The Science of Early Brain Development: Opportunities for Prevention / Early Intervention

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From Neurons to Neighborhoods

" . . . virtually every aspect of early human development, from the brain's evolving circuitry to the child's capacity for empathy is affected by the environments and experiences that are encountered in a cumulative fashion, beginning in the prenatal period and extending throughout the early childhood years."

– Shonkoff and Phillips, 2000

Brain Development

- **Brain's initial wiring is built by orchestrated series of genetic scripts**
- **Experience incorporated into the structure of the brain in two ways**
  - **Experience expectant development**
  - **Experience dependent development**

Experience Expectant Development

- **Species expected experiences**
  - **Complex auditory information facilitates the development of speech and language processing**
    - **Infants born knowing speech sounds are unique**

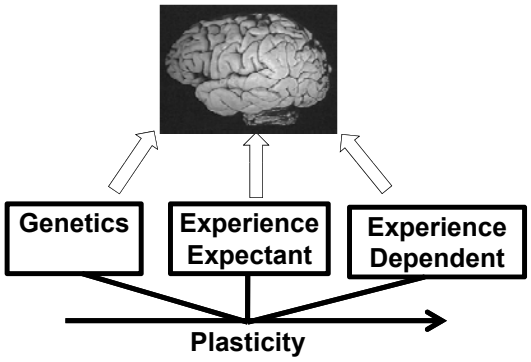
Experience Expectant Development

- Availability of a caregiver facilitates the development of attachments

Experience Dependent Development

- Unique to each person
- Active formation of new synaptic connections throughout the life span, based on individual's interaction with the environment
  - Learning math
  - Remembering events
  - Acquiring vocabulary

Survival of the Species



Early Experiences

- Crucible of infant experiences are in caregiving relationships
- Nurturing and responsive relationships build healthy brain architecture
- Absent buffering effects of early relationships, abnormal circuitry may result

Sensitive Periods in Brain and Behavioral Development

What Guides Brain Development?

- Synapse creation and elimination shaped powerfully by experiences
- After repeated stimulation, synapse stabilizes
  - Otherwise it tends to be eliminated
    - Use it or lose it principle

What Guides Brain Development?

- Pruning / recruitment of synapses occurs in response to experience

Experience and Neural Plasticity

- Impact of experience on brain is not constant throughout life
- In many domains, early experience often exerts a particularly strong influence in shaping the function of the immature brain
  - Referred to as a sensitive period

Experience and Neural Plasticity

- Sensitive period represents a time of susceptibility to specific input

Research Perspectives on Early Experience

Parenting Profoundly Affects School Readiness and Other Qualities

	Parenting
School readiness	.89
Expressive language	.85
Receptive language	.62
Social skills (m)	.61
Behavioral problems (m)	-.15
Social skills (t)	.72
Behavioral problems (t)	-.38
Positive peer interaction	.55
Negative peer interaction	-.27

m = maternal ratings t = teacher ratings

Atypical Caregiving Environments: Limitations on Research with Humans

- Few studies designed to test early experience hypotheses
- Need for studies that examine experience significant change in caregiving environment

– O'Connor and Parfitt, 2009

Ideal Study to Assess Timing

- Comprehensive assessments of infants who have experienced uniform early adversity
- Randomly assigned to interventions that vary systematically in the age at which individuals receive enhanced caregiving
- Followed up longitudinally into adulthood

Research with Rhesus Macques

Effects of Early Life Experience

- At one week of age, rhesus monkey infants were placed in a social group of 4-6 other monkeys with their mothers
- At 1 week, 1 month, 3 months, or 6 months of age, the mother was removed from the group
- Behavior was videotaped twice a week throughout development

Results of Early Life Disruption of Mother Infant Relationship in Macaques

- Behavior displayed depends on the timing of relationship disruption
- Three month separated
- One month separated
- One week separated

Intervention

- Can pairing a separated infant with a very sensitive mother reverse the effects of early maternal separation?
- Does the timing of intervention matter?

