EARLY BRAIN & BIOLOGICAL DEVELOPMENT: A SCIENCE IN SOCIETY SYMPOSIUM

Stress and Neurobehavioral Development in Childhood

Megan R. Gunnar

May 31, 2011



Alberta family wellness initiative

Norlien Foundation

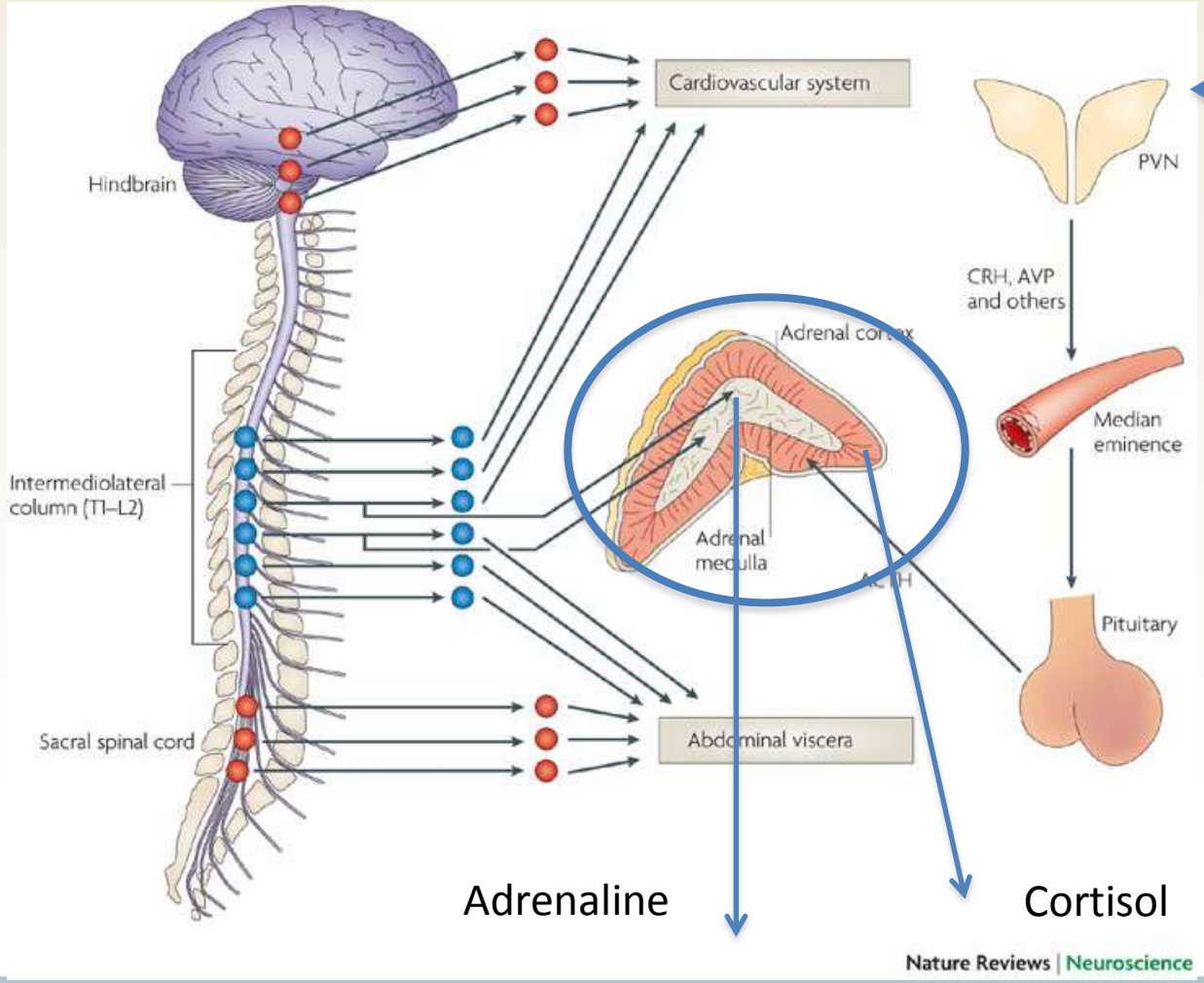
Plan for this Presentation

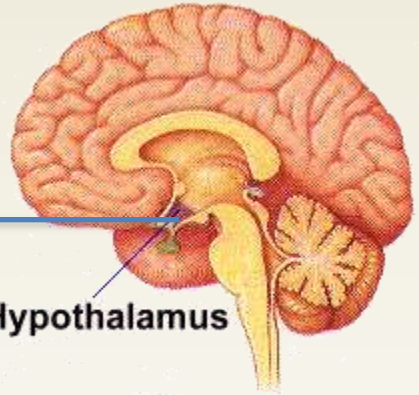
- Recall themes from last year's presentations on stress and epigenetics
- Stress and its Regulation in Human Development
  - Children Reared in Supportive Homes
  - Children reared under adverse caregiving conditions
  - Critical role of relationships as stress regulators
- Set the stage for Dr. Anda's and Dr. Danese's presentations

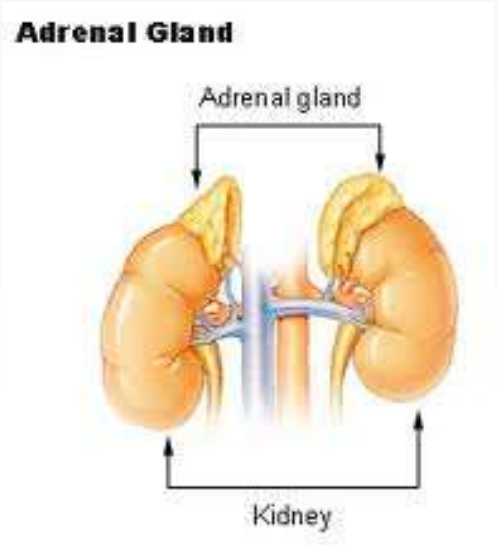
The Biology of Stress

Increases in heart rate, blood pressure, serum glucose, stress hormones, and inflammatory cytokines fuel the “fight or flight response” to deal with acute threat...

Two Arms of the Stress System







The Biology of Stress is a Life Saver

In the framework of stress, all of the changes evoked by stress are intended to ensure survival of the organism

For example, increased glucose levels provides fuel for muscle tissue to cope with a fight-or-flight situation

Matt Hill, 2010

The Good, the Bad and the Ugly of Stress

From Hill, 2010

Allostasis: stability through change; survival through change

Allostatic load refers to the costs which are endured on the body following repeated or chronic bouts of stress

Toxic Stress: Repeated or chronic activation of stress biology that produces severe allostatic load

McEwen, 1998

Effect of Toxic Stress (Allostatic Load)

Excessive insulin secretion, type II diabetes

Hypertension, coronary heart disease

Vulnerability to inflammatory diseases

Loss of interest, depression

Hyperarousal and anxiety disorders

Preponderance of aversive memories

Poor Brain and Physical Growth

Matt Hill, 2010

Should We Wrap Them In Bubblewrap???

Three Levels of Stress

Positive

Brief increases in heart rate,
mild elevations in stress hormone levels.

Tolerable

Serious, temporary stress responses,
buffered by supportive relationships.

