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Risk and Reward: The Core Story Of Healthy Brain Development – The Power of Early Experience Across Generations

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The Core Story

#1 - Child development is <u>the</u> foundation of prosperous communities

#2 - Brains are built over time, from the bottom up (skill begets skill)

#3 - Genes and experiences together build brains (serve and return relationships)

#4 - Cognitive, social and emotion development are inextricably intertwined

#5 - Toxic stress damages brain architecture

#6 - Resilience is not an internal character strength, but rather is built through combined impact of genes and experiences of a child

#6 - For many functions, the brain's capacity for change decreases over time (cost-effectiveness factor) - but not all functions are impacted equally

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Building Healthy Brain Architecture – The Ingredients

- Our genes, and ultimately our developing brain architecture, are influenced powerfully by positive early experiences—and negative ones, too.

- Genes provide the hardware, but early experience is the software that drives the system.

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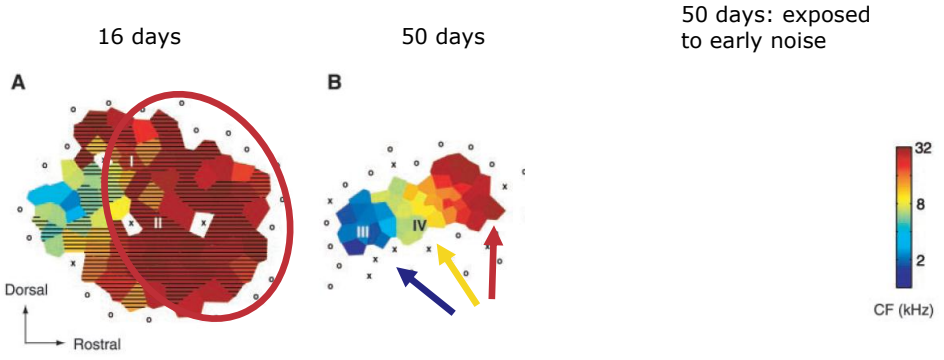
Early Experiences Establish How Senses Form



Source: Chang & Merzenich (2003)

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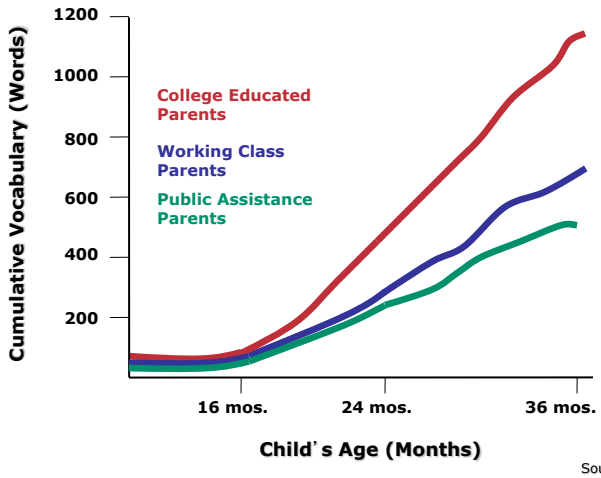
Exposure to Complex Language Repertoire Begets Complex Language Repertoire



Source: Hart & Risley (1995)

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Study Impact of Early Secure Relationships in Foster Care

Oosterman et al, Devel. Psychopath 2010

- Children ages 22-84 months
- All placed in at least 1 prior family
- Monitor attachment quality with current family
- Measure Sympathetic/Vagal Reactivity

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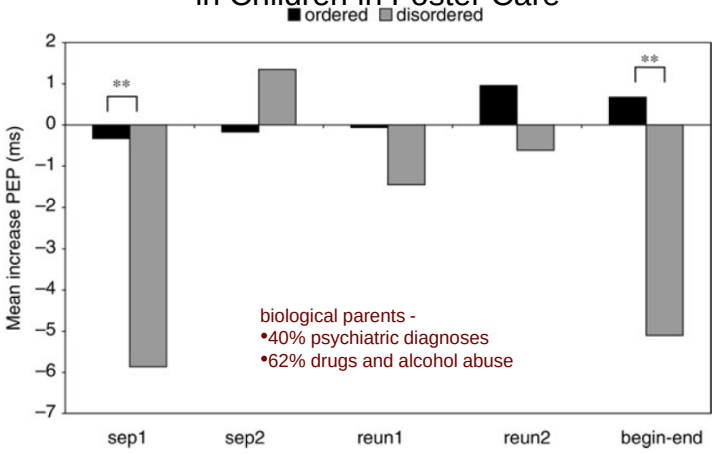
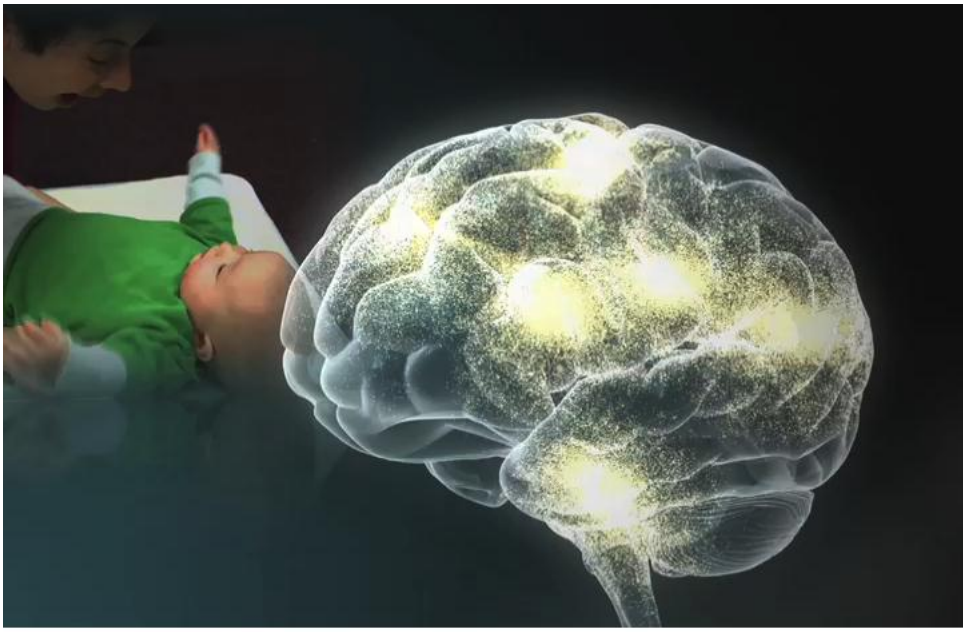
Sympathetic Regulation is Disrupted in Disordered Attachment
in Children in Foster Care



