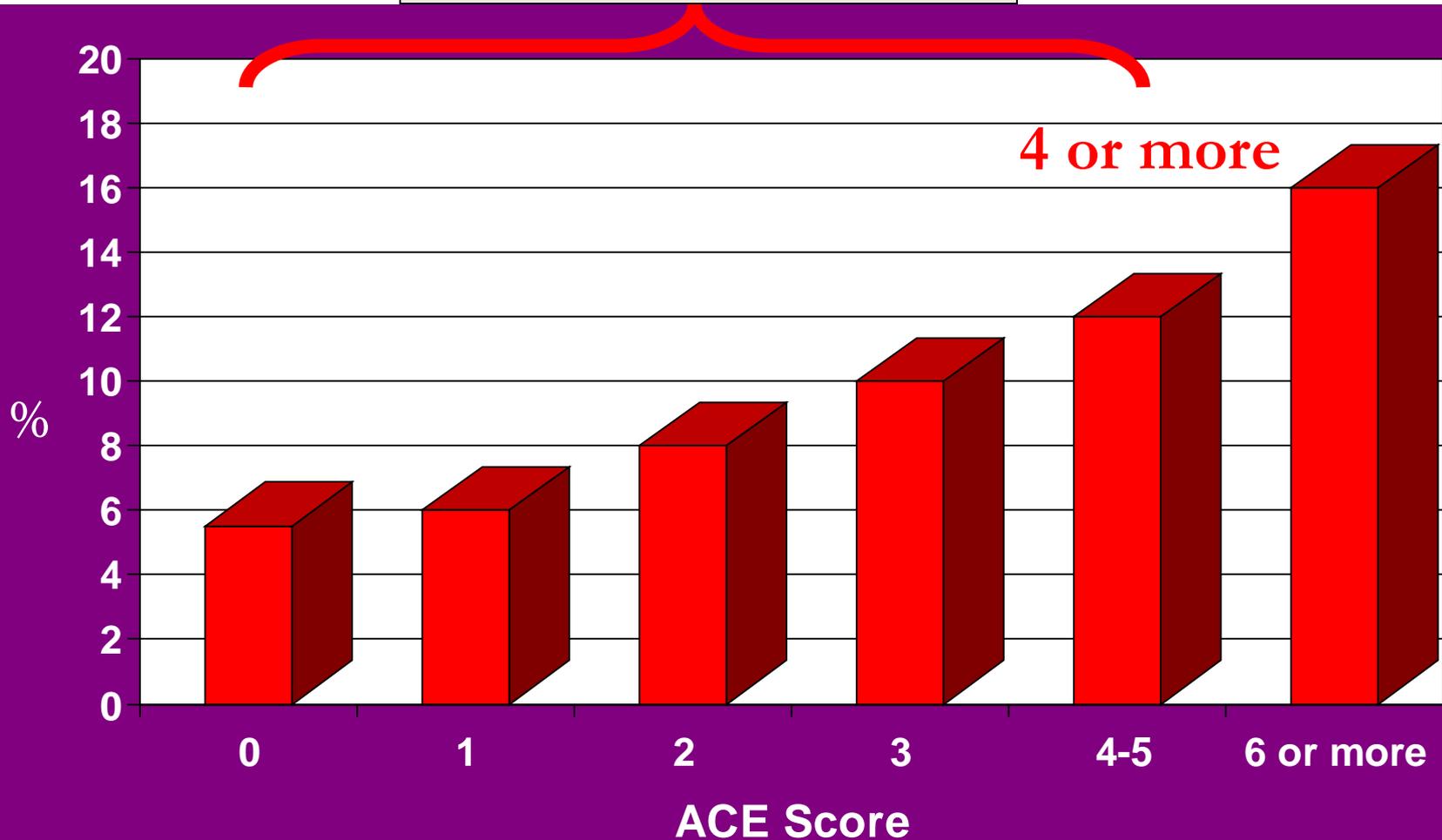


Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.

Also earlier onset!!

# ACEs and Current Smoking

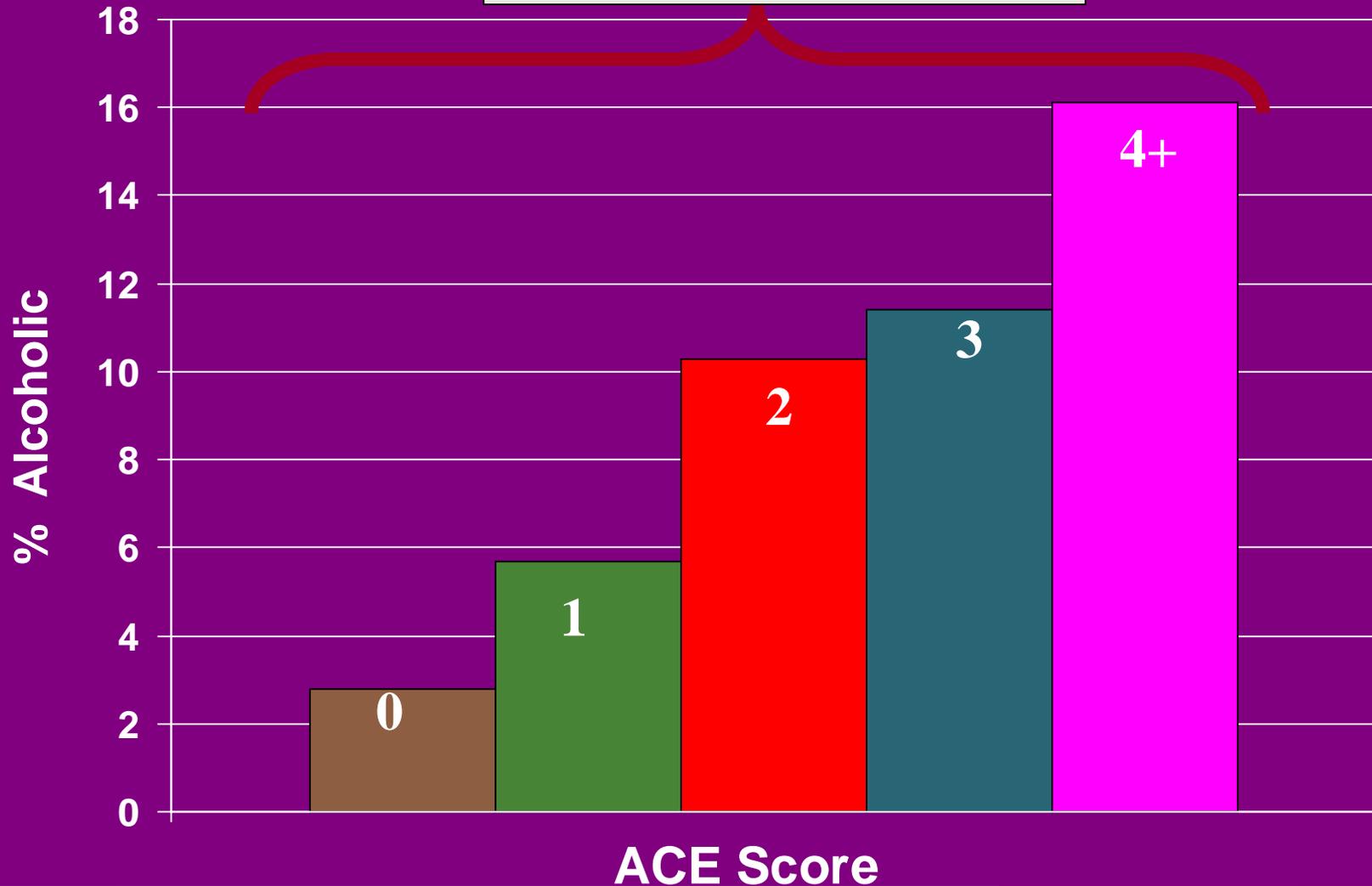
AOR = 1.8 (1.5-2.1)



Also earlier onset!!