Toxic

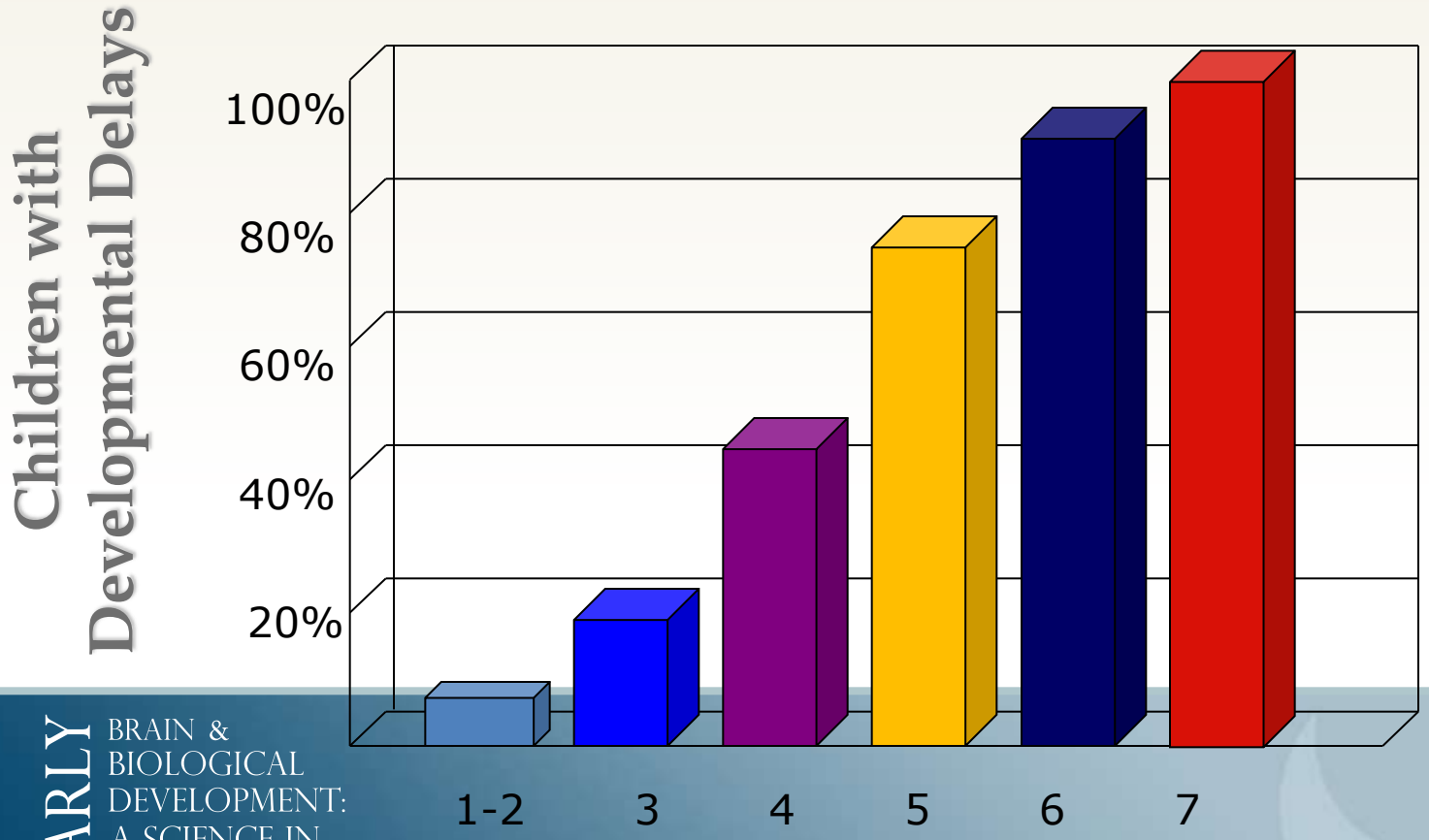
Prolonged activation of stress response systems
in the absence of protective relationships.

Sources that can Produce Toxic Stress in Young Children

Risk Factors

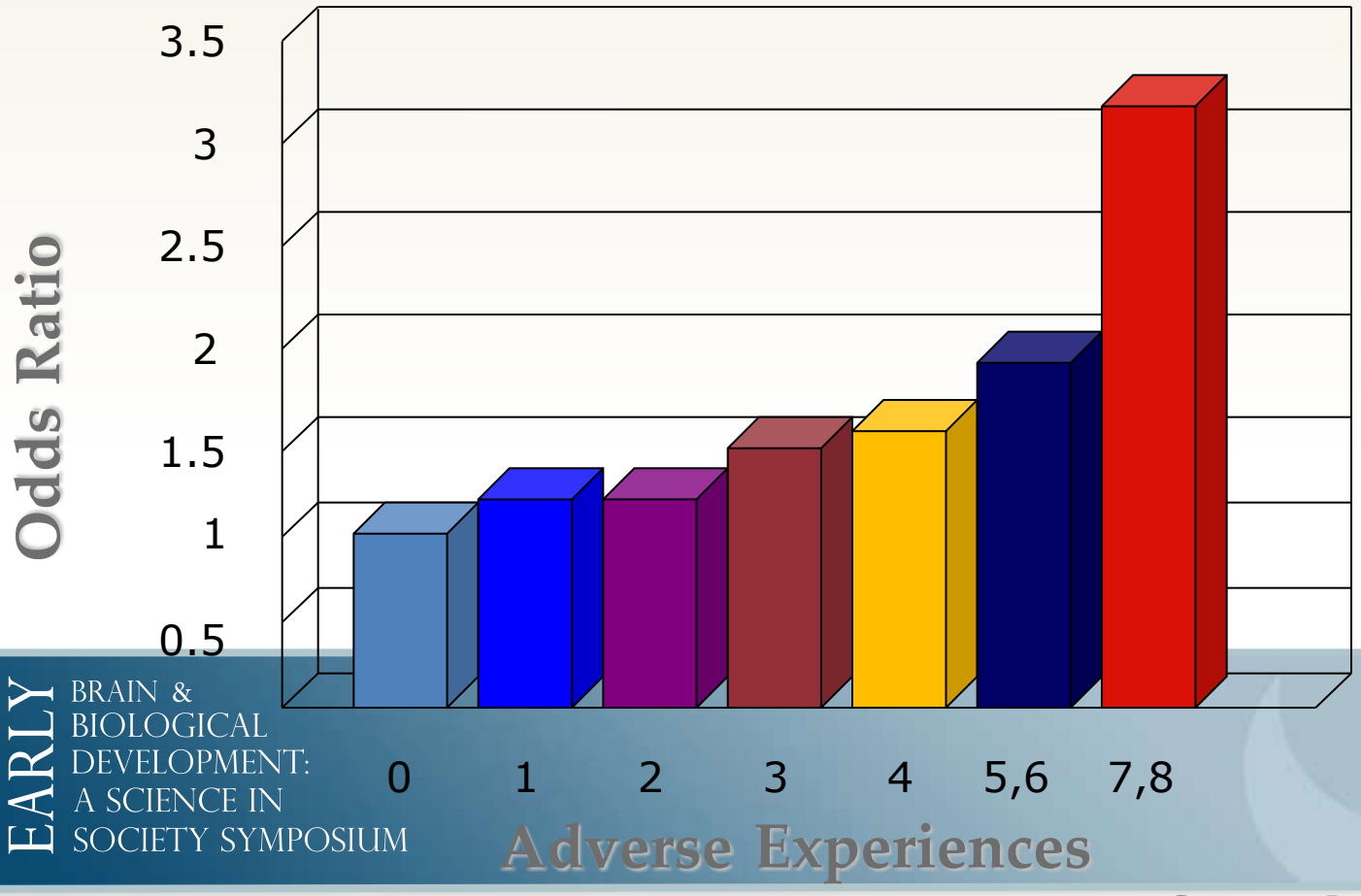
- Neglect
- Abuse
- Exposure to Violence
- Parental Mental Illness
- Parental Substance Abuse
- Homelessness/High Mobility
- Death of parent
- Incarceration of Parent
- Etc.

Significant Adversity Impairs Development in the First Three Years



Source: Barth et al. (2008)

Risk Factors for Adult Heart Disease are Embedded in Adverse Childhood Experiences



Source: Dong et al. (2004)

Biological Effects of Profound and Prolonged Toxic Stress in Childhood

Markedly reduced brain activity and brain volume

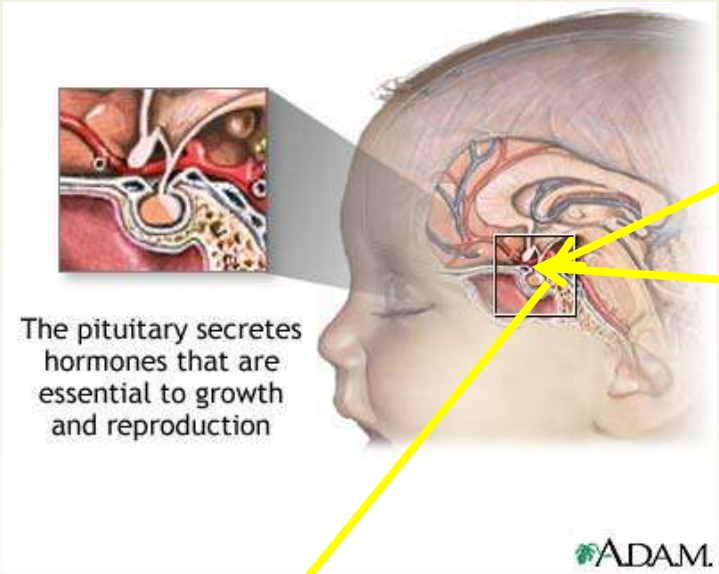
Markedly reduced growth

What is the age and gender of this child?