Oosterman et al, Devel. Psychopath 2010

Interaction as Serve and Return



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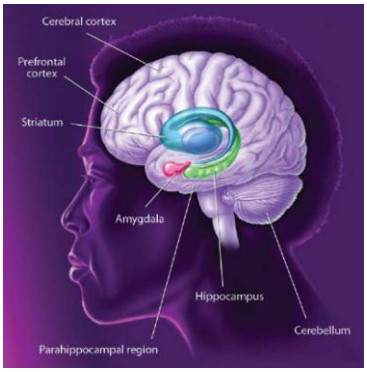
Social-Emotional and Cognitive Skill Building are Interconnected

The Brain Architecture of Anxiety and Fear



The Brain Architecture of Learning and Memory

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Executive Function – Our Air Traffic Control System (Top-down)

Volitional Control Over:

- **Attention (selective attention, interference suppression)**
- **Working memory representations (our file drawer of information)**
- **Long-term memory (controlled retrieval)**
- **Actions (response inhibition; response selection)**
- **Emotions (emotional suppression; reappraisal)**

the best early predictors of problems to come and to remain

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How Do We Test Executive Function

"Say the name of the color that the word is printed in"

Red

Green

Black

Blue

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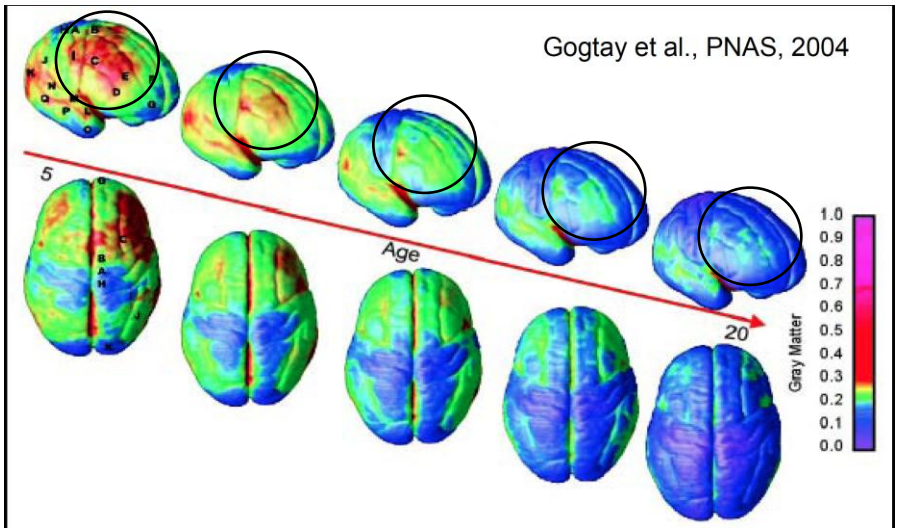
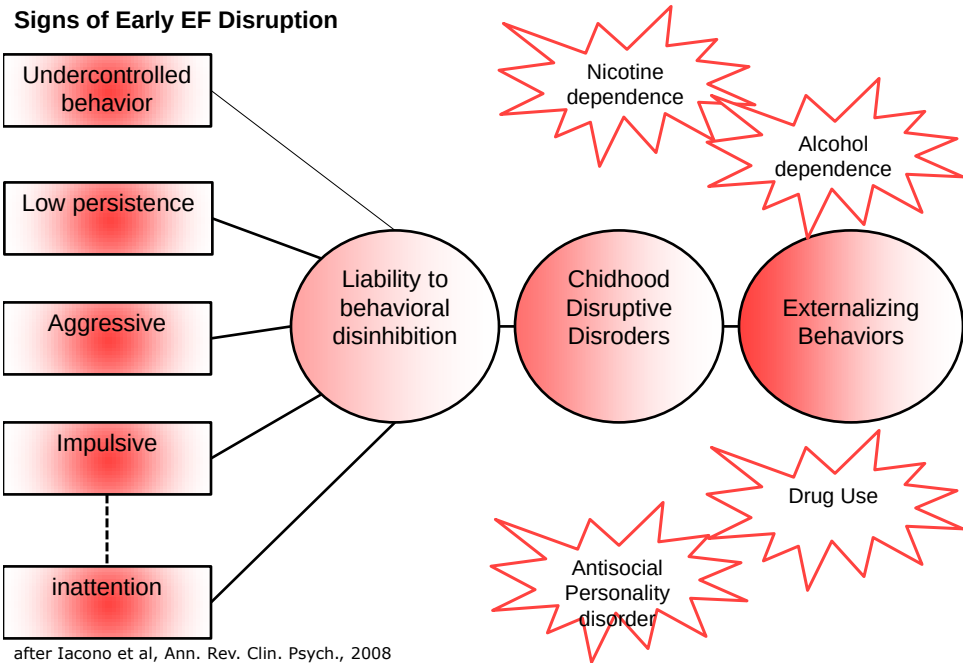
The Brain Architecture That Is Responsible for Executive Function Appears Early, But Is Refined Over a Long Period of TIme