Atypical Caregiving Environment: Maltreatment / Foster Care and Abandonment / Institutional Rearing

Attachment Formation in Foster Care

- Begins in days to weeks (Stovall and Dozier, 2000)
- Will be secure if foster parent is securely attached (Dozier et al., 2001)
- Substantially increased risk for disorganized of foster parents not securely attached (Dozier et al., 2001)

Why Institutional Rearing Might be Bad for the Brain

- Insensitive care
  - Regimented daily schedule
  - Non-individualized care
- Isolation
  - No response to distress
  - Unchecked aggression

Why Institutional Rearing Might be Bad for the Brain

- Lack of psychological investment by caregivers
  - Rotating shifts
  - High child / caregiver ratio

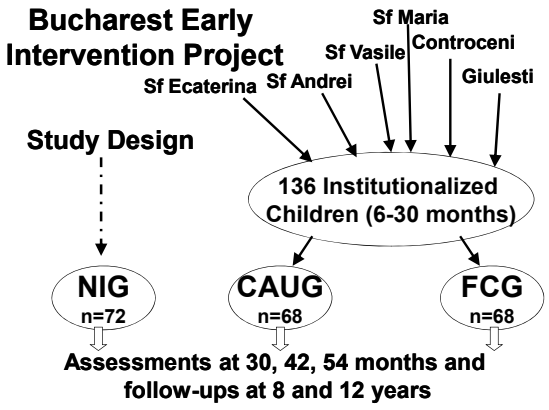
Outcomes of Institutional Rearing

- Children raised in institutions are at dramatically increased risk for a variety of social and behavioral problems:
  - Disturbances of attachment
  - Indiscriminate behavior
  - Behavior problems

Outcomes of Institutional Rearing

  - Inattention / hyperactivity
  - Deficits in executive functions
  - Syndrome that mimics autism
- Developmental problems believed to result from deprivation inherent in institutional care

Bucharest Early Intervention Project



Foster Care Intervention

- Recruited and trained to fully commit and love the children as their own
- Supported by Tulane clinicians, weekly consultations

Foster Care Intervention

- Goal was to have foster care that was:
  - Effective
  - Affordable
  - Replicable
  - Culturally sensitive
  - Informed by latest findings

BEIP Foster care

- Explicitly encouraged foster parents to attach
- Frequent contact by BEIP social workers
- 87% placement stability through 54 months of age
- Higher caregiving quality at 30 and 42 months based on observational ratings

Main Effects of Intervention

- Higher IQs
- Enhanced expressive and receptive language
- Greater height and weight
- Reduced stereotypes
- More expression of positive emotions

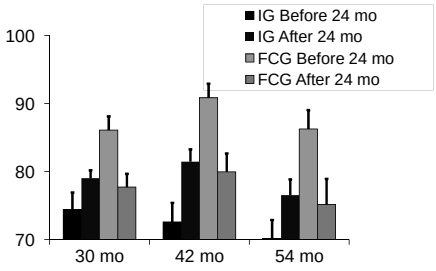
Main Effects of Intervention

- More secure and fewer aberrant attachments
- Fewer attachment disorders
- Less anxiety and depression
- Reduced psychiatric symptomatology

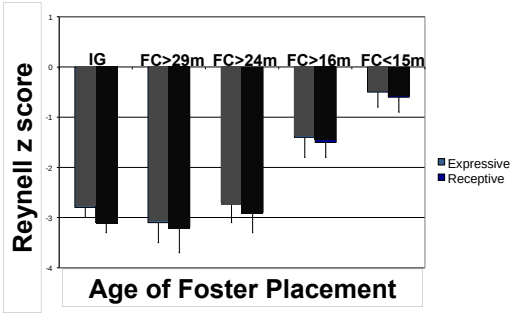
Main Effects of Intervention

- More mature and better functioning brains
- Better peer relationships and social skills

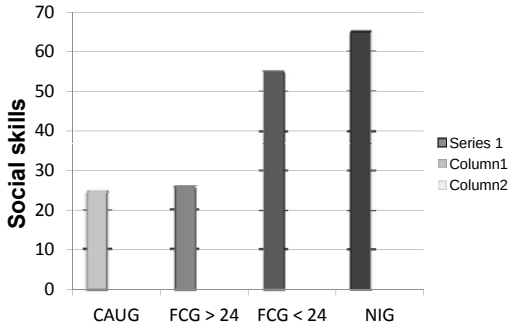
IQ of FCG and CAUG at Follow-up by Age of Placement