11-Year-Old Girl
(height-for-age = 48 month old)

Source: Johnson et al. (2000)

Growth System and HPA Axis



GHRH (+)

Somatostatin (-)

CRH

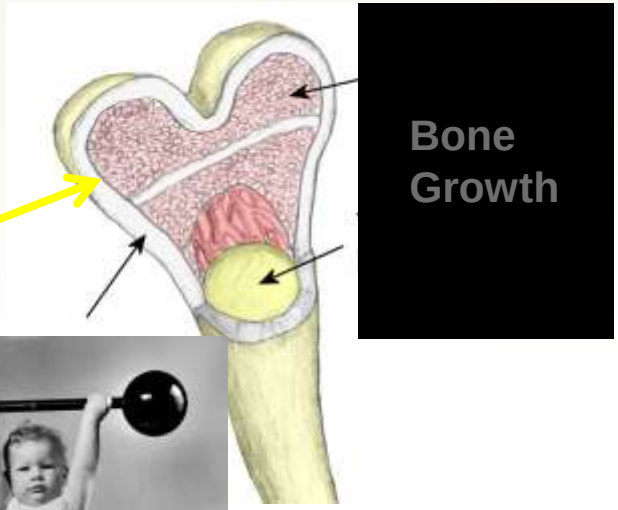
\+

GH

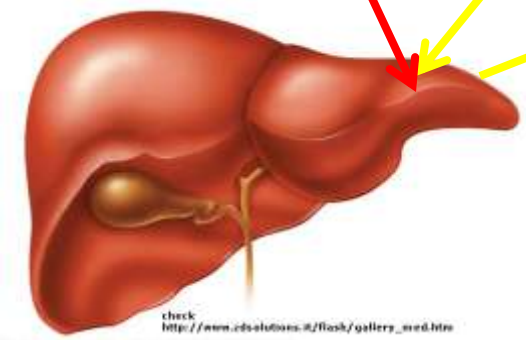
Cortisol

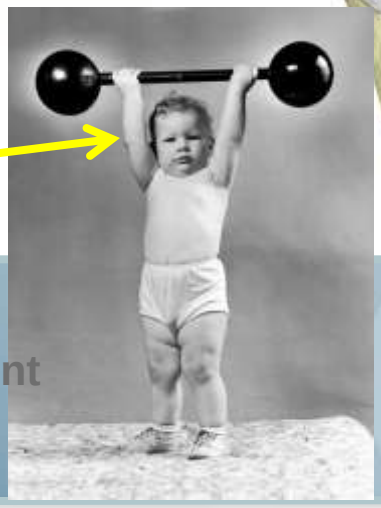
\-

IGF-1



Bone Growth





Muscle Development

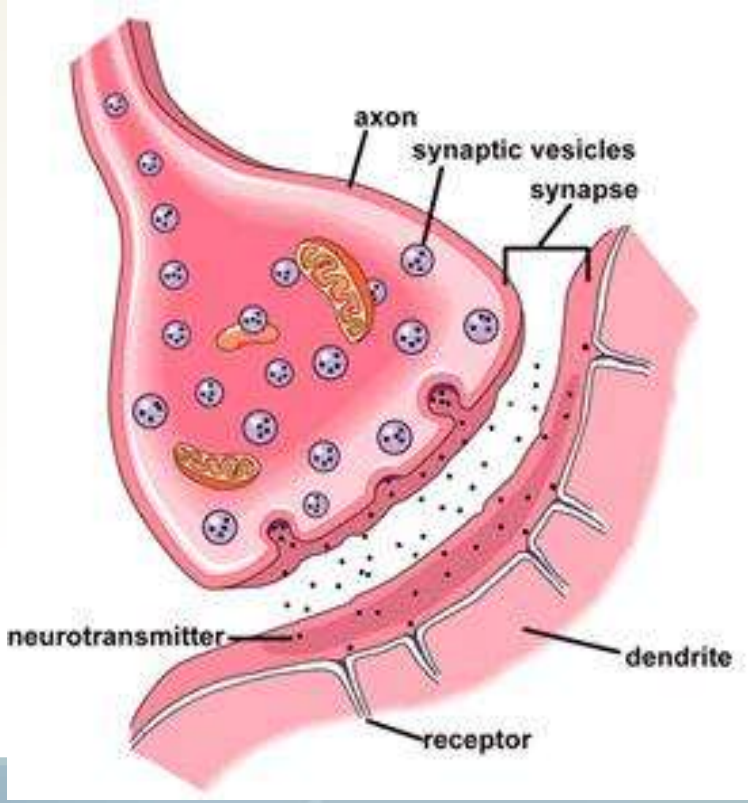
Allostatic Load and the Brain from Hill, 2010

Brain is also a target of stress and stress hormones

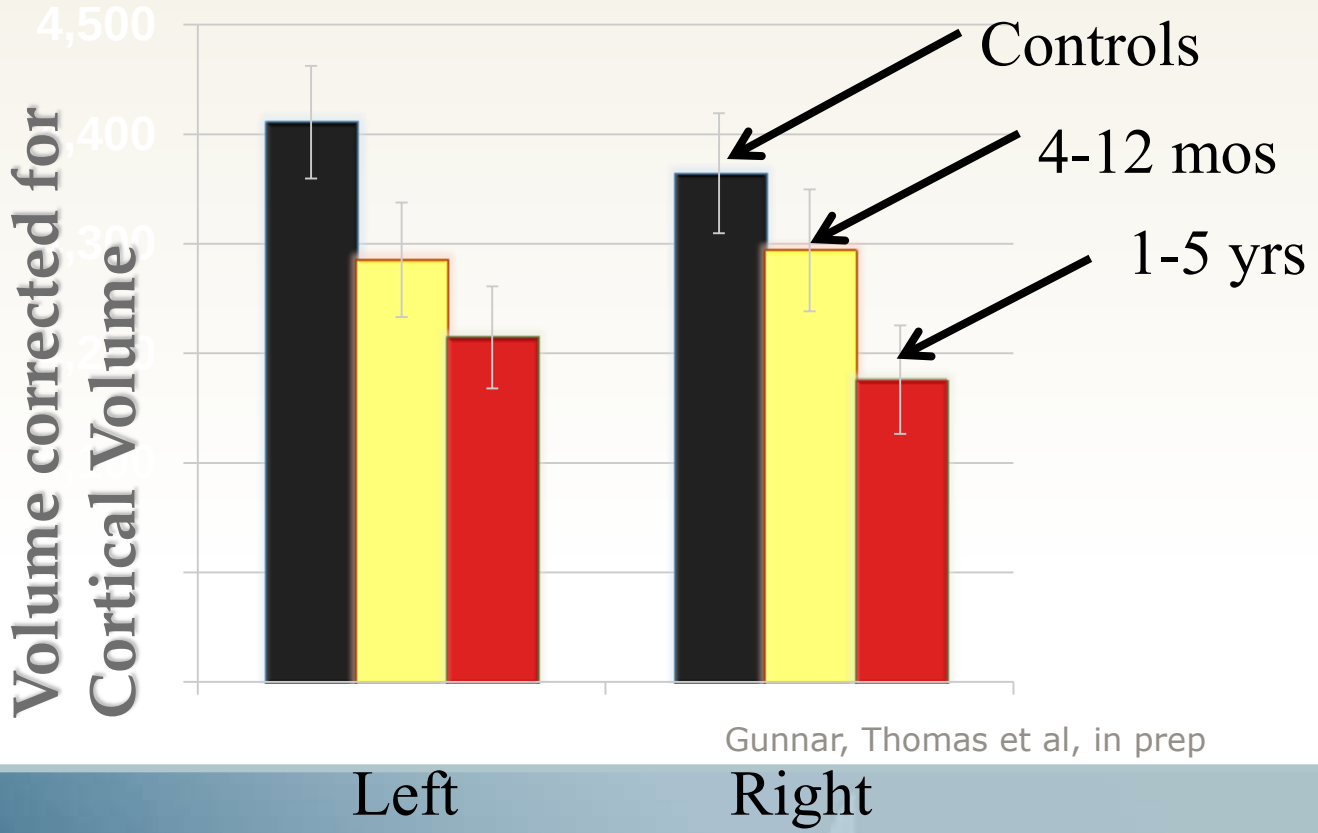
Stress hormones increase the release of excitatory neurochemicals that activate neurons

If prolonged this can be toxic to neurons. Neurons can pull back their receptive fields to protect themselves. Observed in PFC and hippocampus