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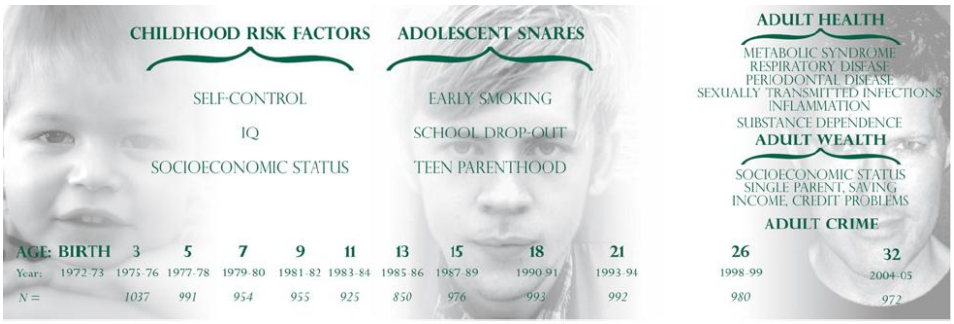
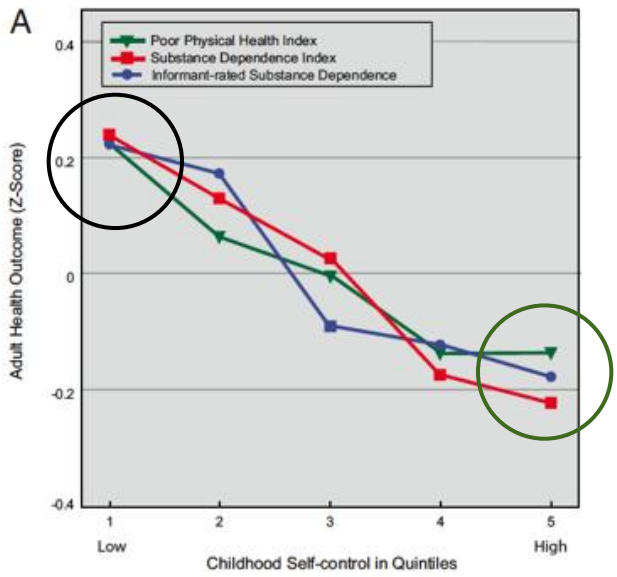
Early Executive Function Disruption - Predictor of At-Risk Adolescents and Adults

The Dunedin Study



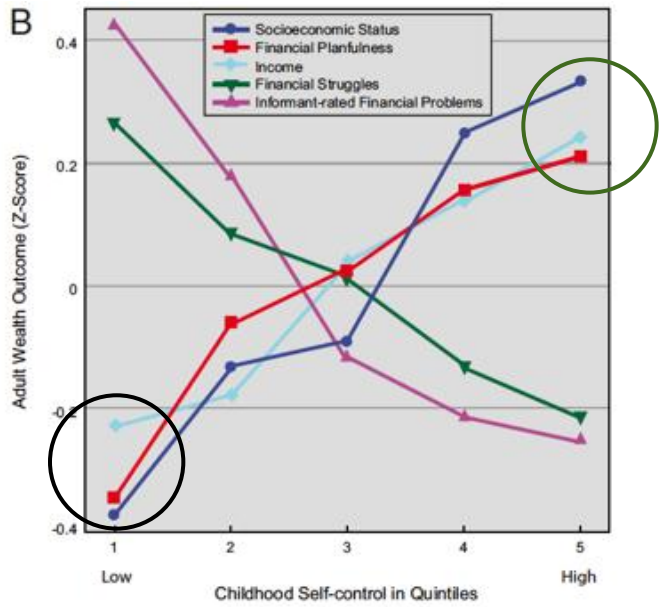
Moffitt et al PNAS 2011

Early Executive Function Disruption - Adolescents and Adults At-Risk for Physical Health and Substance Abuse Problems