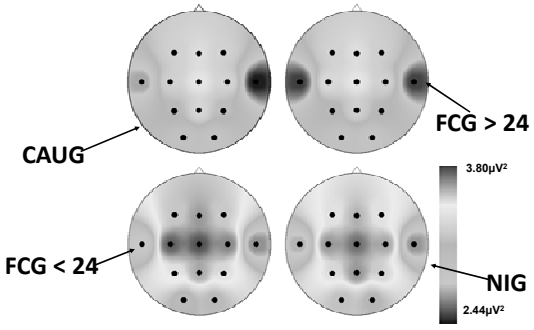
Age at Placement and Language at 42 Months



Teacher Rated Social Skills in 8-Year-Old Children with Histories of Deprivation



Distribution of Alpha Power Across the Scalp by Timing and Group



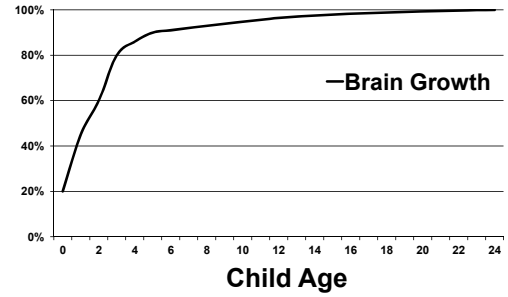
Knudsen, Heckman, Cameron, Shonkoff (2006)

- **Early experiences have a uniquely powerful influence on the development of:**
  - **Cognitive and social skills**
  - **Brain architecture and neurochemistry**

Knudsen, Heckman, Cameron, Shonkoff (2006)

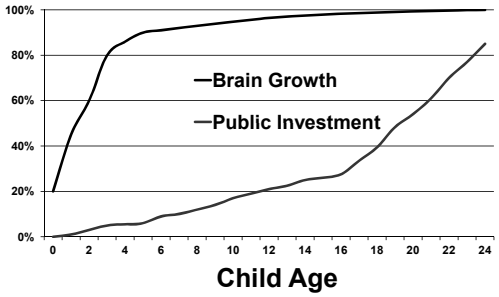
- **Skill development and brain maturation are hierarchical processes in which higher level functions depend on, and build on, lower level functions**
- **Capacity for change in neural circuitry is highest earlier in life and decreases over time**

Brain Growth and Public Investments



Source: *Early Learning Left Out*, February 2004

Brain Growth and Public Investments



Source: *Early Learning Left Out*, February 2004

The Clinical Science of Early Experiences

Infant Mental Health:

A Public Health Perspective

Infant Mental Health

- **The young child's capacity to experience, regulate, and express emotions, form close relationships, and explore the environment and learn**

Infant Mental Health

- **All of the capacities develop within the context of the care-giving environment that includes family and community, and cultural expectations for young children**
- **Developing these capacities is synonymous with healthy social and emotional development**

– **Zero to Three, 2001**

Essence of Infant Mental Health

- **Primary caregiving relationships most important predictor of psychological and social outcomes in young children**
- **All caregiving relationships matter**

Essence of Infant Mental Health

- Caregivers will help support mental health of young children when they:
  - Provide sensitive and responsive care
  - Know and value child as an individual
  - Place needs of the child ahead of their own needs

Infant Mental Health (IMH)

- More adaptive developmental trajectories
- Caregiving relationships are what drive trajectories for most young children, and that is where most intervention efforts are directed

Infant Mental Health (IMH)

- Implications for prevention, intervention, and long-term health and development
- Multidisciplinary field of inquiry, practice and policy about the importance of early experiences

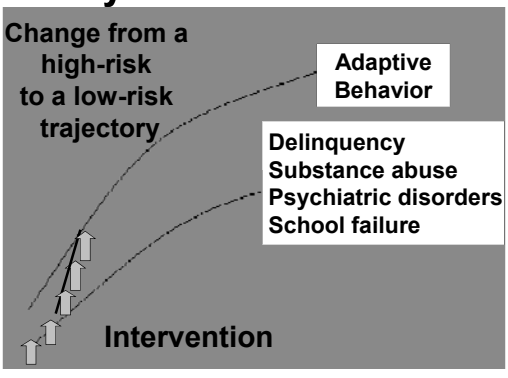
Core Infant Mental Health Clinical Activities

- Enhance the ability of caregivers to nurture young children more effectively
- Expand the ability of non-family caregivers to identify, address, and prevent social-emotional problems in early childhood