In development, however, we tend to see reduction in brain volume that persists



12 and 13 years at Scanning



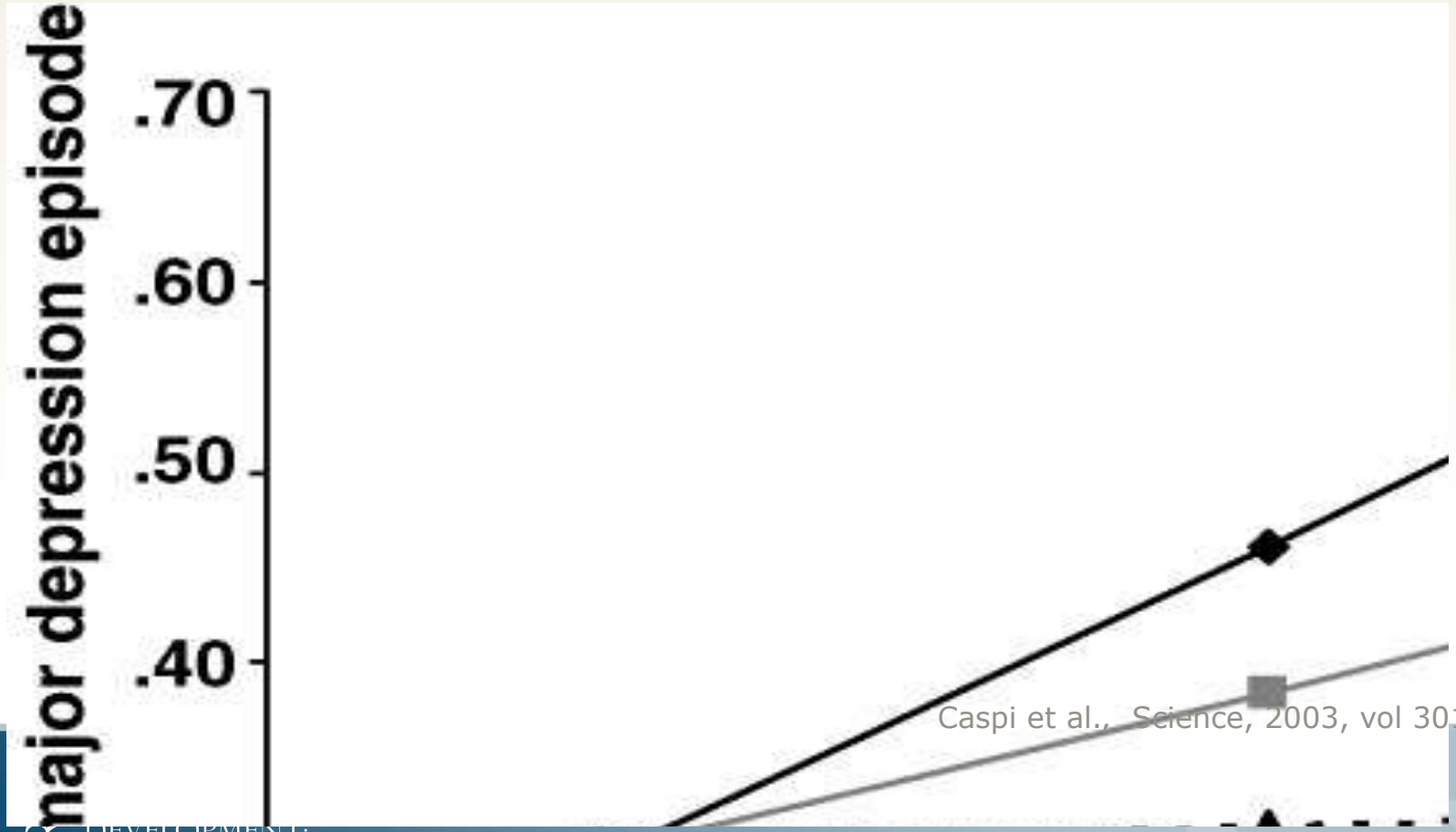
Gunnar, Thomas et al, in prep

Hippocampus

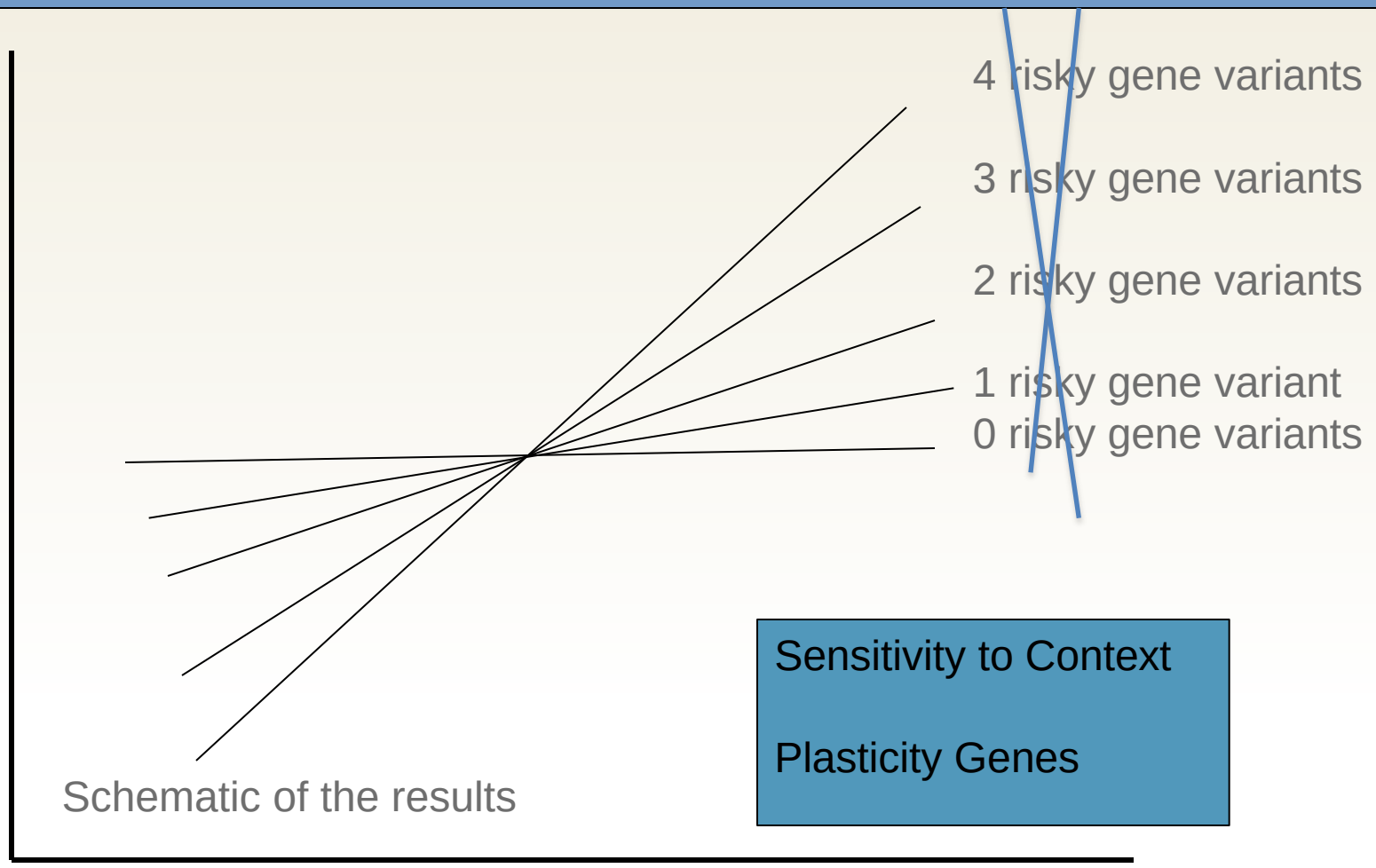
Not Everyone is Affected the Same

Gilchrist, Texas after Hurricane Ike

Depression in Early Adulthood and Serotonin Transporter Polymorphism