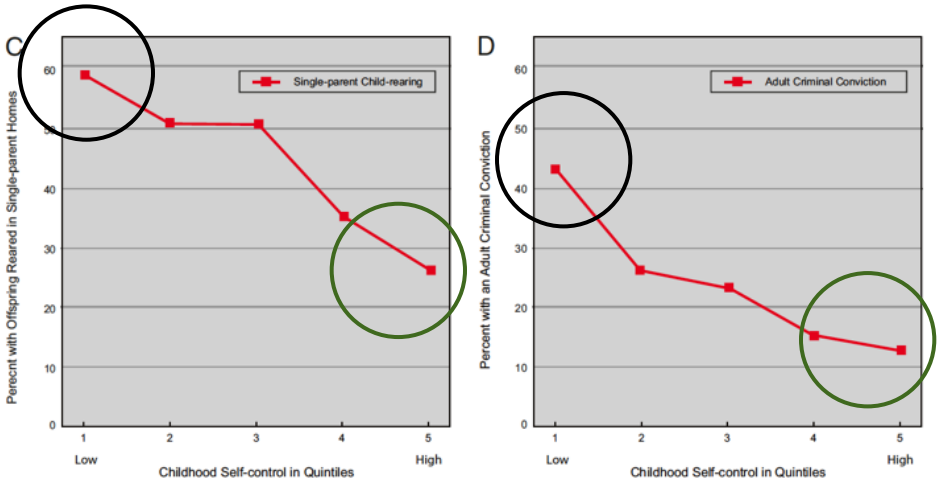
Moffitt et al PNAS 2011

Early Executive Function Disruption - Predictor of Adolescents and Adults At-Risk for Financial Problems



Moffitt et al PNAS 2011

Early Executive Function Disruption - Predictor of Adolescents and Adults At-Risk for Parental Challenges and Criminal Convictions



Moffitt et al PNAS 2011

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A Major Challenge:

Why does early toxic stress have long-lasting effects?

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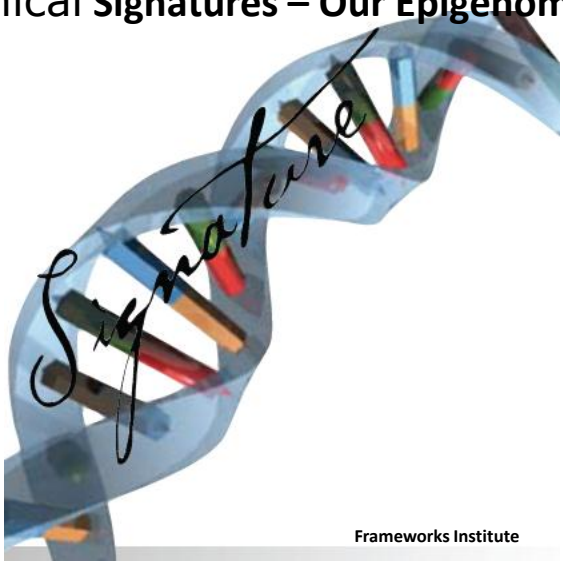
Creation of Chemical Signatures – Our Epigenome

- Experiences
- Malnutrition
- Emotional stressors
- Oxidative stressors
- Immune challenges



Frameworks Institute

The Signature Can Control When and Where Genes are Expressed

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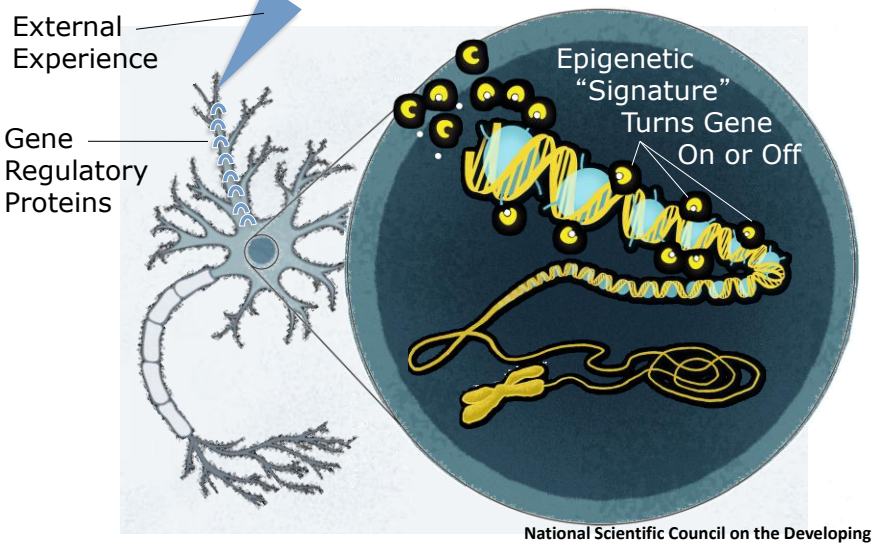
Early Experiences Leave Lasting Chemical "Signatures" on Genes