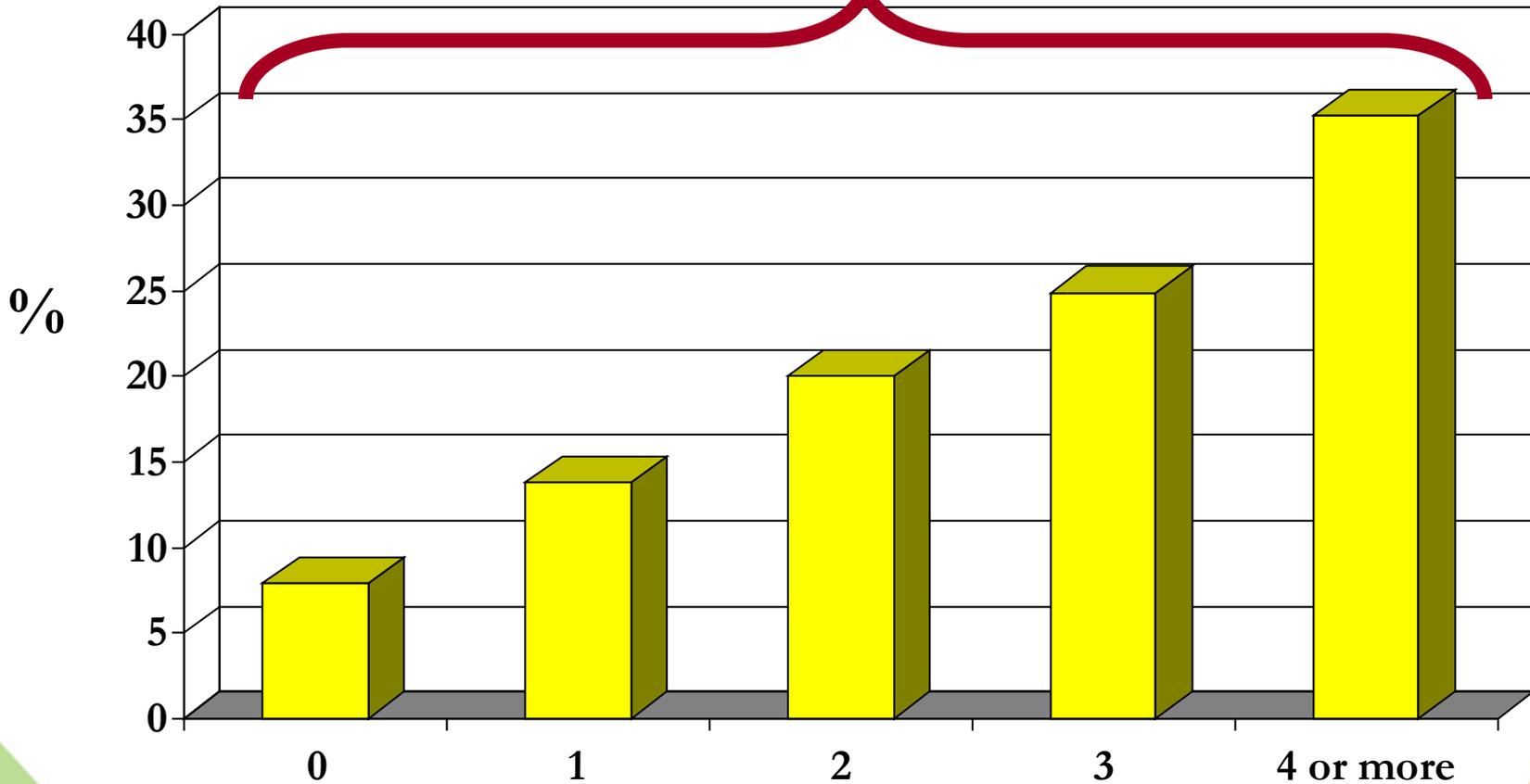
# ACEs and Alcoholism

AOR = 7.2 (5.9-8.9)



# ACEs and Illicit Drug Use

AOR = 4.5 (3.9-5.3)



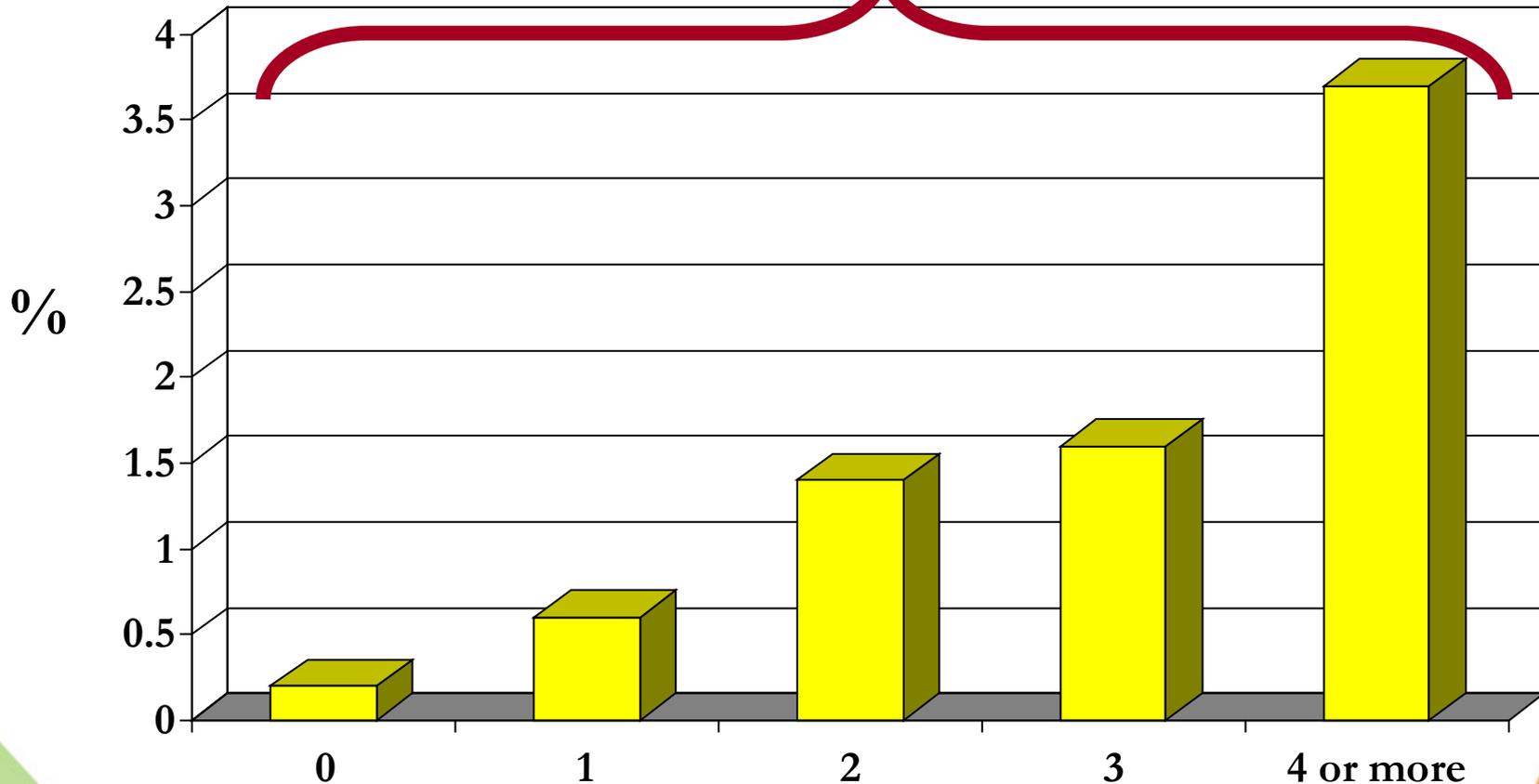
ACE Score



Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.

# ACEs and IV Drug Use

AOR = 11.1 (6.2-19.9)