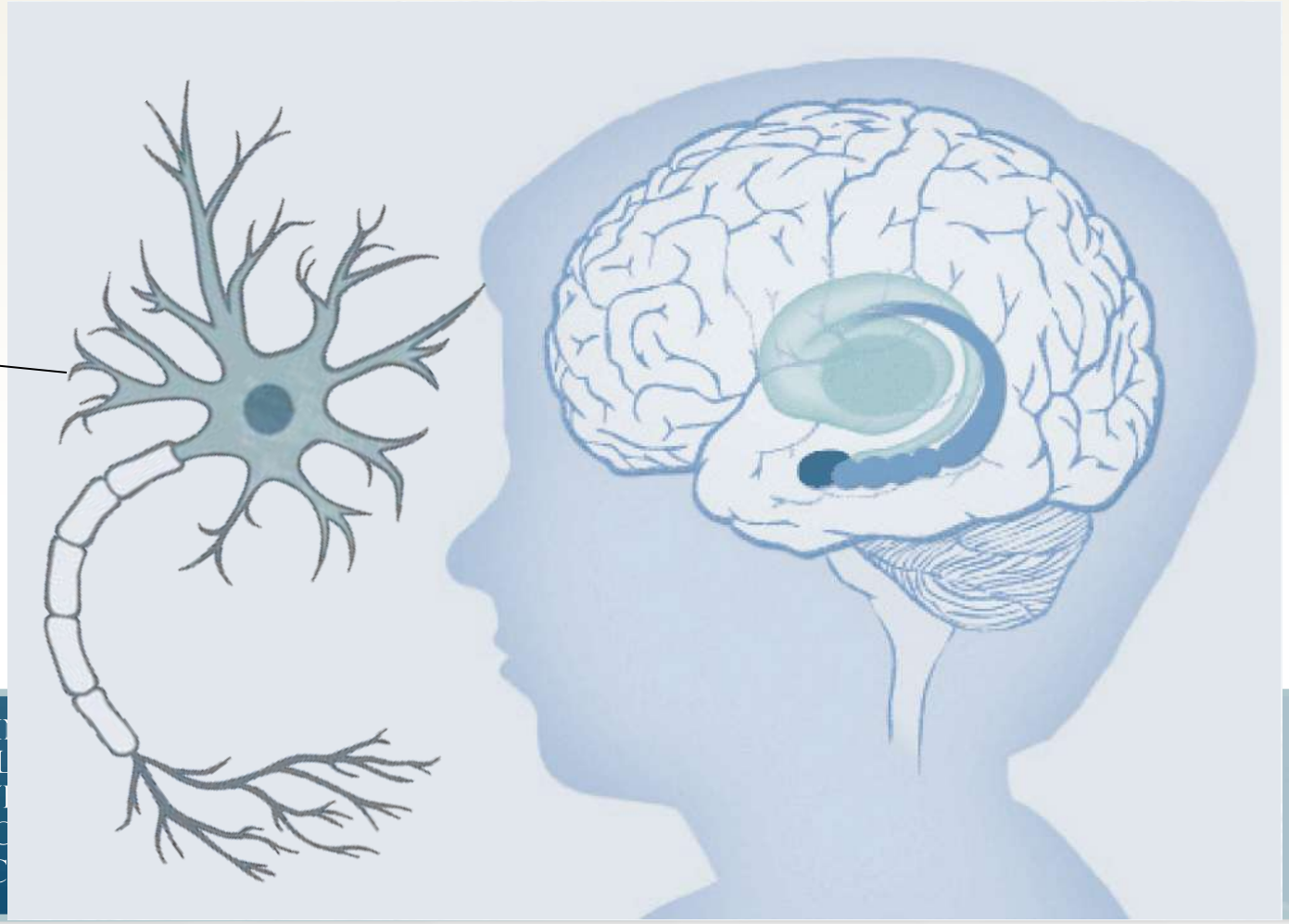


Caspi et al., Science, 2003, vol 301, 386-389.

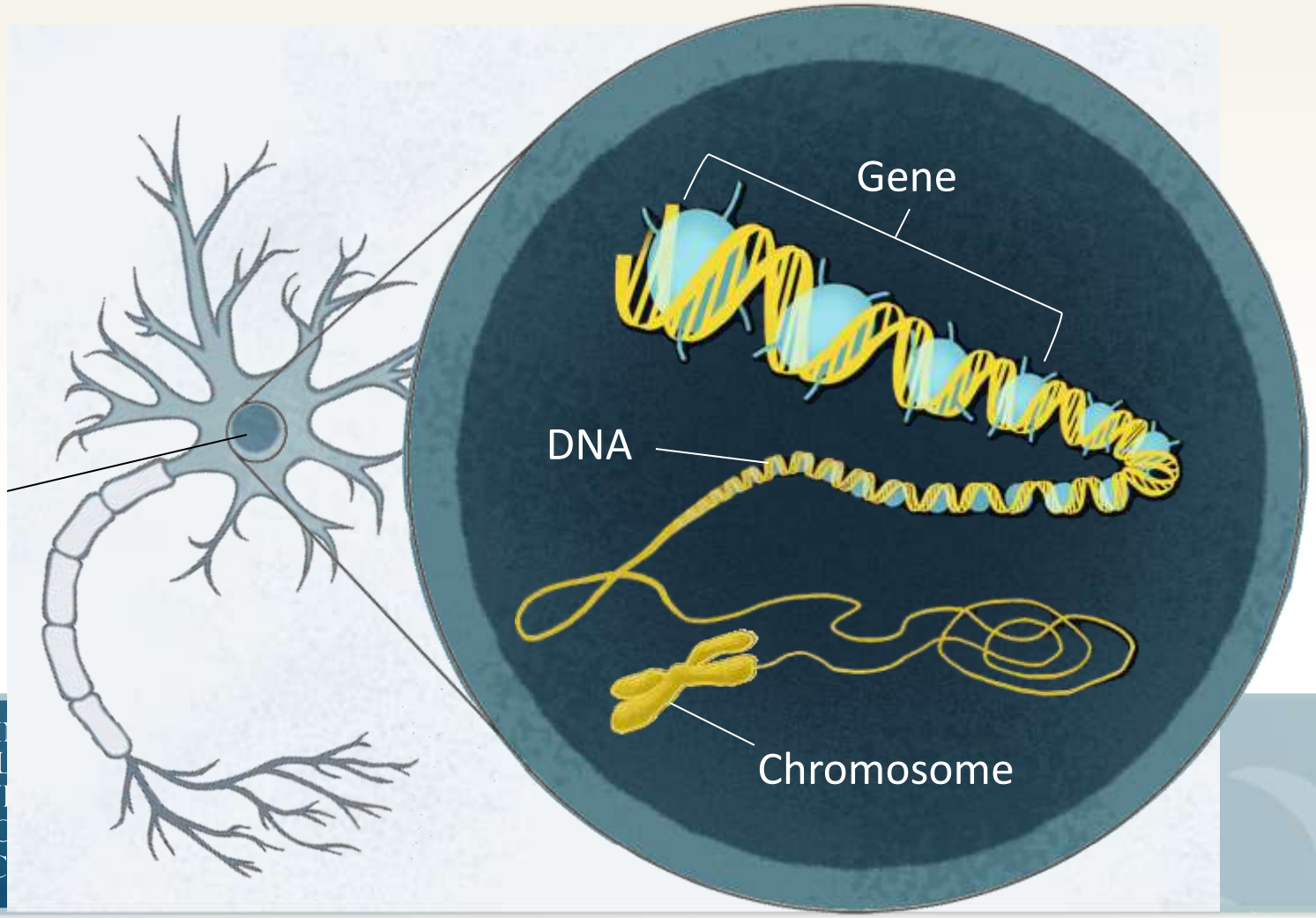


Belsky & Beaver, 2010

How Early Experiences Alter Gene Expression and Shape Development



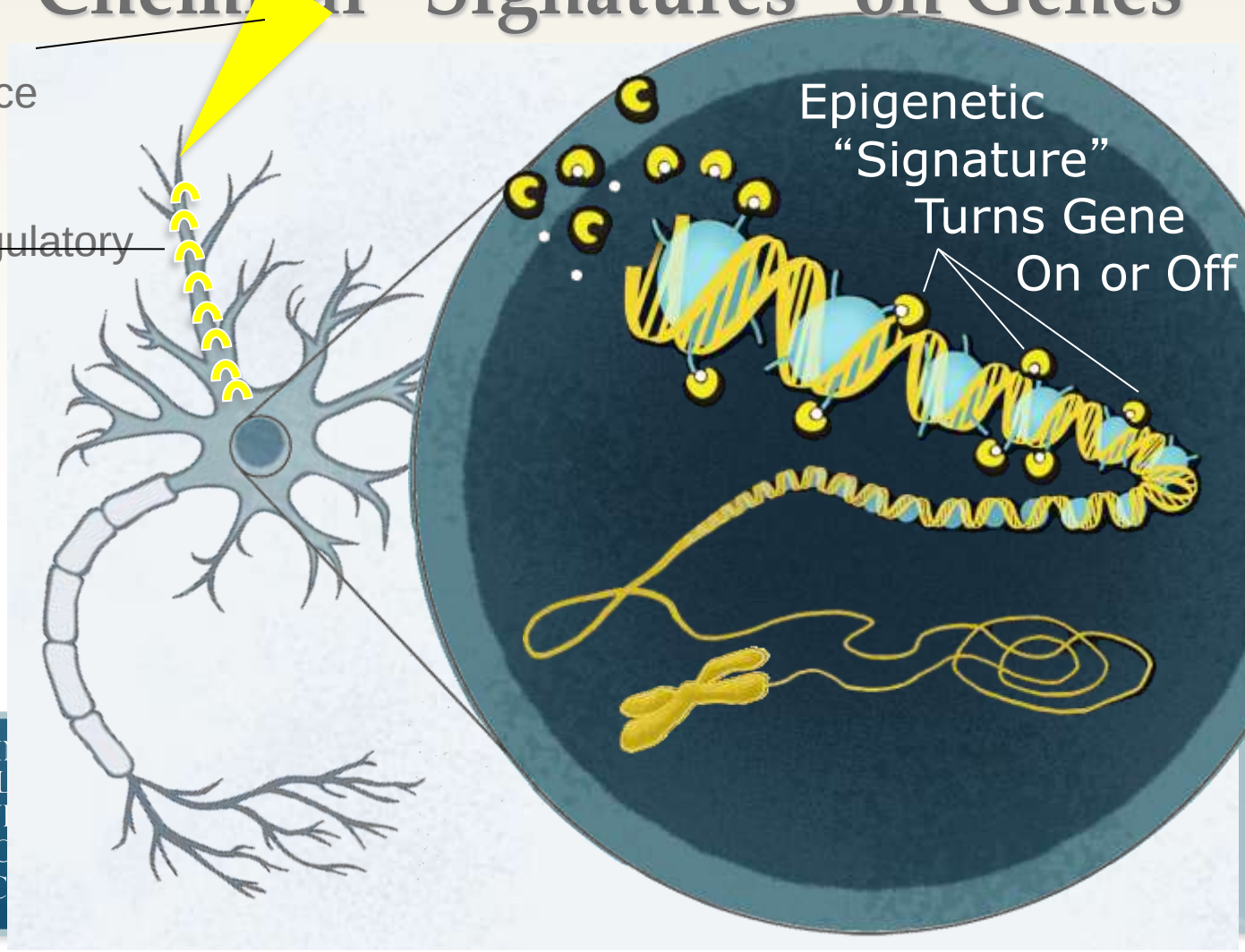
Genes Carry Instructions that Tell Our Bodies How to Work