National Scientific Council on the Developing Child

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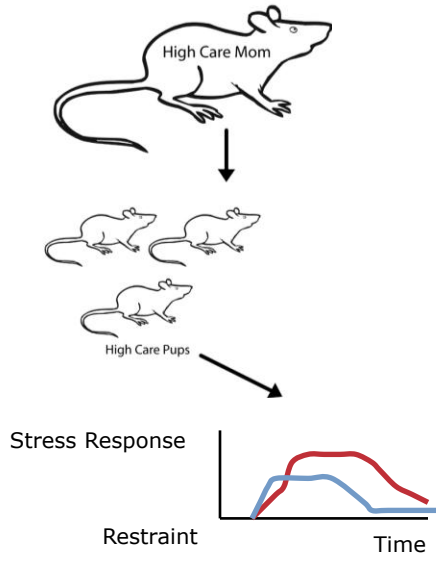
Experience Affects Stress Response for a Lifetime!



Source: Meaney et al. (200?)

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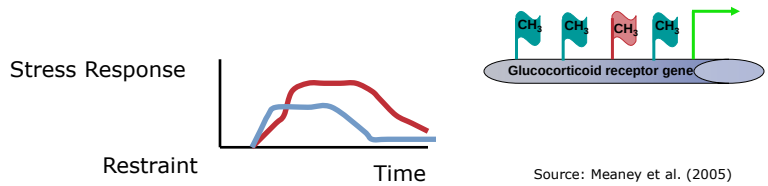
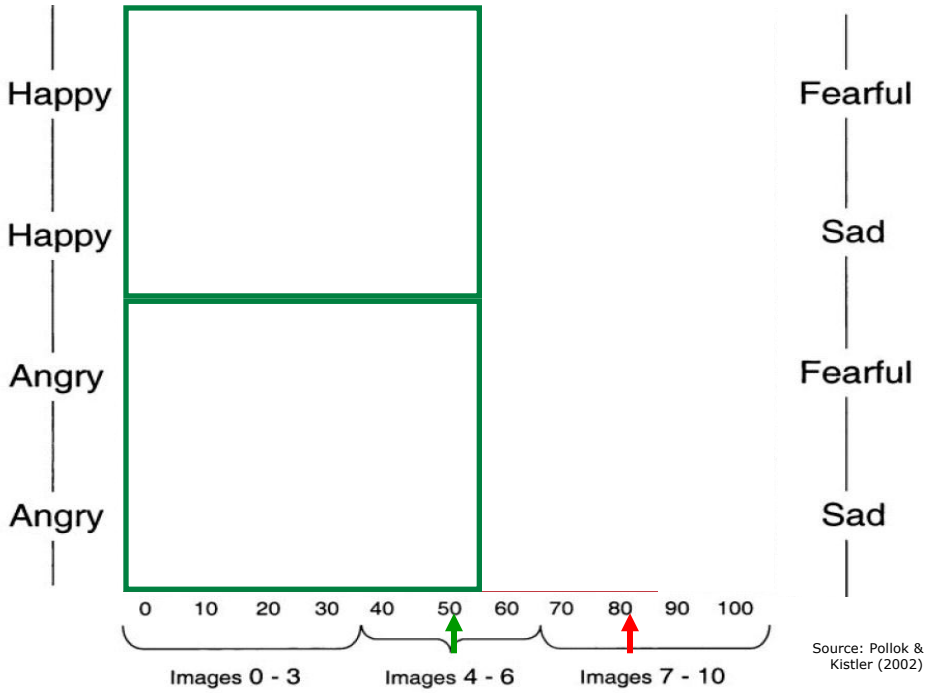
How Experience Influences Genes



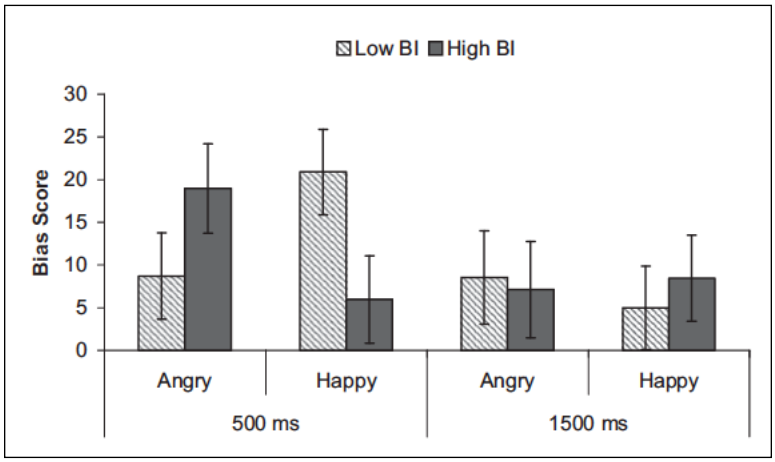
Source: Meaney et al. (2005)