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ACE Score

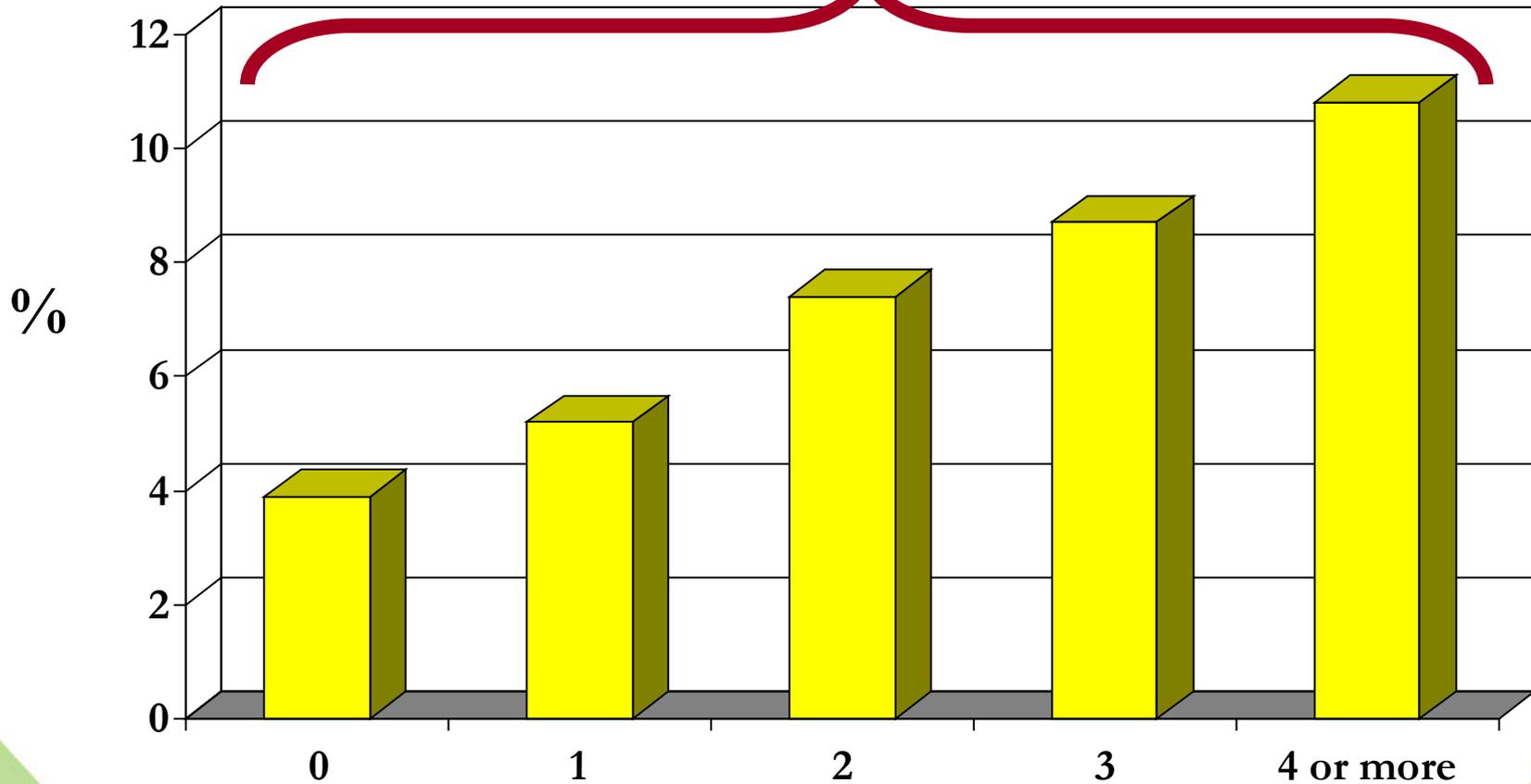


Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.

Also earlier onset!!

# ACEs and Promiscuity ( $\geq 30$ )

AOR = 3.6 (3.0-4.4)

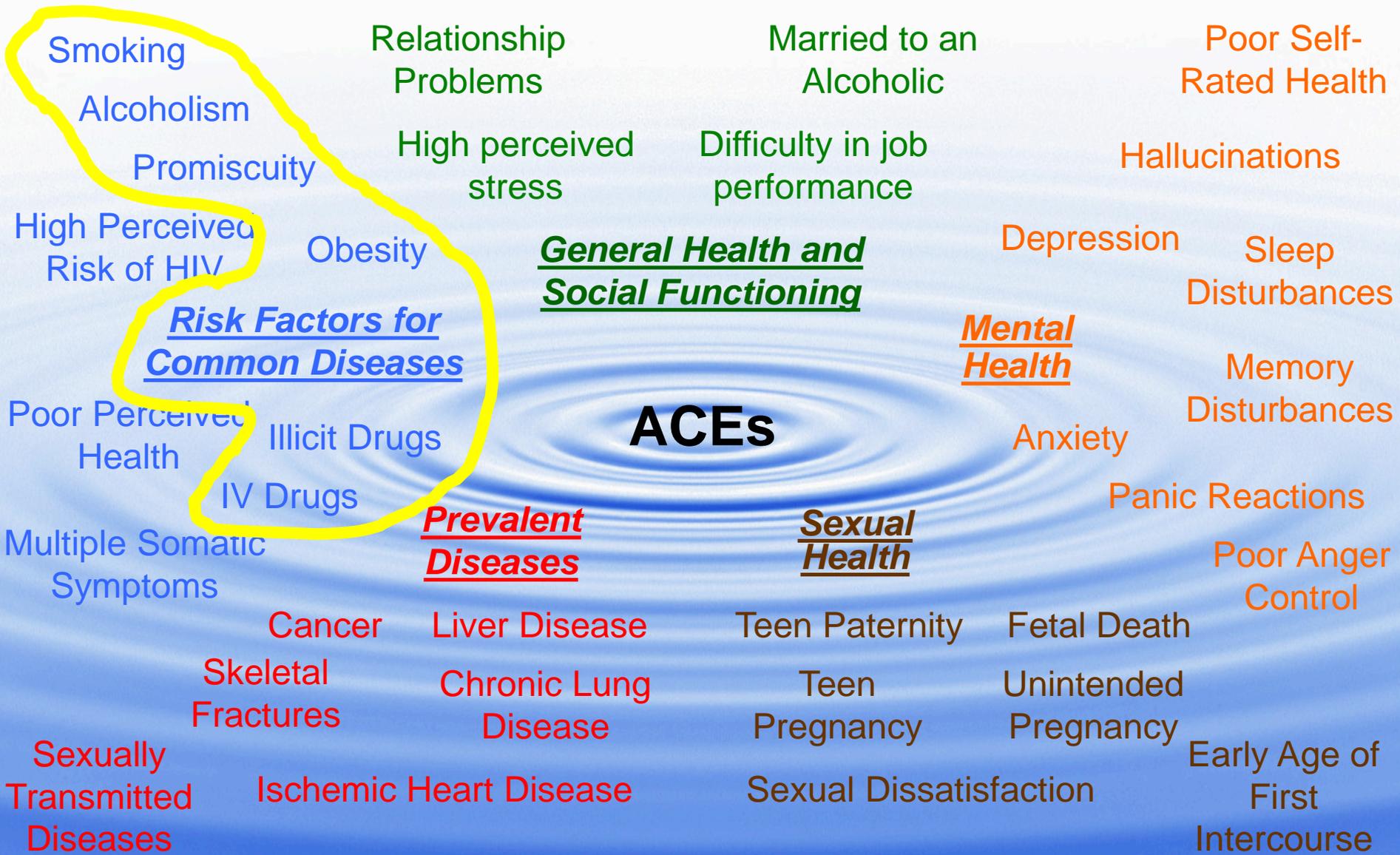


ACE Score

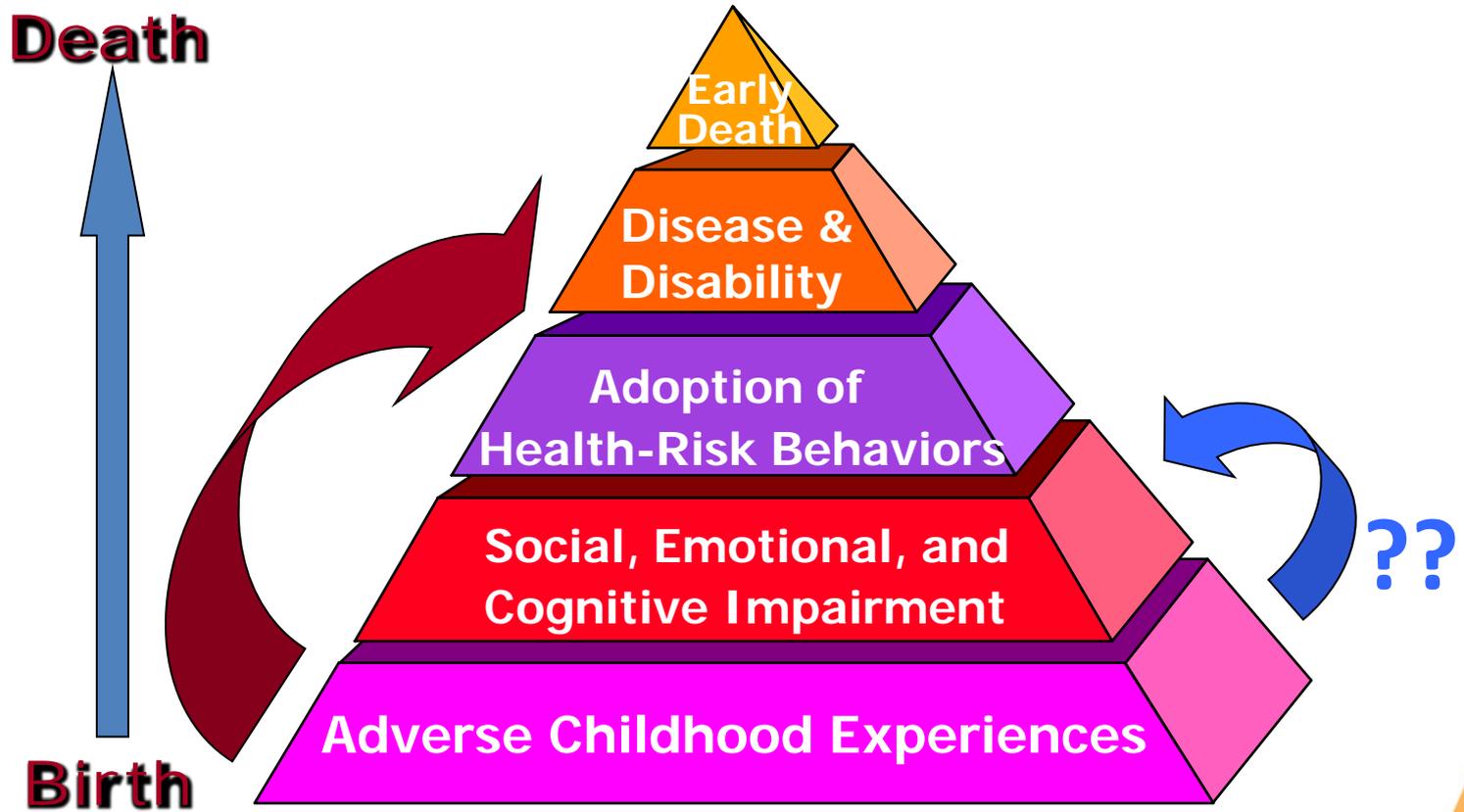


Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.