Early E eriences Leave Lasting Chemi al "Signatures" on Genes

External Experience

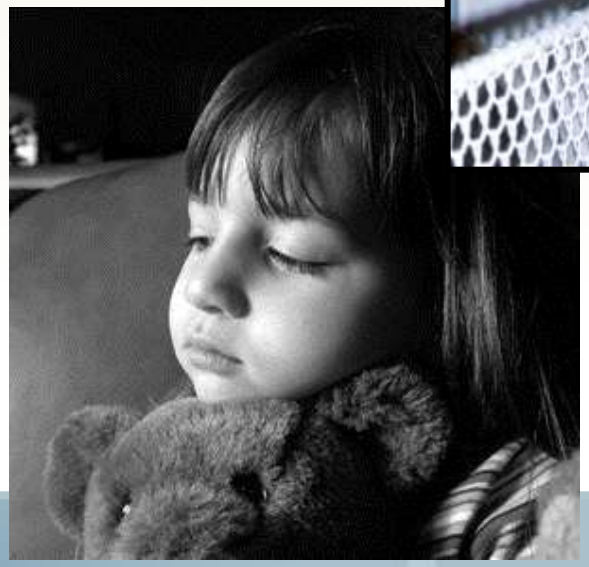
Gene Regulatory Proteins



Part II: Stress Regulation in Human Development

Supportive Caregiving

Neglectful Abusive Caregiving



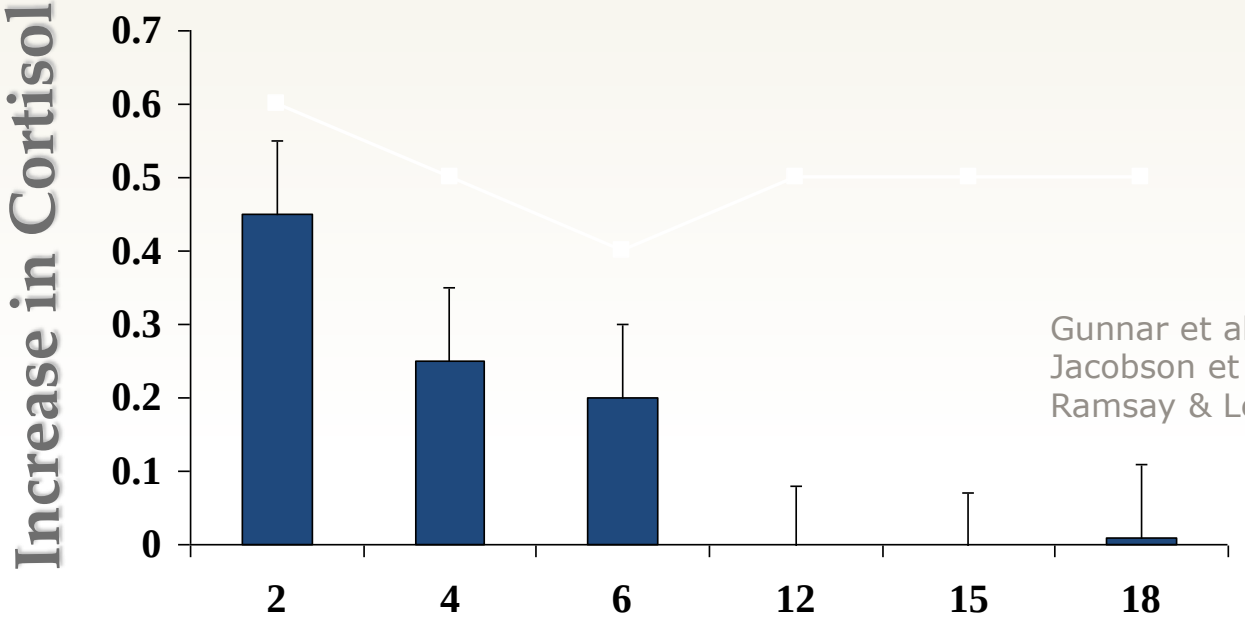
Newborns are Highly Cortisol Reactive

Takes very little to elevate cortisol in newborns

Cortisol rises near the end of gestation

Cortisol help mature tissues, like the lungs, to prepare the baby for life outside the womb.

Highly Buffered System Emerges Over 1st Year



Gunnar et al, Child Dev, 1996
Jacobson et al., Dev Psychopath, 1999
Ramsay & Lewis, Child Dev, 1994

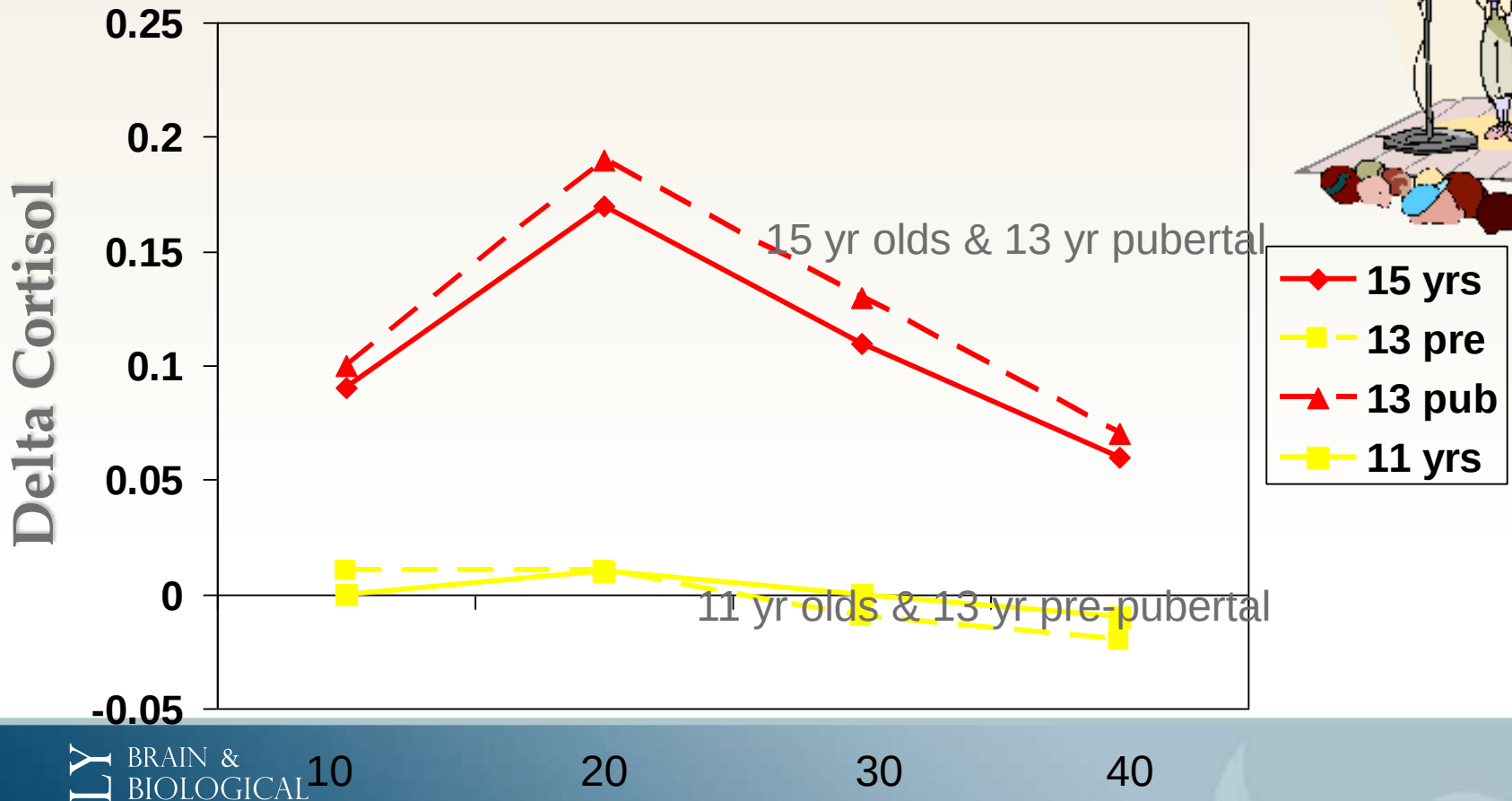
Buffered Stress System Demonstrated: 12 months to 12 yrs

