Translating Brain Science into Positive Impact for Wisconsin’s Children and Families

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A First Fundamental

“A baby alone does not exist.”

D.W. Winnicott, 1965
What the Public Has Thought Regarding Child Development

Successful child

Unsuccessful child

But it has changed.........
The Core Story

#1 - Child development is the 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.
Experience Shapes Brain Architecture by Over-Production Followed by Pruning Through Childhood
Two Key Principles

• Development is not a blank slate (i.e. children are not sponges; the brain is experience expectant)

• Skill begets skill (a strong foundation increases odds for positive outcomes)
Extreme Early Experiences Can Dramatically Disrupt How Senses Form

Source: Chang & Merzenich (2003)
Exposure to Complex Language Repertoire Begets Complex Language Repertoire

Cumulative Vocabulary (Words)

Child’s Age (Months)

College Educated Parents

Working Class Parents

Public Assistance Parents

Fernald et al 2012
Brain Growth and Poverty

Hanson et al, PLoS One 2013
Social-Emotional and Cognitive Skill Building are Interconnected
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The Brain Architecture of Anxiety and Fear

The Brain Architecture of Learning and Memory
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)
How Do We Test Executive Function

“Say the name of the color that the word is printed in”
Red
Green
Black
Blue
Liability to behavior disinhibition

Undercontrolled behavior

Low persistence

Aggressive

Impulsive

inattention

Chidhood Disruptive Disorders

Externalizing Behaviors

Nicotine dependence

Alcohol dependence

Drug Use

Antisocial Personality disorder

Low education achievement

Signs of Early EF Disruption

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

The Dunedin Study
Early Executive Function Disruption - Long Term Impact

Moffitt et al PNAS 2011

![Line graph showing the relationship between executive function (EF) and poor health outcomes. The graph illustrates that as executive function decreases (from low to high), poor health outcomes increase.](Moffitt et al PNAS 2011)
Early Executive Function Disruption - Long Term Impact

Moffitt et al. PNAS 2011

Diagram showing the impact of low and high EF on adult criminal conviction rates.

- Low 'EF': 40% conviction rate
- High 'EF': 0% conviction rate

Moffitt et al. PNAS 2011
Early Executive Function Disruption - Long Term Impact

Moffitt et al. PNAS 2011

The graph illustrates the relationship between adult outcome and executive function (EF) disruption. The x-axis represents low ('EF') and high ('EF') executive function, while the y-axis shows the adult outcome. The graph shows a positive correlation, indicating that higher executive function is associated with better adult outcomes.
Early Executive Function Disruption - Long Term Impact

Moffitt et al PNAS 2011
The extended development of ‘EF’ establishes both greater vulnerability and opportunity
A Taxonomy of Adverse Childhood Experiences (ACEs)
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.
NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD
We know that:

Early Adverse Experiences (ACEs) contribute directly to the risk for long-term physical and mental health.

Neglect is the Most Prevalent Form of Child Maltreatment

- Neglect
- Physical Abuse
- Other
- Sexual Abuse
- Psychological Maltreatment
- Medical Neglect

U.S. Dept. Health and Human Services, 2010
Powerful Impact of ACEs on Brain Architecture
Positive or Adverse Childhood Experiences – Impact on Brain Architecture

(PAPA-based)

Toxic Stress Damages Brain Architecture

Prefrontal Cortex and Hippocampus - EF Regions

Normal

Typical neuron—many connections

Toxic stress

Damaged neuron—fewer connections

Sources: Radley et al. (2004)
Bock et al. (2005)
Extreme Neglect - BEIP Follow-up at 8 years - Absolute Alpha Power

• Abuse - difficulty in distinguishing anger from other emotions, and difficulty disengaging

• Neglect - difficulty in distinguishing between any emotions, and poor face processing
Why does toxic stress have such long-lasting impacts?
Creation of Chemical Signatures – Our Epigenome

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

The Signature Control When and Where Genes are Expressed

Frameworks Institute
Early Experiences Leave Lasting Chemical “Signatures” on Genes

External Experience

Gene Regulatory Proteins

Epigenetic “Signature” Turns Gene On or Off

National Scientific Council on the Developing Child
“But I know someone who was ok after a traumatic childhood……”
Resilience - It’s Not About Rugged Individualism
Think of development as a scale--positive factors get put on one side and negative factors on the other--the way that the scale tips is like the outcomes of development

e.g. Risk Genes - SERT, MAOA, FKBP5
   e.g. Risk Environments - ACEs
What is the Neuroscience Telling Us?
The Ability to Change Brains of Children Decreases Over Time

Normal Brain Plasticity Influenced by Experience

Physiological “Effort” Required to Enhance Neural Connections

Source: Levitt (2009)
Classical Program Strategies That Do Work

• 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.
Second Language Proficiency and Timing

EF Development Correlates with Patterns of Structural Maturation

Gogtay et al., PNAS, 2004
Executive Function Interventions

The Recipe of Programs that Work
(4-12 yr old in clinical studies)

• Computerized training (CogMed) for working memory
• Reasoning and speed training - domain-specific
• Aerobic exercise (high dose - 40-70 min daily)
• Martial arts (inhibitory control, mindfulness)
• Curricula (*Tools of the Mind* - planning, inhibitory control)

reviewed in Diamond and Lee, Science 333 (2011)
Remember Serve and Return?
Current Conceptual Framework Guiding Early Childhood Policy and Practice

Significant Adversity

Healthy Developmental Trajectory

Impaired Health and Development

Parenting Education, Sound Nutrition, Stimulating Experiences, and Health-Promoting Environments
Building an Enhanced Theory of Change that Balances Enrichment and Protection

Significant Adversity

New Protective Interventions

Healthy Developmental Trajectory

Parenting Education, Sound Nutrition, Stimulating Experiences, and Health-Promoting Environments

Shonkoff, PNAS, 2012
How Caregiver Capacities Interact with Social & Economic Environments

Triggers
- Isolation
- Lack of infrastructure
- Economic uncertainty

Impulsive reactions
Focused on the self and on the present

Self-Regulate
- Behaviors
- Emotions
- Unbalanced
- Stressed
- Despairing

Personal State
- Balanced
- Hopeful
- In control

Monitor
- Self
- Others

Plan
- Goals
- Rules
- Timeframe

Supports
- Trusted family & friends
- Continuity of care
- Economic stability

Carefully considered responses
Empathetic to others
Future-oriented
Cost/Benefit Data on Nurse Family Partnership
(Dollars returned for each dollar invested)

Total Return per $1 Invested

Nurse Family Partnership (High Risk Group) $5.52
Nurse Family Partnership (Full Sample) $2.59

$5.70

Returns to Society
Reduced welfare, crime, child maltreatment and injury costs; increased tax revenues

Returns to Individuals
Increased earnings

$2.88

Source: Karoly et al. (2005)

- Multidimensional Therapeutic Foster Care (MTFC)
- Standard Foster Care

![Graph showing probability of a stable permanent placement against number of foster care placements prior to study.](image)

Source: Fisher, Burraston & Pears (2005)
Invest Early

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

Major increase human capital via ready workforce

It’s Patriotic
Thank You!

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http://www.developingchild.harvard.edu