# ACEs Influence Multiple Outcomes



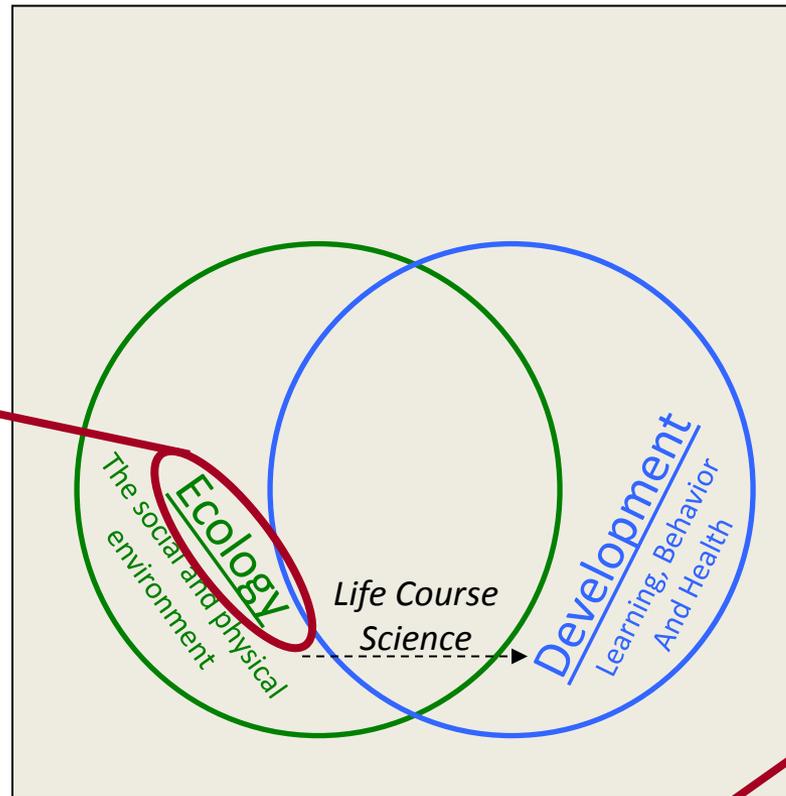
# The True Nature of Preventive Medicine



## Mechanisms By Which Adverse Childhood Experiences Influence Adult Health Status

# Developing a Model of Human Health and Disease

How do you begin to define or **measure** the ecology?



What are the **mechanisms** underlying these well-established associations?

**Early childhood ecology** strongly **associates** with lifelong **developmental** outcomes

# Defining Adversity or Stress



- How do you define/**measure** adversity?
- Huge **individual variability**
  - **Perception** of adversity or stress (subjective)
  - **Reaction** to adversity or stress (objective)
- National Scientific Council on the Developing Child (Dr. Jack Shonkoff and colleagues)
  - **Positive** Stress
  - **Tolerable** Stress
  - **Toxic** Stress

Based on the **REACTION**  
(objective physiologic responses)

# Defining Adversity or Stress



- **Positive Stress**

- Brief, infrequent, mild to moderate intensity
- Most normative childhood stress
  - Inability of the 15 month old to express their desires
  - The 2 year old who stumbles while running
  - Beginning school or daycare
  - The big project in middle school
- **Social-emotional buffers** allow a return to **baseline**  
(responding to non-verbal clues, consolation, reassurance, assistance in planning)
- **Builds motivation and resiliency**
- Positive Stress is **NOT** the **ABSENCE** of stress

# Defining Adversity or Stress



- **Toxic Stress**

- Long lasting, frequent, or strong intensity
- More extreme precipitants of childhood stress (**ACEs**)
  - Physical, sexual, emotional abuse
  - Physical, emotional neglect
  - Household dysfunction
- **Insufficient social-emotional buffering**  
(Deficient levels of emotion coaching, re-processing, reassurance and support)
- Potentially permanent changes with long-term consequences
  - **Epigenetics** (there are life long / intergenerational changes in how the genetic program is turned **ON** or **OFF**)
  - **Brain architecture** (the mediators of stress impact upon the mechanisms of brain development / **connectivity**)

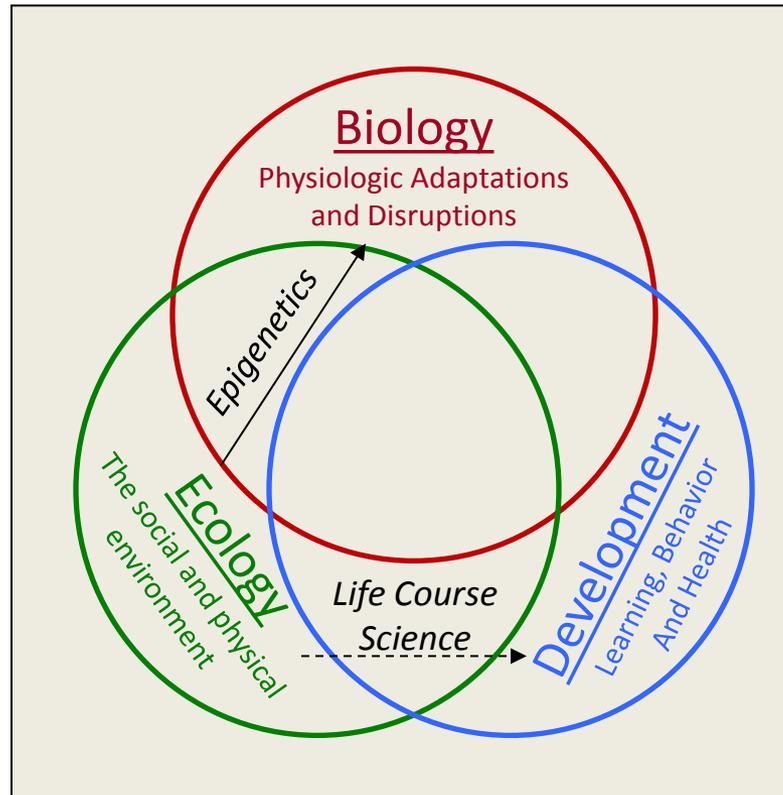
# *Critical Concept #2*

## Epigenetics:

- **Which** genes are turned on/off, **when**, and **where**
- **Ecology** (environment/experience) influences how the genetic blueprint is read and utilized
- Ecological effects at the **molecular level**
- **Stress-induced** changes in **epigenetic markers**

**“Genes** may load the gun,  
but the **environment** pulls the trigger”

# Developing a Model of Human Health and Disease



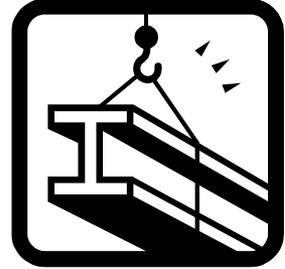
**Through epigenetic mechanisms, the early childhood **ecology** becomes **biologically embedded**, influencing how the genome is utilized**

# **Critical Concept #3**

## **Developmental Neuroscience:**

- **Synapse** and **circuit** formation are experience and activity dependent
- **Ecology** (environment/experience) influences how brain architecture is formed and remodeled (**plasticity**)
- **Diminishing cellular plasticity** limits remediation
- Early childhood adversity -> **vicious cycle of stress**
- **Potentially permanent** alterations in brain architecture and functioning

# Two Types of Plasticity



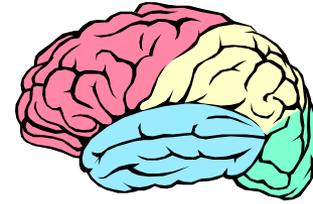
- Synaptic Plasticity -

- Variation in the STRENGTH of individual connections
- “from a whisper to a shout”
- Lifelong (how old dogs learn new tricks)

- Cellular Plasticity -

- Variations in the NUMBER (or COUNT) of connections
- “ from one person shouting to a stadium shouting”
- Declines dramatically with age (*waning by age 5*)

# Differential Brain Maturation



**- The Brake – PFC (with some hippocampal help)**

Frontal lobes:

Abstract thought, reasoning, judgment, planning, impulse and affect regulation, consequences

Parietal Lobe:

Integration of sensory data and movement

Temporal lobe (outside):

Processing sound and language

Occipital Lobe:

Visual processing

Limbic System (inside):  
Emotions and impulsivity

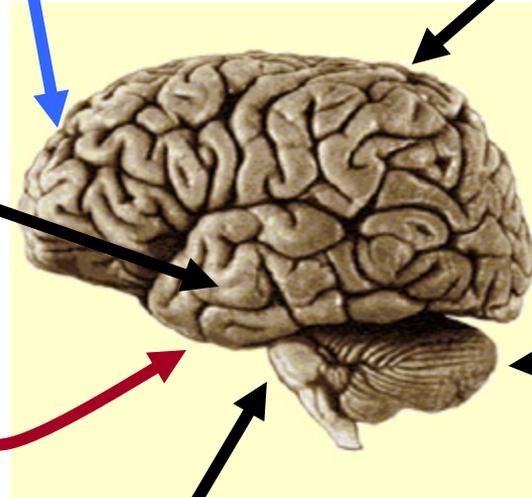
**+ The Gas Pedal +  
Amygdala**

Cerebellum:

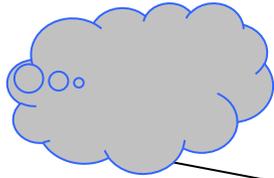
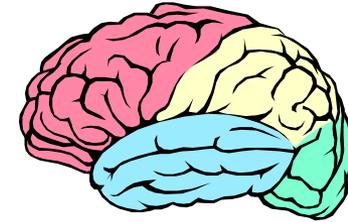
Smooth movements  
Coordination

Brain Stem & Cranial Nerves:

Vital functions  
Swallowing



# Out of Balance?



## Prefrontal Cortex

**Cold** Cognition

**Judgmental**

**Reflective**

**Calculating**

**Think about it**

## Amygdala

**Hot** Cognition

**Emotional**

**Reactive**

**Impulsive**

**Just do it**

Biological maturity by **24**

Biological maturity by **18**

# Impact of Early Stress

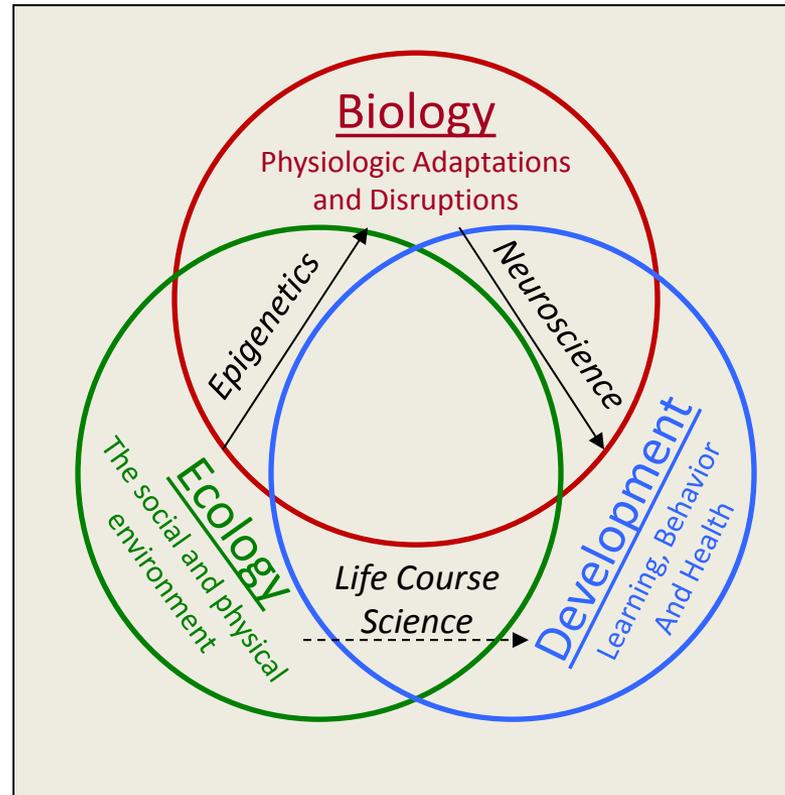
**CHILDHOOD STRESS**

**Hyper-responsive  
stress response;  
↓ calm/coping**

**Chronic “fight or  
flight;” ↑ cortisol /  
norepinephrine**

**Changes in Brain  
Architecture**

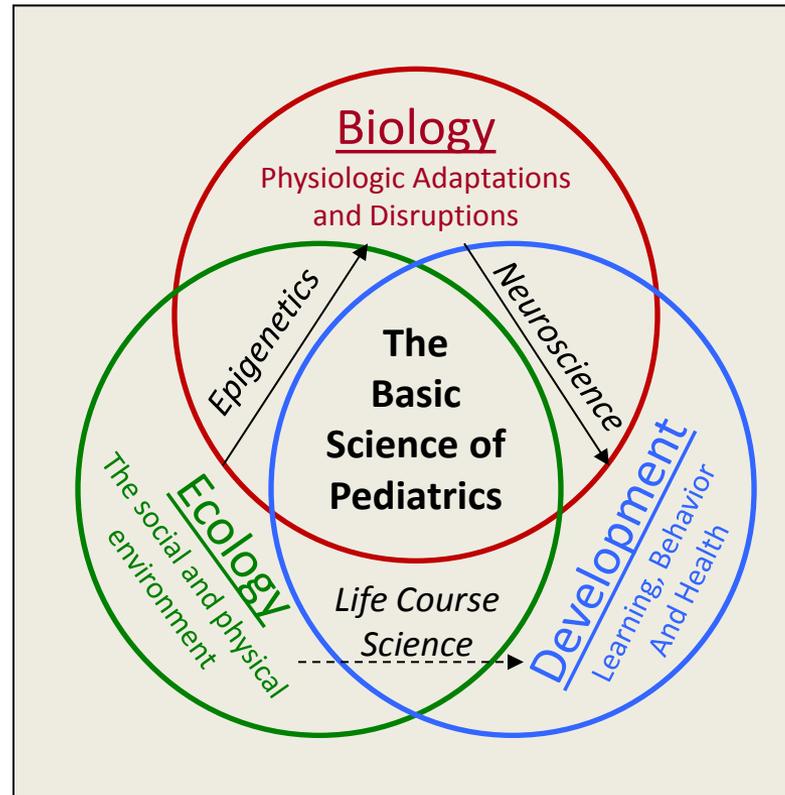
# Developing a Model of Human Health and Disease



**Declining plasticity** in the developing brain results in potentially permanent alterations in brain functioning and **development**