Exams/Shots
30 min Separations
Strange/Novel Events
Speech Stressors

All these events elicit distress/fear/shyness AND Heart Rate Increases But not activation of the HPA (or SAM) system

EARLY BRAIN & BIOLOGICAL DEVELOPMENT: A SCIENCE IN SOCIETY SYMPOSIUM

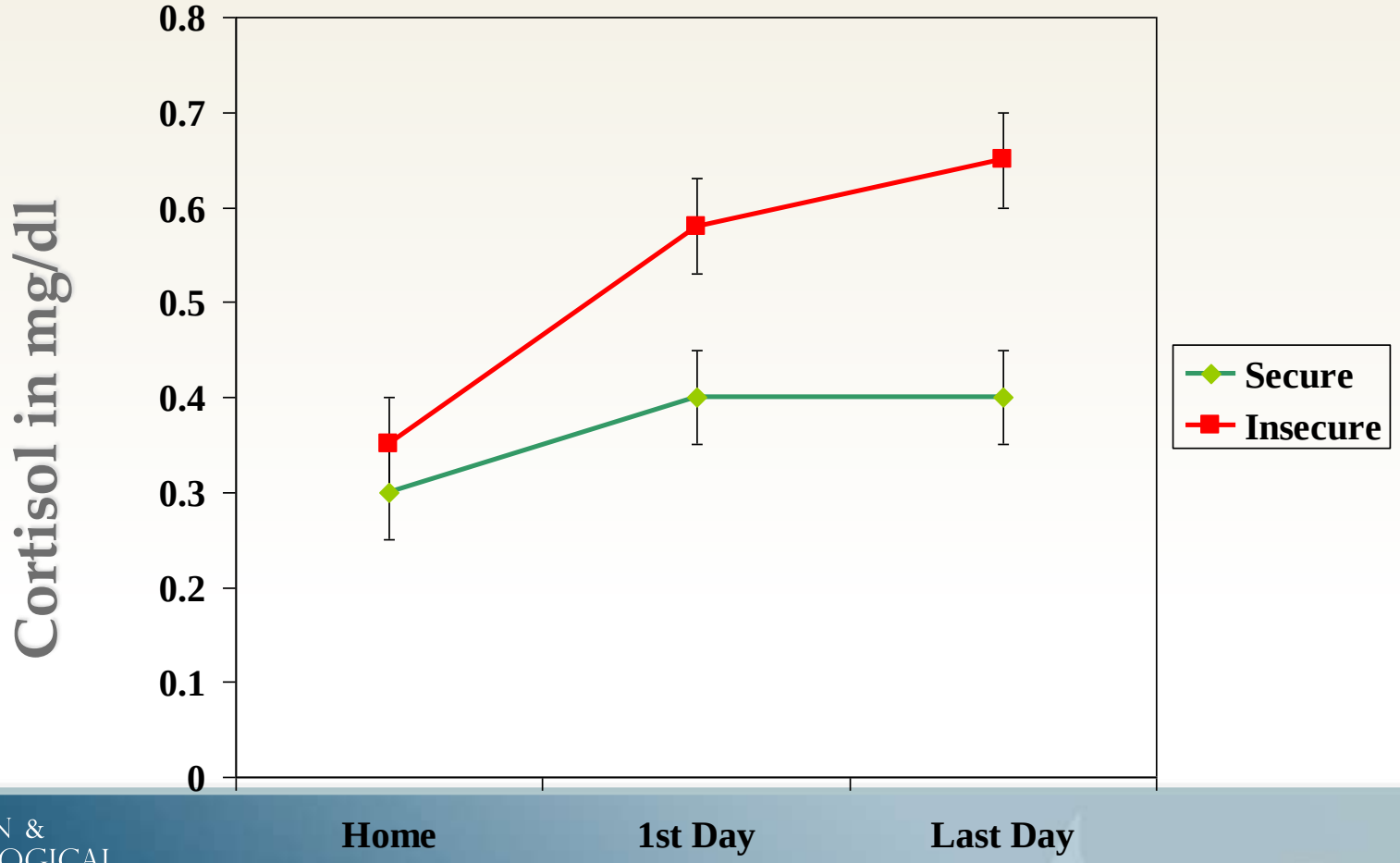
Puberty and Cortisol Reactivity: TSST-C



Secure Attachment Buffers Cortisol Response Among Fearful Toddlers

Nachmias et al.(1996). Child Development, 67(2), 508-522.

Mother's Presence Buffers Cortisol Response to Entering Child Care Among Securely Attached Toddlers