Core Infant Mental Health Clinical Activities

  - Promotion, prevention, early intervention
  - Risk and protective factors
- Minimize / avert suffering, and ensure that families in need of more intensive services can obtain them

Early Intervention Effects



Goals and Focus

- Public Health
  - Assure health and safety
  - Population-focused
    - Environmental and
    - Societal approaches

Goals and Focus

- Assessment and interventions
  - Communities
  - Systems
- Prevention or eradication of problems

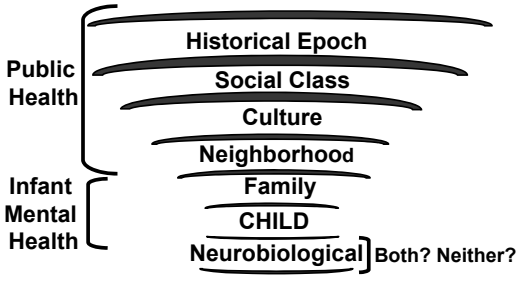
Goals and Focus

- Infant Mental Health
  - Improve social and emotional development
  - Relationship-focused
    - Dyads
    - Families
    - Provider-client relationships

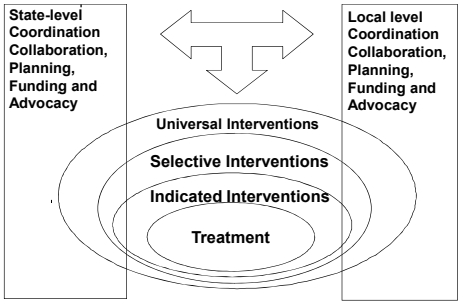
Goals and Focus

- Assessment and interventions
  - At the individual or family level
- Prevention at the individual or family level
  - Systems implications

Contexts of IMH and Public Health: Are They Exclusive?



Continuum of Infant Mental Health Services



Infant Mental Health Interventions

- Universal Interventions
  - Primary care: screening, education, promotion
  - Child care programs
  - WIC programs
- Selective (targeted) Interventions
  - Nurse Family Partnership

Infant Mental Health Interventions

- Indicated Interventions
  - Maternal depression
  - ABC Intervention

Universal Intervention: Childcare

What Is Quality Child Care?

"There is an extraordinary international consensus among childcare researchers and practitioners about what quality childcare is: It is warm, supportive interactions with adults in a safe, healthy and stimulating environment, where early education and trusting relationships combine to support individual children's physical, emotional, social, and intellectual development."

– Sandra Scarr (1998)

NICHD Study of Early Child Care

- Prospective, longitudinal study designed to examine concurrent, long-term and cumulative influences of variations in early child care experiences
- 1,364 healthy full-term newborns recruited in 10 sites around U.S.

NICHD Study of Early Child Care

- Children were assessed serially from early infancy through school age
- Outcomes include:
  - Cognitive, communicative, social, emotional and physical development of infants and toddlers

Factors Contributing to Positive Caregiving

- Across all settings, following factors associated with positive caregiving:
  - Smaller group sizes
  - Lower child-adult ratios
  - Caregivers' non-authoritarian childrearing beliefs

Factors Contributing to Positive Caregiving

- Safe, clean, stimulating physical environments
- Fewer than one half of centers in U.S. met standards derived

A Quality Rating System for Child Care in Louisiana

- Design to incentivize and sustain quality
- Developed by Louisiana stakeholders
- A voluntary system
- Inform parents about the quality of care to assist choice

A Quality Rating System for Child Care in Louisiana

- Components
  - Program and staff qualifications
  - Technical assistance
  - Mental health consultation

QRS Model Emphasizes Social-Emotional Development

- Requires centers to conduct social-emotional screening at higher levels
- Requires directors and lead teachers to complete training in social-emotional screening
- Provides mental health consultation for 6 months to aid centers

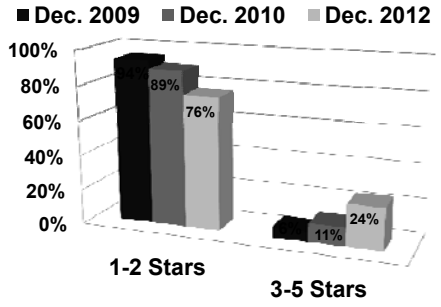
Tax Credits and Costs

- Tax credits to parents
  - $3.35 million
- Tax credits to providers
  - $14.5 million
- Tax credits to teachers
  - $7.4 million