# Eco-Bio-Developmental

## Model of Human Health and Disease

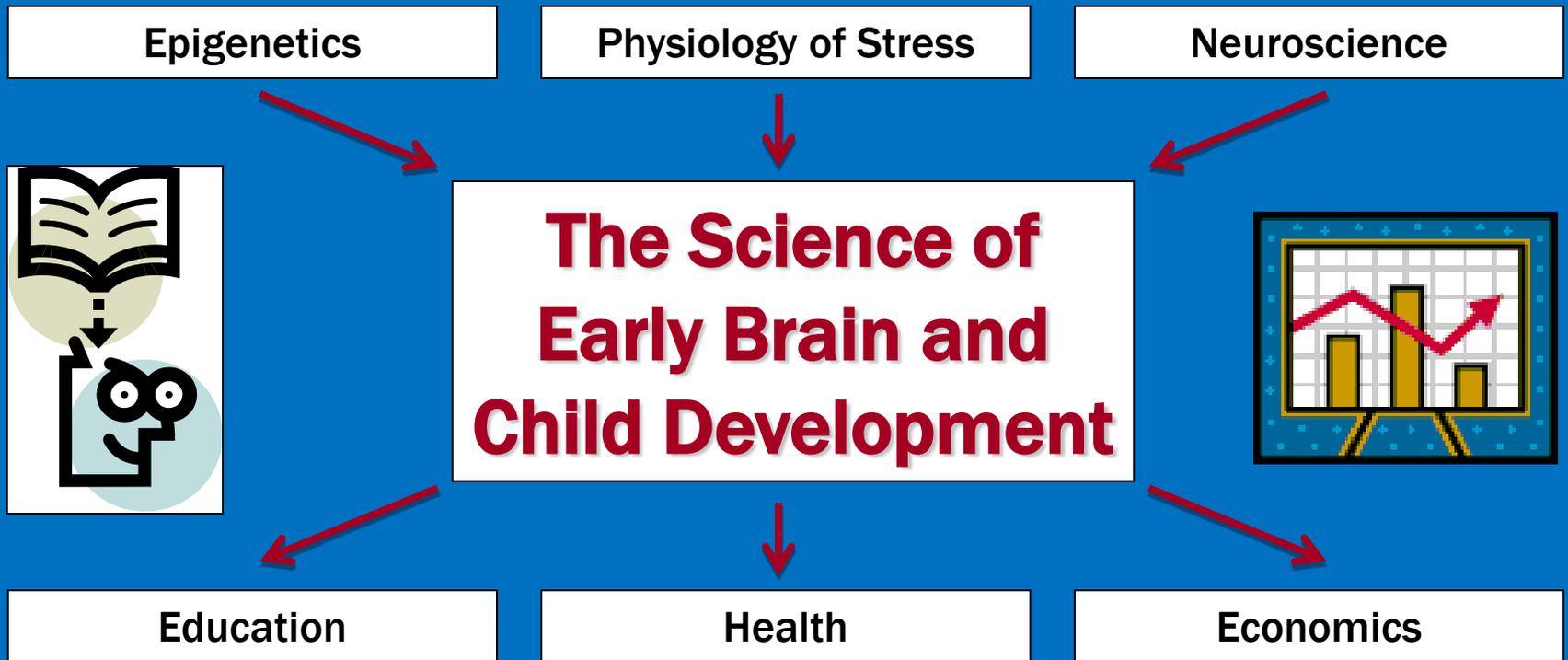


**Ecology**

becomes **biology**,

And together they drive **development** across the lifespan

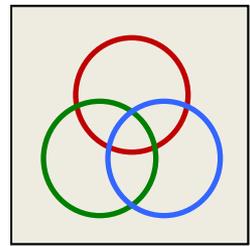
# Critical Concept #4



**One Science – Many Implications**

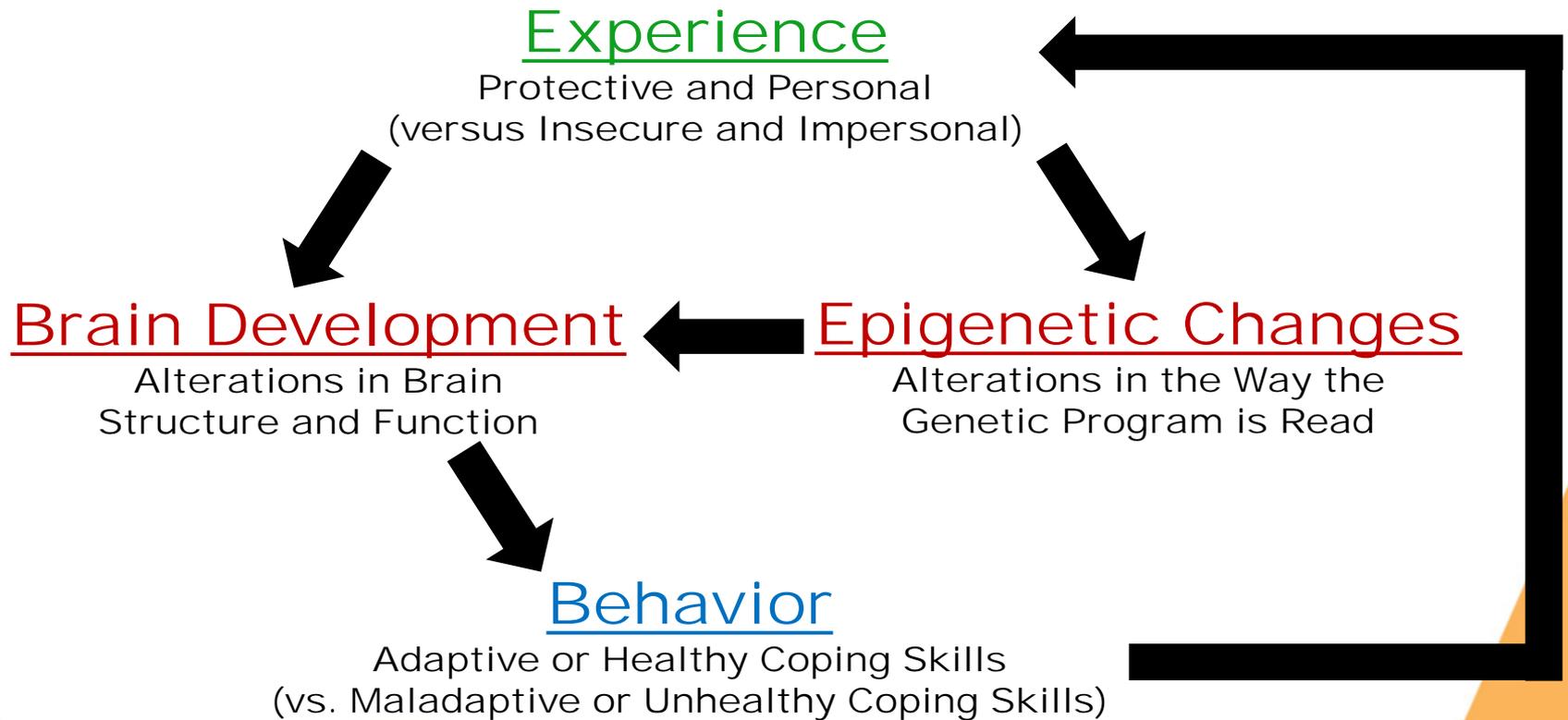
The critical challenge now is to **translate** game-changing advances in **developmental science** into effective **policies** and **practices** for families w/ children to improve **education, health** and **lifelong productivity**

# Advantages of an **EBD** Framework

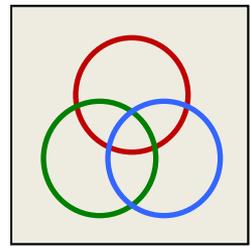


- Though grounded in **developmental science**, the **simplicity** of the EBD framework may promote understanding as well as support for **translation** (investing in childhood is the right thing to do **BIOLOGICALLY!**)
- Psychosocial stressors and other salient features of the **ecology** are every bit as **biological** as nutrition or lead (no distinction between mental and physical health, just healthy vs. unhealthy **development**)
- Emphasizes the dimension of **time** – to reflect the **on-going, cumulative** nature of benefits and threats to health and wellness

# Development results from an on-going, re-iterative, and cumulative dance between **nurture** and **nature**



# Advantages of an **EBD** Framework

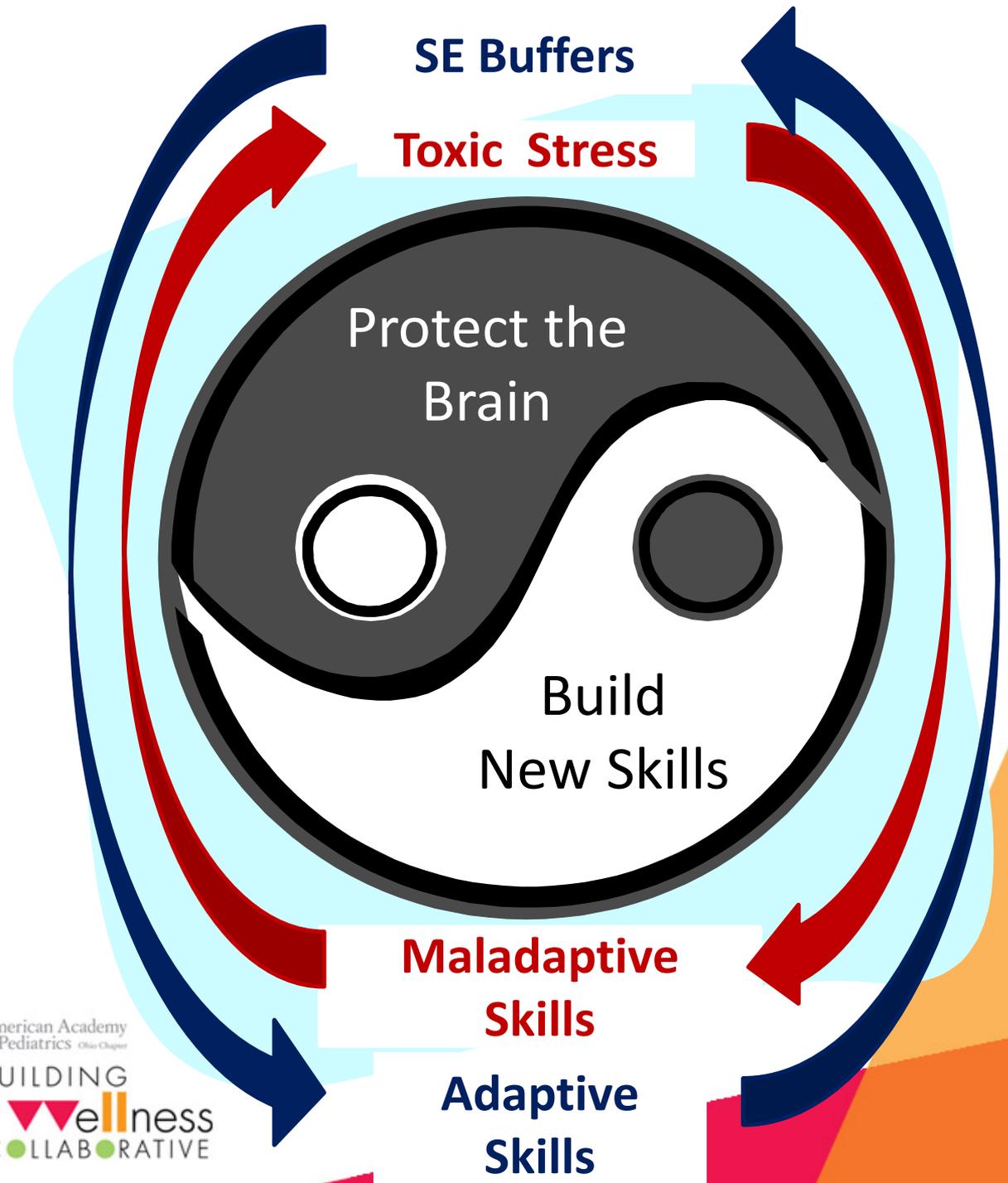


- Underscores the need to improve the early childhood **ecology** in order to:
  - Mitigate the **biological** underpinnings for educational, health and economic **disparities**
  - Improve **developmental**/life-course trajectories
  - Changing the **ecology** will demand a **public health approach and unprecedented levels of collaboration!**
- Highlights the pivotal role of **toxic stress**
  - Not just “**step on the gas**” or enrichment
  - But “**take off the break**” by treating, mitigating or immunizing against toxic stress