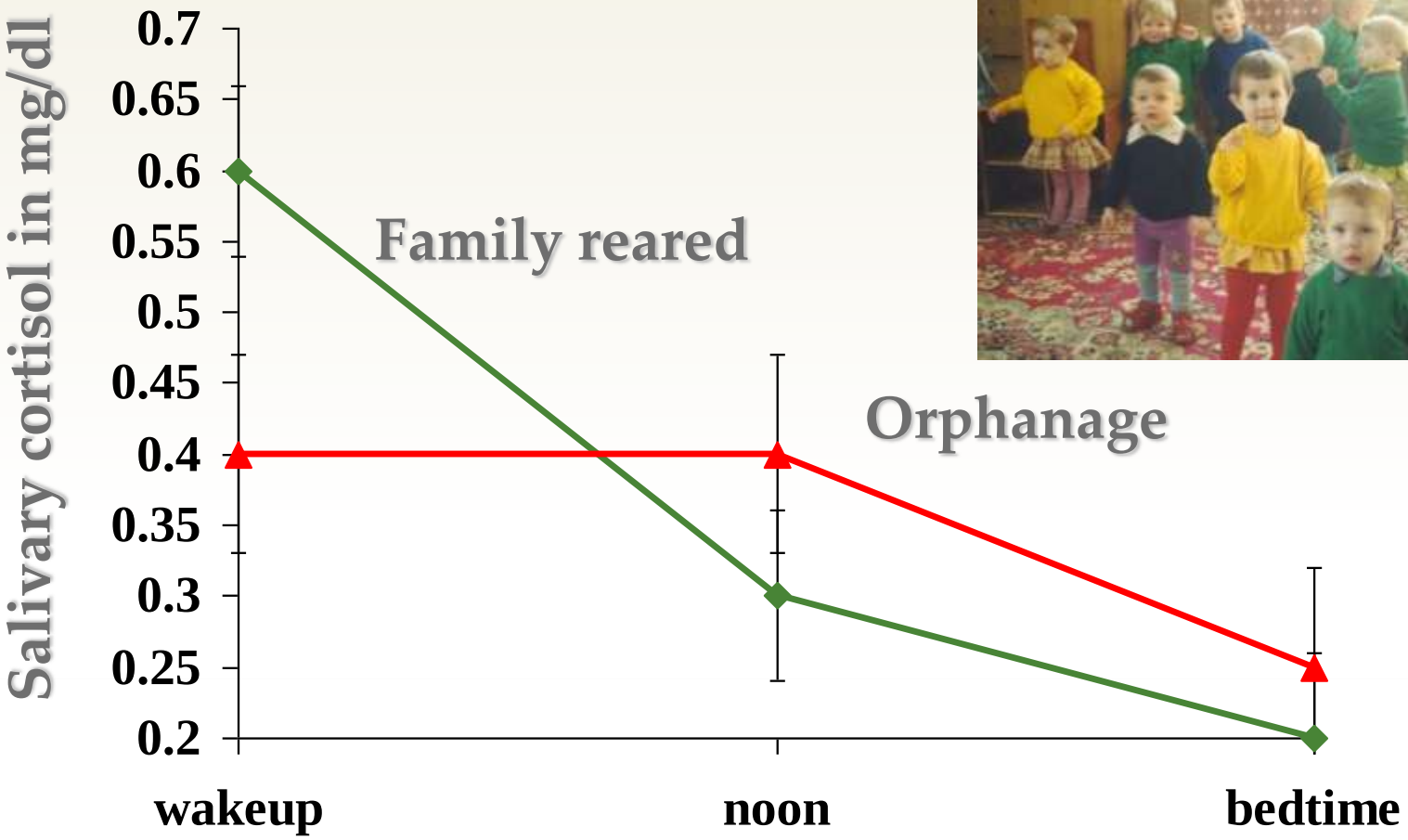
Ahnert et al Child Development, 2004

Sensitive/Response Care Buffers Stress Hormones in 9-month-olds

Most institutions provide reasonably adequate physical care and nutrition

Lack individualized “serve and return” care by consistent caregivers

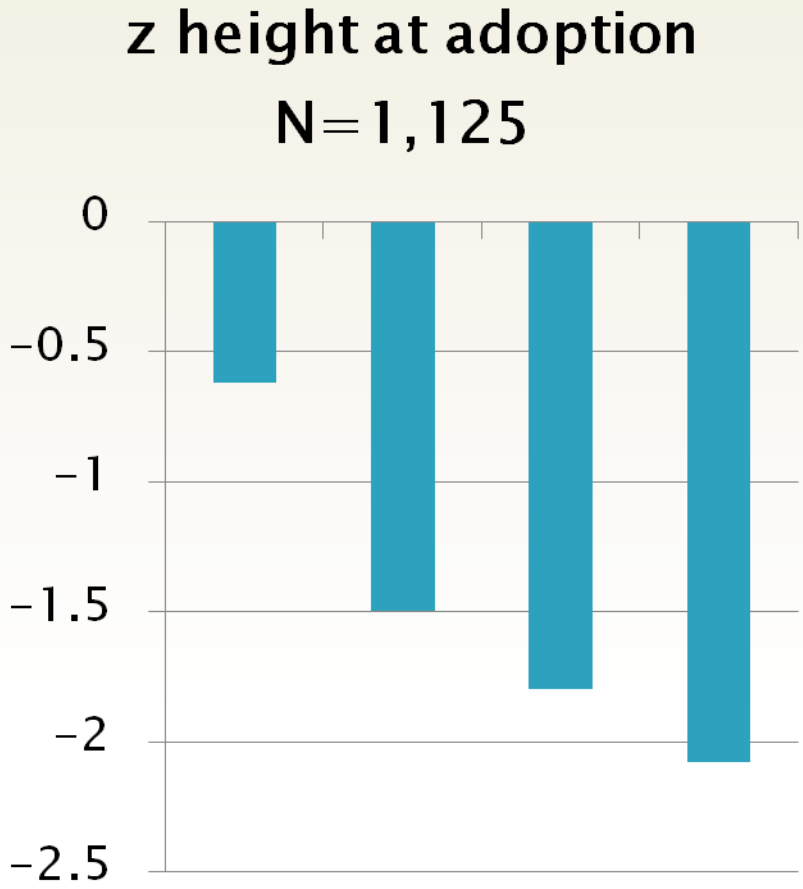
Lack of Daily Patterning in Cortisol Production For Children in Romanian Orphanage



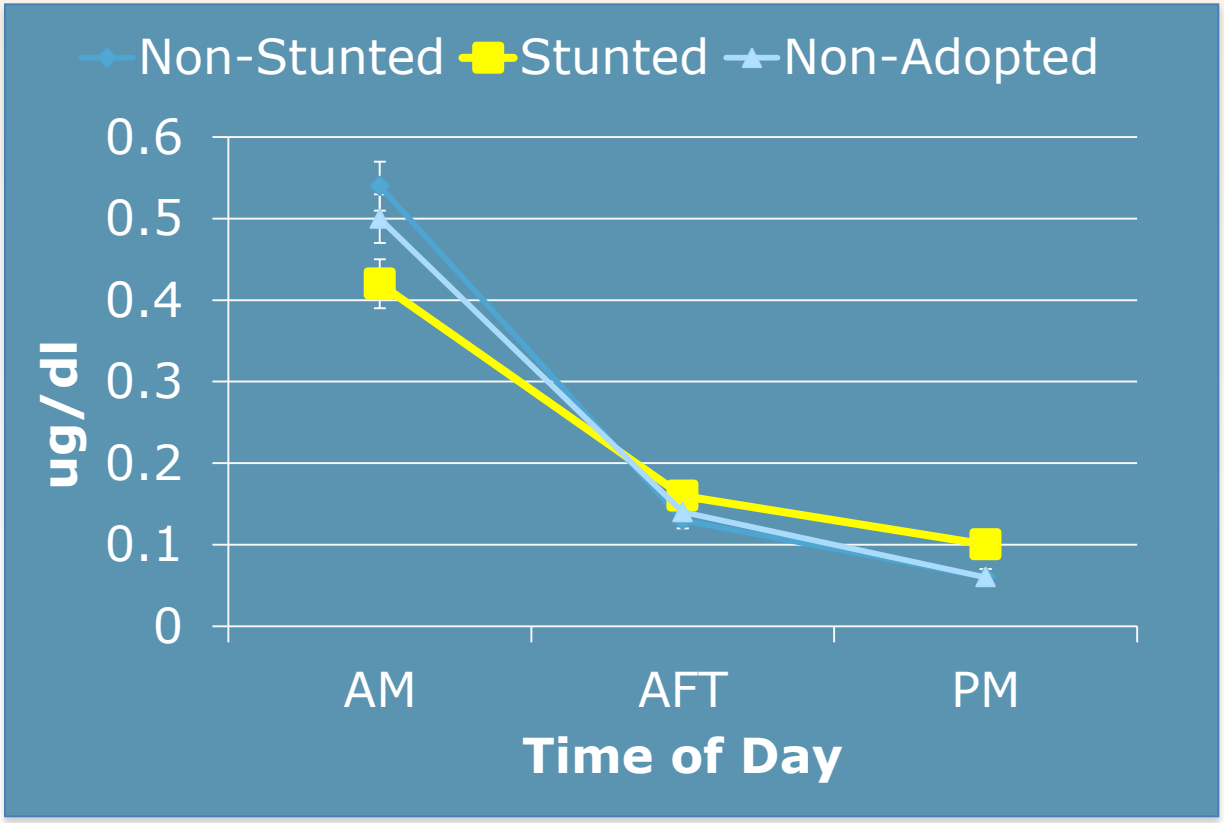
Carlson & Earls, Annals NYAS, 1997

With adoption, deprivation ceases

Growth (Height) Suppression in Institutionalized Children



Stunting and Diurnal Cortisol 4 Years Post Adoption



Conclusions

Adverse early life experiences increase the risk of physical and mental disorders, including increased risk of drug and alcohol abuse.

The biology of stress helps to explain how early adversity gets "under the skin" to produce the changes in brain and body that increase these risks

Healthy development does not mean preventing children from experiencing stress; it does mean making sure that children have secure and consistent relationships that help them regulate stress so that they do not experience prolonged activation of stress biology that becomes toxic to their development.

Conclusions--- Continued

Healthy development does mean making sure that children have secure and consistent relationships that help them regulate stress so that they do not experience prolonged activation of stress biology that becomes toxic to their development.

Some genes make children more susceptible to adverse early life care; but remarkably we are finding that the same genes may confer positive effects if the child grows up in a supportive environment. The more we learn about genes, the more we understand how important children's environments of relationships are to how they develop.

Responsive and sensitive "serve and return" care or its lack early in life writes on our genes, affecting how they work throughout life.

Staff, Students, & Collaborators

Early Experience, Stress and Neurobehavioral Development Center, NIMH

Experienced-Based Brain and Biological Development Program, CIFAR

National Scientific Council on the Developing Child-Harvard Center

Collaborators:

Ahnert, Cicchetti, Ames, D. Phillips, P. Phillips, Fox, Pollak, Dozier, Pears, Bruce, Thomas

Gunnar Laboratory Past and Present

Donzella, Mliner, Frenn, Davis, Kroupina, Kertes, Nachmias, Hart, Tout, Sebanc, Watamura, Wiik, Loman. Talge, Quevedo, Hostinar, Johnson, Esposito, and others