Tax Credits and Costs

- Tax credits to business
  - $500,000
- Total
  - $26 million

Growth of Quality Child Care 2009-2012



Selective Intervention: Nurse Family Partnership

Nurse Family Partnership: Program Targets

- First time pregnant women
- Low SES (Medicaid-eligible)
- Program Goals
  - To improve the outcomes of pregnancy
  - To improve infant / child health and development

Nurse Family Partnership: Program Targets

- To improve mother's own personal life-course development

NFP Nurse Activities

- Form a relationship with parents by reinforcing their strengths
- Work intensively with parents for two and a half years
- Help women improve their health behaviors
  - Broadly defined

NFP Nurse Activities

- Promote effective and responsible care of children
- Help parents plan future pregnancies, complete their education, and find work

National Outcomes: Proximate

- Pregnancy
  - Decreased smoking
  - Decreased hypertension, kidney infections
  - Increased spacing between first and second births

National Outcomes: Proximate

- Infancy
  - 56% reduction in ER visits
    - Elmira
  - 79% fewer days hospitalized
    - Memphis

National Outcomes: Proximate

- Maternal life course development
  - Increased work force participation
    - All trials
  - Reduced use of government assistance

Long Term Outcomes

- Children
  - Improved language and cognition ages 4, 6, 9
  - Fewer deaths by age 9 due to prematurity, SIDS, injury
  - 48% decrease abuse and neglect
  - 59% reduction in arrests
  - 90% decrease in adjudications (FINS equiv.)

Long Term Outcomes

- Mothers
  - 61% fewer arrests
  - 72% fewer convictions
  - 98% fewer days in jail
  - More stable partner relationships

Washington State Institute for Public Policy (2004)

	Per Child Benefit	Per Child Cost	Saved per $1 spent	Benefit minus cost
Nurse Family Partnership	$26,298	$9,118	$2.88	$17,180
Early Childhood Education for 3-4 year olds	$17,202	$7,301	$2.36	$8,901
Even Start	$0	$4,863	$0	-$4,863
Systems of Care / Wrap Around Services	$0	$1,914	$0	-$1,914
Family Preservation	$0	$2,531	$0	-$2,531

Indicated Intervention: Attachment and Bio-behavioral Catch-up for Maltreatment

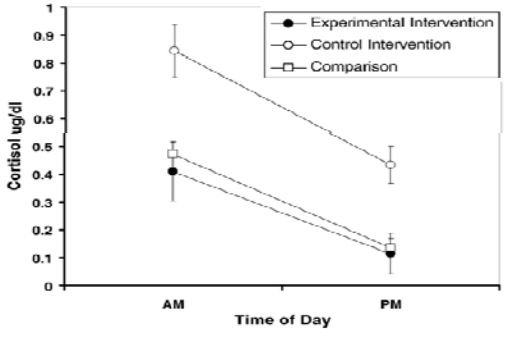
Attachment and Biobehaviorial Catch-up (ABC) Intervention

- 10 session, manualized intervention
- Four intervention modules:
  - Caregiver / parental nurturance
  - Following the child's lead
  - "Overriding" one's own history and / or non-nurturing instincts

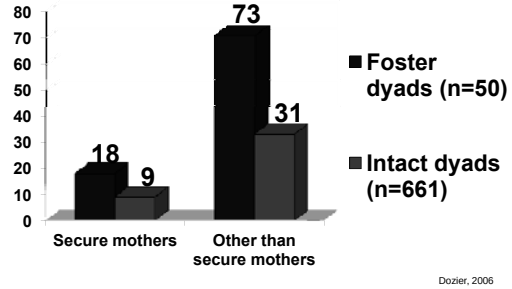
Attachment and Biobehaviorial Catch-up (ABC) Intervention

- The importance of non-threatening caregiving

Cortisol Metabolism in Maltreated and Control Children



ABC: Disorganized Attachment Among Foster and Intact Dyads



Dozier, 2006

Conclusions

- Brains are constructed over time and experiences have powerful effects on structure and function
- Relationships are the "active ingredients" of early experiences

Conclusions

- Relationship based interventions provide opportunities for prevention of adverse outcomes and treatment of distress and disability
- Evidenced based interventions available across levels of intervention

Conclusions

- More work needed at individual as well as population level
  - Promotion, systems