Pollak - Faces Tell the Story



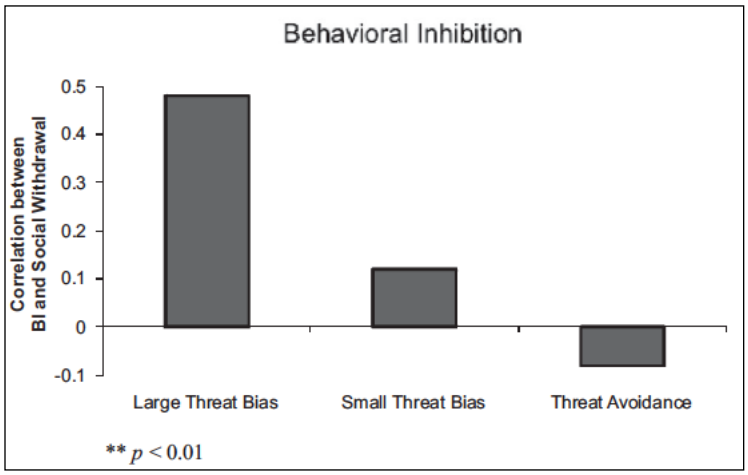
Source: Pollok & Kistler (2002)

Early Behavioral Inhibition Predicts Attentional Bias to Threatening Stimuli



Perez-Edgar, Biol. Psych. 2010

Early Behavioral Inhibition Predicts Social Withdrawal as a Teen



Perez-Edgar, Biol. Psych. 2010

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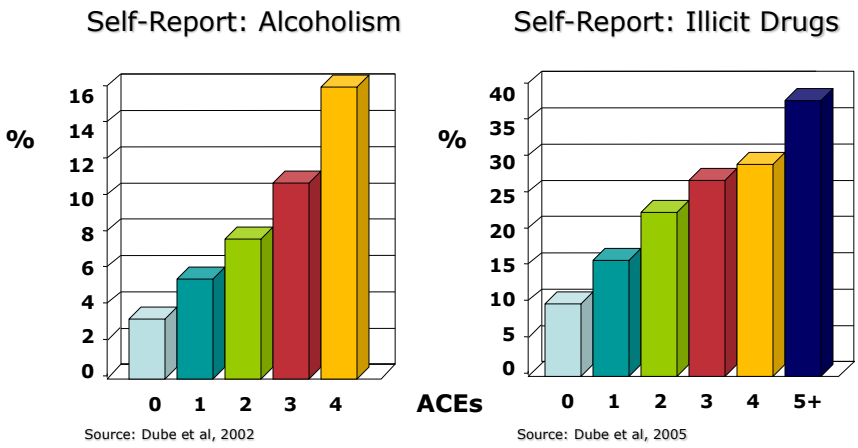
Risk Factors for Adult Substance Abuse are Embedded in Adverse Childhood Experiences



Schilling et al, BMC Public Health 7 (2007)

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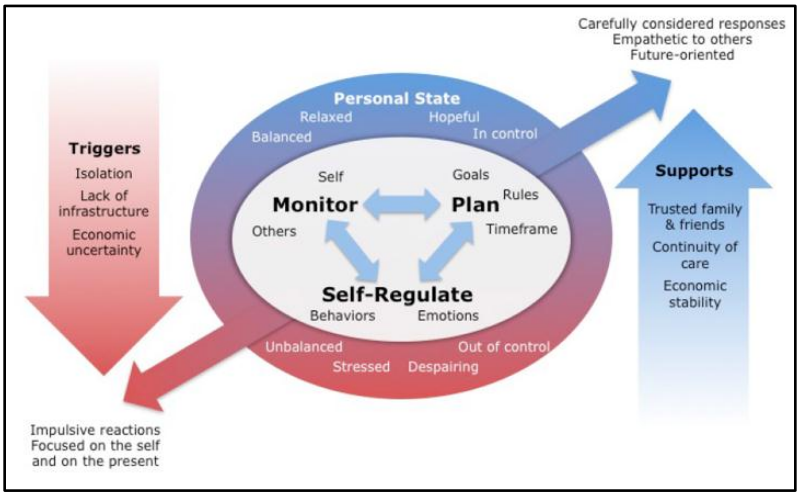
The Implications of the Research – Caregiver Capacities Matter



J. Shonkoff, Harvard Center for the Developing Child

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Developmental Programming

Fetal Programming and Environmental Exposures: Implications for Prenatal Care and Pre-Term Birth

June 11 - 12, 2012
The New York Academy of Sciences

Presented by the New York Academy of Sciences and Cincinnati Children's Hospital Medical Center

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Early Experiences Can Transmit Across Generations

Maternal diet change during pregnancy causes changes to offspring's **fur color**, **obesity**, and **cancer risk** in genetically identical mice.