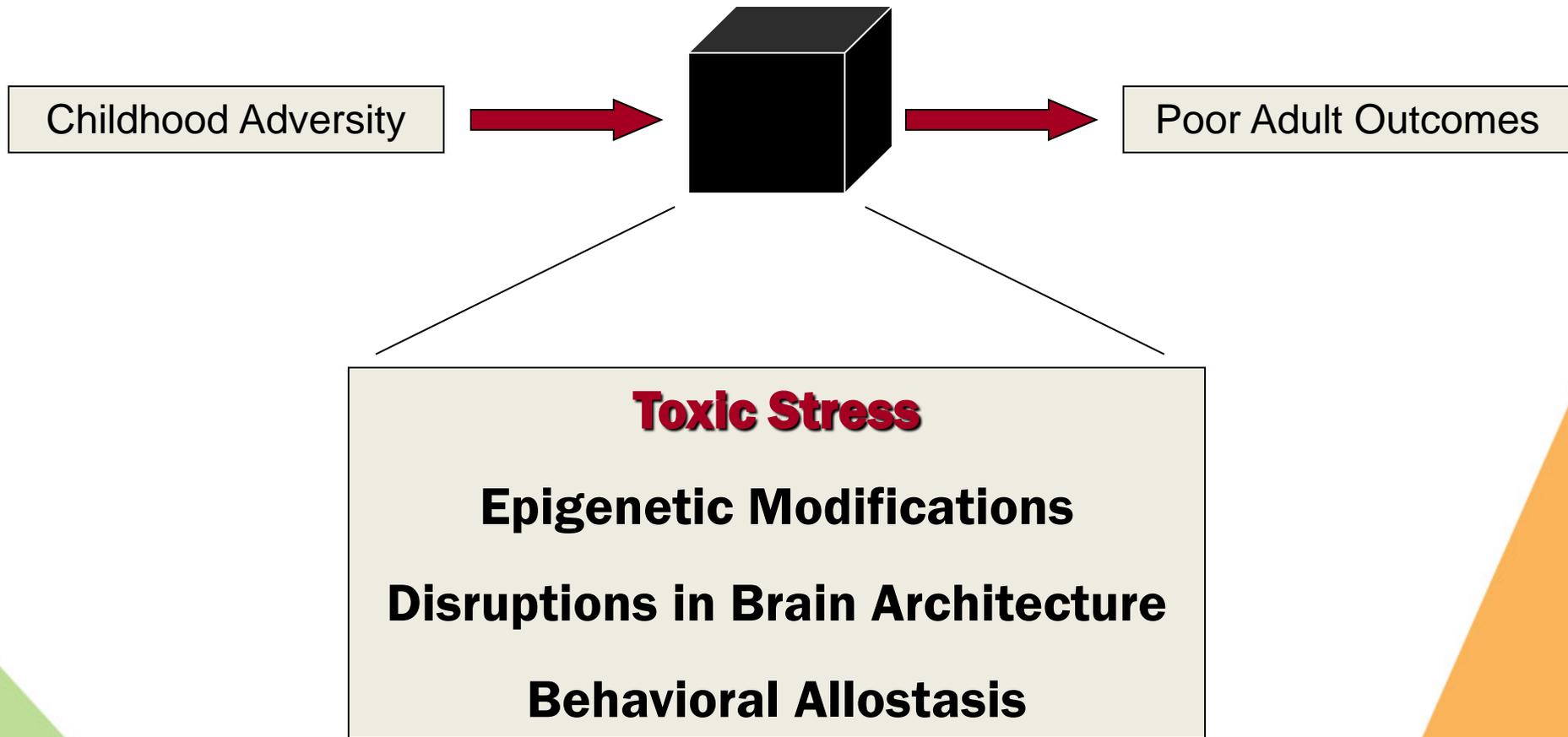
**The Yin and Yang of Early Childhood:**

**Protect the Brain and ...**

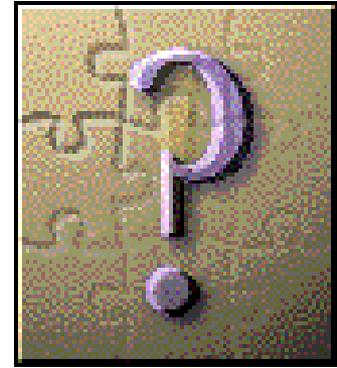
**Build New Skills.**



# Linking **Childhood Experiences** and **Adult Outcomes**



# The **BIG** Questions are...

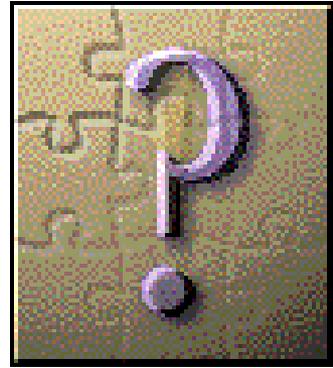


If **TOXIC STRESS** is the missing link between **ACE exposure** and **poor adult outcomes**, it raises the following BIG questions:

- Are there ways to:
  - **treat**,
  - **mitigate**, and/or
  - **immunize against** toxic stress?
- Is there a mismatch between:
  - what we **KNOW** ... and ...
  - what we actually **DO**?

**YES!!**  
**See**  
**Part 2!!**

# The **BIG** Questions are...

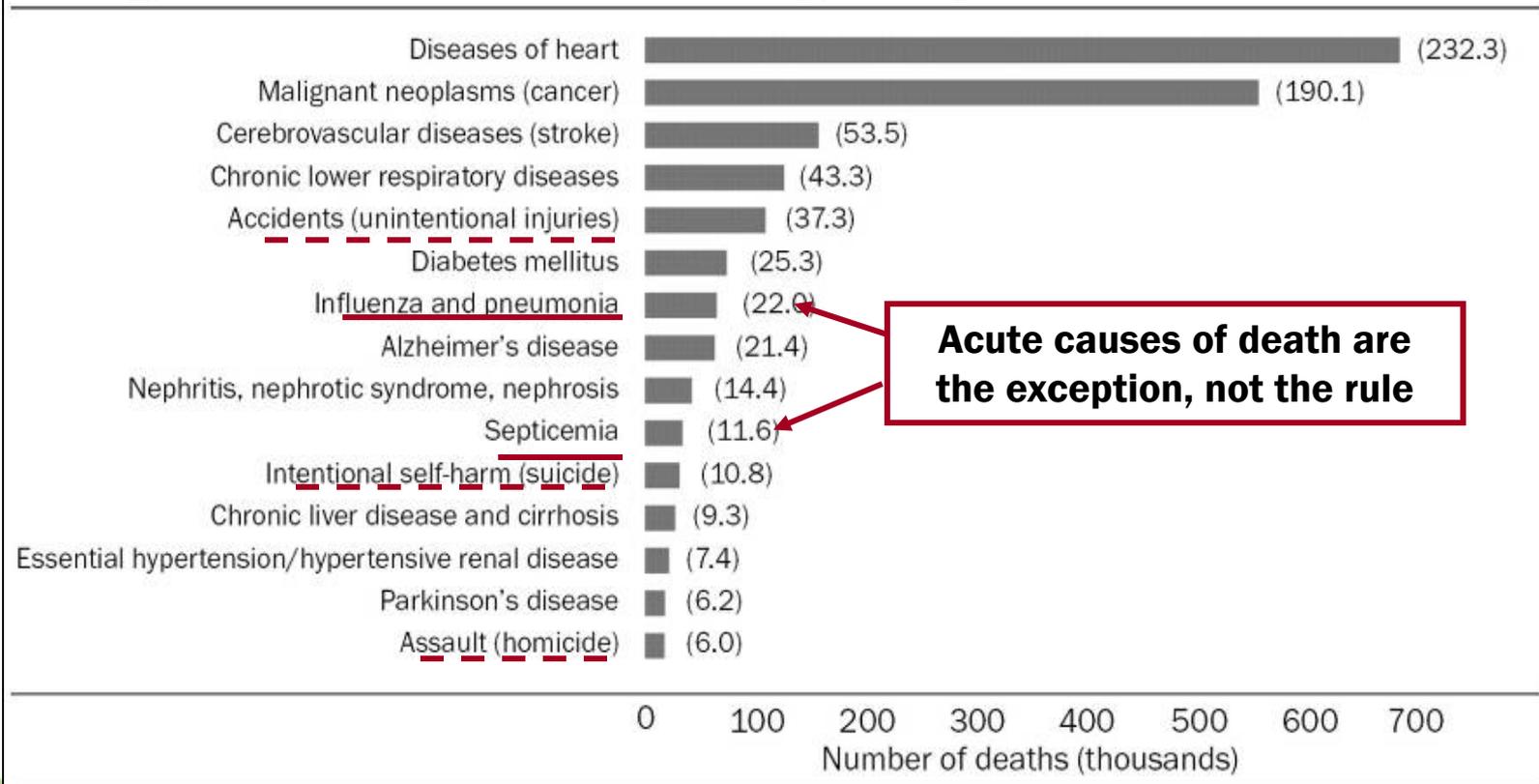


- What we **DO**:
  - 95% of the trillions of dollars that we spend on health is on **treatment** and **NOT prevention**
- What we **KNOW**:
  - That **70% of early deaths are preventable**, with...
  - **The majority (40%) due to behavioral patterns**  
(behavioral allostasis due to toxic stress!)

# Proximal Causes of Death: Chronic Disease

## EXHIBIT 2

### Total Deaths And Age-Adjusted Death Rates (Per 100,000 Population) For The Fifteen Leading Causes Of Death In The Total U.S. Population, 2003



**SOURCE:** D.L. Hoyert et al., "Deaths: Final Data for 2003," *National Vital Statistics Report* 54, no. 13 (2006): 1-120.

**NOTE:** Numbers in parentheses are age-adjusted death rates per 100,000 population.

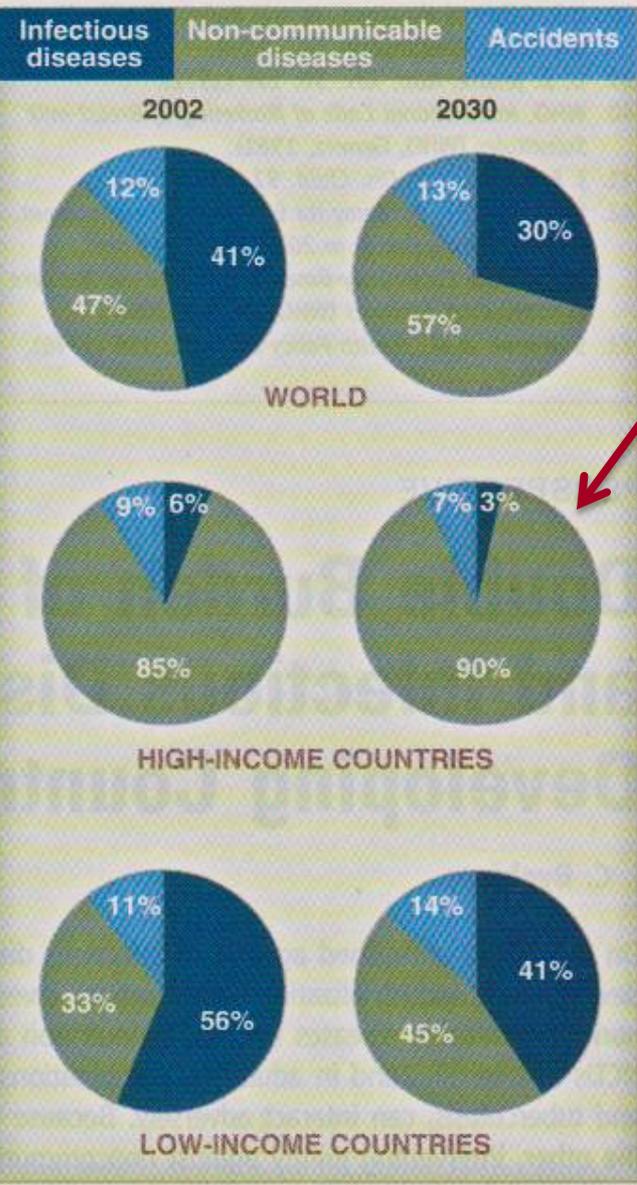
# Distal Causes of Death: Unhealthy Lifestyles

**Table 2.** Actual Causes of Death in the United States in 1990 and 2000

Actual Cause	No. (%) in 1990*	No. (%) in 2000
<u>Tobacco</u>	400 000 (19)	435 000 (18.1)
<u>Poor diet and physical inactivity</u>	300 000 (14)	400 000 (16.6)
<u>Alcohol consumption</u>	100 000 (5)	85 000 (3.5)
Microbial agents	90 000 (4)	75 000 (3.1)
Toxic agents	60 000 (3)	55 000 (2.3)
Motor vehicle	25 000 (1)	43 000 (1.8)
Firearms	35 000 (2)	29 000 (1.2)
<u>Sexual behavior</u>	30 000 (1)	20 000 (0.8)
<u>Illicit drug use</u>	20 000 (<1)	17 000 (0.7)
<b>Total</b>	<b>1 060 000 (50)</b>	<b>1 159 000 (48.2)</b>

\*Data are from McGinnis and Foege.<sup>1</sup> The percentages are for all deaths.

If these unhealthy lifestyles are manifestations of behavioral allostasis, a **FUNDAMENTAL** cause of death is **TOXIC STRESS!**



- By 2030, **90%** of the morbidity in high income countries will be due to **Non-Communicable Diseases**
- Most NCDs are due to **unhealthy behaviors** (overeating, smoking, alcohol, promiscuity, and illicit drugs)

**Fig. 1.** The proportional distribution of disability-adjusted life years, contributable to infectious diseases and NCDs for (top) the world, (middle) high-income countries, and (bottom) low-income countries for 2002 and 2030 (3).

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PERSPECTIVE

# Changing Human Behavior to Prevent Disease: The Importance of Targeting Automatic Processes

Theresa M. Marteau,<sup>1\*</sup> Gareth J. Hollands,<sup>1</sup> Paul C. Fletcher<sup>2</sup>

Much of the global burden of disease is associated with behaviors—overeating, smoking, excessive alcohol consumption, and physical inactivity—that people recognize as health-harming and yet continue to engage in, even when undesired consequences emerge. To date, interventions aimed at changing such behaviors have largely encouraged people to reflect on their behaviors. These approaches are often ineffectual, which is in keeping with the observation that much human behavior is automatic, cued by environmental stimuli, resulting in actions that are largely unaccompanied by conscious reflection. We propose that interventions targeting these automatic bases of behaviors may be more effective. We discuss specific interventions and suggest ways to determine whether and how interventions that target automatic processes can enhance global efforts to prevent disease.

**How/When do those automatic processes form in the first place!?**

## *Critical Concept #5*

### A PUBLIC HEALTH DILEMMA:

Do we continue to treat **disease**,

the **unhealthy lifestyles** that  
lead to disease,

or the **TOXIC STRESS** that leads to the  
adoption of unhealthy lifestyles??

# SUMMARY



- **What is Toxic Stress?**
  - **A physiologic stress response that is excessive or prolonged** (reflects an inability to “turn it off”)
  - **Results in potentially permanent changes in:**
    - **Gene expression** (epigenetics)
    - **Brain development** (neuroscience)
    - **Behavior** (allostasis)

# SUMMARY



- Why should I care?
  - **Toxic stress** is a **MEDIATOR** between early childhood **adversity** and less than optimal outcomes in **learning, behavior** and **health**
  - Understanding the **BIOLOGY** underlying these well established associations opens up new opportunities for **primary prevention** and **early intervention**

# SUMMARY

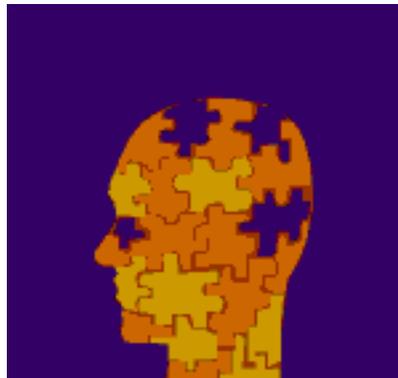


- **What can I do?**
  - **Understand** the **ecobiodevelopmental framework** (advocate for a public health approach to address toxic stress – see part 2)
  - **Help** children figure out how to **turn off** their stress response (in developmentally appropriate, healthy ways – see part 2)
  - **Intervene early** for those children who are at high risk or appear **unable to turn off** their stress response (see part 2)

# CONCLUSION:

It is easier to **build strong children**  
than to **repair broken men.**

Frederick Douglass



# Question & Answer



# How to request a certificate

- When we end the webinar, you will be automatically directed to an evaluation survey
- This survey link will also be sent via email to those who attended the webinar
  - Complete the survey and submit
  - Please allow 4-6 weeks to receive your certificate via email





# THANK YOU!

- **Today's webinar recording will be posted to;**
  - [www.healthychildcare.org](http://www.healthychildcare.org)
  - <https://oh.train.org>

## **Building Bridges Part II; Purposeful Parenting and the Primary Prevention of Toxic Stress**

### **Sponsored by:**

Ohio Chapter, American Academy of Pediatrics

Webinar Date: October 23, 2013

Contact [hsouthworth@ohioaap.org](mailto:hsouthworth@ohioaap.org) for registration information