Source: Jirtle & Skinner (2007)

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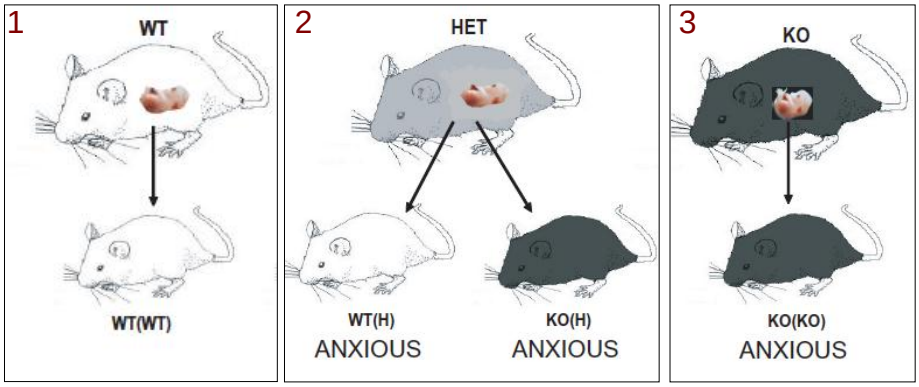
Maternal Genetics Influences Emotional Outcome



1 - Not Surprising
3 - Not Surprising
2 - Surprising

Gleason et al Front. Psych. 2011

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But why is the normal mouse anxious?

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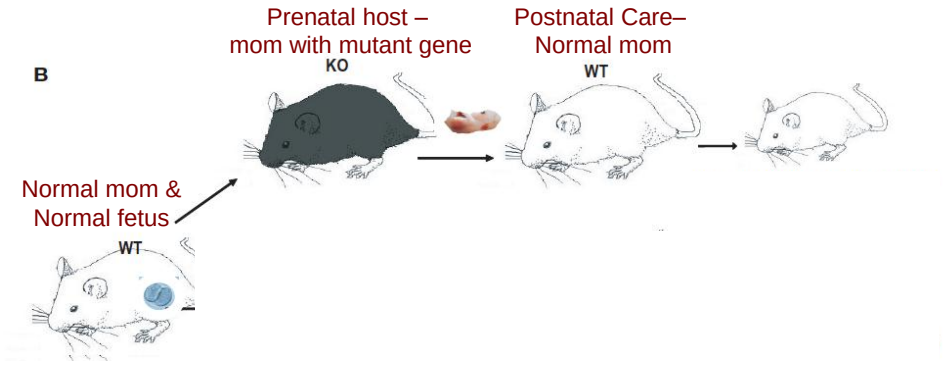

Gleason et al Front. Psych. 2011

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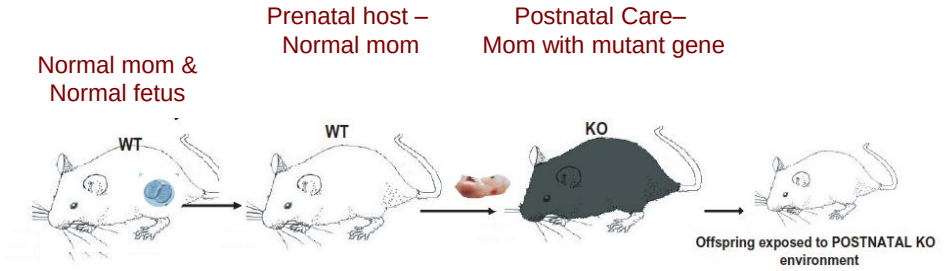

Offspring – Normal!

Gleason et al Front. Psych. 2011

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What does this mean?

Here, the intergenerational transmission comes from a prenatal factor influenced by the gene mutation

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Possible Origins

- Maternal mutation increases risk for adverse response to stress
- Maternal mutation changes production of biological factors that influence fetal development
- Mutation influences disrupted prenatal behavior/decision-making
- A mystery

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So early means early

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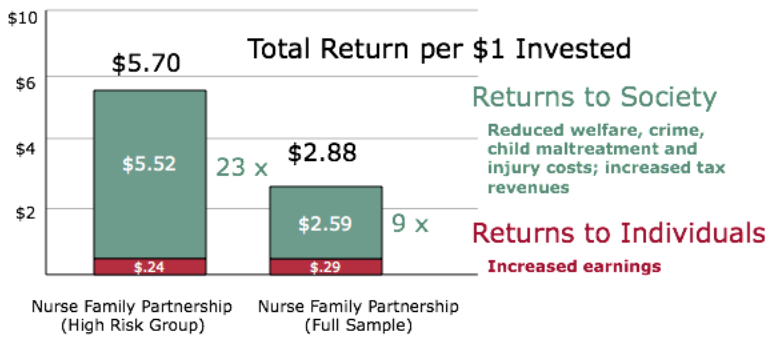
Cost/Benefit Data on Nurse Family Partnership

(Dollars returned for each dollar invested)



Source: Karoly et al. (2005)

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Context Clearly Matters – for caregiver and child

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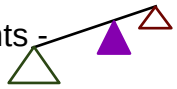
The Dandelion and the Orchid Child

The Orchid Child

- Context-dependent

-e.g. high stress-reactive in highly adversity environments - poorer outcomes

-e.g. high stress-reactive in low adversity environments - better outcomes



cf. Obradovic et al, Child Development 81 (2010)

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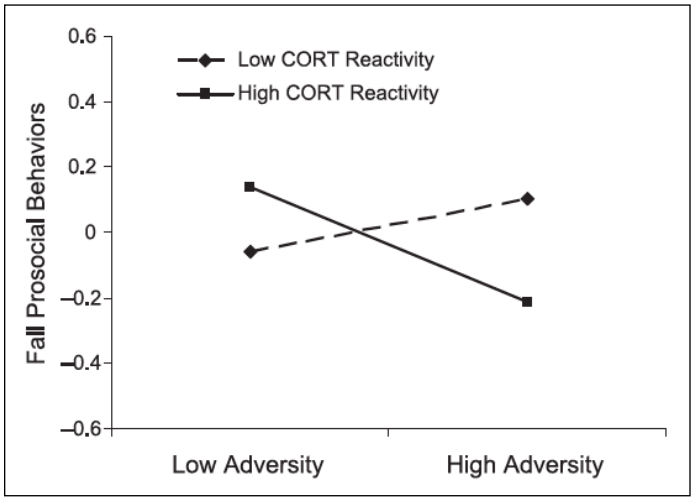
Context Drives Behavior Differently
in Children with Different Physiology



Orbadovic et al, 2010

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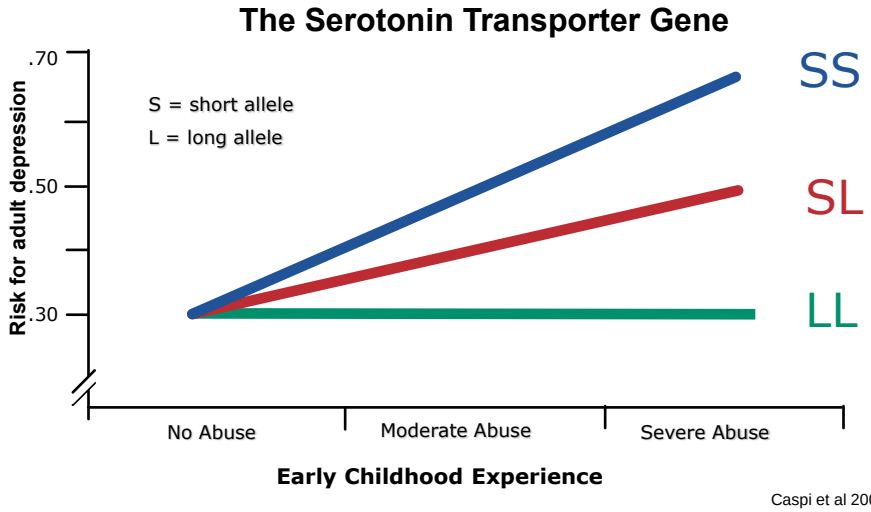
Really, genes and context matter

Resilience is Related to the Interaction Between Genetics and Experience



Caspi et al 2003

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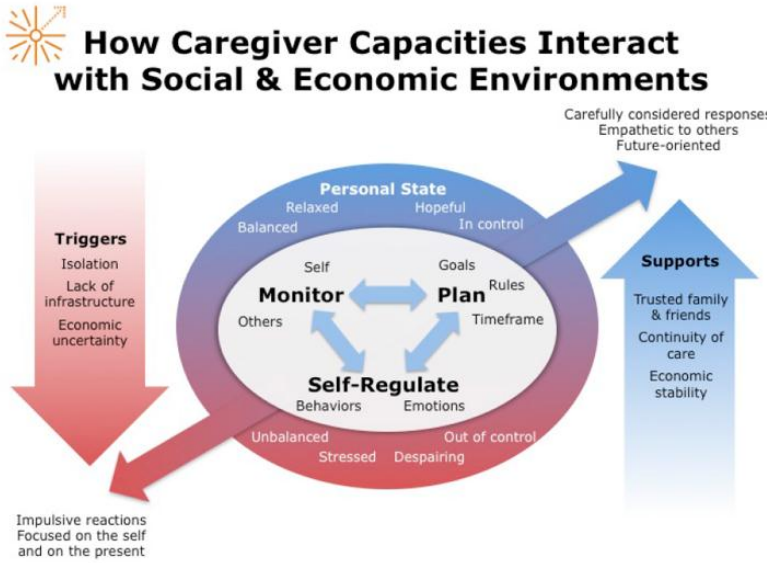

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So what is the science telling us?

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Think Broadly About Children's Environment of Relationships

- Plan from pregnancy, and look beyond education and health care.
- Invest in the development and retention of a skilled workforce in early childhood and public education.
- Make sure vulnerable children have access to stable, supportive relationships with adults—as early and as consistently as possible.
- Skill development for 'serve and return' in adults is a way forward - **FOI**

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Policy Changes - What Can They Mean?

Reduce special needs populations; increase emotionally sound, learning-ready children with sound Executive Function

Invest Early

Major increase human capital via ready workforce

It's

Patriotic

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Neuron 67:689 (2010)
NeuroView

Neuroscience and the Future of Early Childhood Policy: Moving from Why to What and How

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