THE EFFECTS OF ADVERSITY ON BRAIN AND BEHAVIORAL DEVELOPMENT: LESSONS FROM THE BUCHAREST EARLY INTERVENTION PROJECT

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OUTLINE OF TALK

- The effects of early profound deprivation on development
- The role of experience in brain development
- Critical periods
- Findings from the Bucharest Early Intervention Project
EFFECTS OF PROFOUND NEGLECT ON BRAIN DEVELOPMENT

Why neglect is bad for the brain

- Brain expects input it doesn’t receive, so its wiring is altered
- Particularly egregious if experiences expected to occur during a sensitive period fail to occur (e.g., patterned light, sound, caregiving)

Focus of talk: what happens to the brain and behavior when it is deprived of most expected experiences during a sensitive period of development?
NEGLECT IS COMMON

Neglect is the Most Prevalent Form of Child Maltreatment

![Bar chart showing different types of child maltreatment with neglect being the most prevalent.]

Each state defines the types of child abuse and neglect in its own statute and policy, guided by federal standards, and establishes the level of evidence needed to substantiate a report of maltreatment. The data above, from the National Child Abuse and Neglect Data System (NCANDS), reflects the total number of victims (defined as a child for whom the state determined at least one report of maltreatment was found to be substantiated or indicated) as reported by all 50 states, the District of Columbia, and Puerto Rico, between Oct. 1, 2009, and Sept. 30, 2010. “Other” includes abandonment, threats of harm, and drug addiction.

Source: U.S. Department of Health and Human Services (2010b)
INSTITUTIONAL CARE IS COMMON

>100 million orphaned or abandoned children around the world

2-8 million raised in institutions

Institutional (congregate) care common form of care for orphaned and abandoned young children in much of the world (e.g., Europe, Asia, Middle East, Central and South America)
A PARTICULARLY EGREGIOUS FORM OF NEGLECT CAN BE FOUND IN CHILDREN GROWING UP IN INSTITUTIONS

Insensitive care

- regimented daily schedule
- Non-individualized care

Isolation

- no response to distress
- unchecked aggression

Lack of psychological investment by caregivers

- rotating shifts
- high child/caregiver ratio
THE PROBLEM
And yet...

The best conditions for the infant thus require a home and a mother. The further we get away from these vital necessities of beginning life, the greater will be our failure to get adequate results in trying to help the needy infant. Strange to say, these important conditions have often been overlooked, or, at least, not sufficiently emphasized, by those who are working in this field.
So this is an old problem....

FOR WHICH NEW SOLUTIONS ARE DESPERATELY NEEDED NOT ONLY INTERNATIONALLY BUT IN THE UNITED STATES
I. The impact of experience on the brain is not constant throughout life.

II. Early experience often exerts a particularly strong influence in shaping the functional properties of the immature brain.

III. Many neural connections pass through a period during development when the capacity for experience-driven modification is greater than it is in adulthood.

IV. Such phases are referred to as sensitive or critical periods.
Early windows of experience shape brain function

Figure courtesy of Takao Hensch
Lorenz and imprinted ducklings walking after him
Monocular deprivation in early infancy led to deficits in brain organization in visual cortex.
The timing and nature of experience with language affects perception of different languages

Before 9-10 months of age, infants can discriminate the sounds of all languages. By the end of the first year of life, they are only able to discriminate the language(s) they hear in their environment.
GENERAL CONCLUSIONS ABOUT SENSITIVE PERIODS

Collectively, in most cases sensory/perceptual development proceed normally if such systems are “set” correctly during a sensitive period of development.

The human brain “expects” certain types of input at particular times in development.

It is not clear what aspects of cognitive or social and emotional development require experience at particular (e.g., sensitive) points in time. Inferences drawn from intervention studies suggest some advantage to early experience.
The Bucharest Early Intervention Project seeks to:

- Examine the effects of psychosocial deprivation on brain and behavioral development of young children

- Determine if these effects can be remediated through intervention, in this case: foster care

- Examine the issue of timing of intervention or duration of deprivation and its effects on brain and behavior with an eye towards identifying sensitive periods in cognitive and social development
Project Background
CEAUSESCU’S LEGACY TO ROMANIA

• Raise production by increasing population
• Establishment of the MENSTRUAL POLICE - state gynecologists who conducted monthly checks of women of childbearing age who had not borne at least 5 children
• Establishment of CELIBACY TAX - families received a stipend for having more than 2 children; were levied tax for having fewer than 5 children
• OUTLAWED all contraception and abortion
THE RESULTS OF CEAUSESCU’S 1966 POLICY

• Child abandonment became a national disaster, as families could not afford to keep their children, and were encouraged to turn them over to the state. This destroyed the family unit and led to thousands of children being raised in institutions.
Poverty #1 reason for child abandonment

International media brought the plight of these children to the attention of the world

Large numbers of children adopted internationally, often by Western families unprepared for challenges that lay ahead

And then, Romania banned international adoption

1989: The fall of the Ceausescu regime
The aftermath….

100,000 children “warehoused” in state institutions
The Study
BEIP STUDY DESIGN

187 Institutionalized Children
6-30 months

136 Institutionalized Children

68 Care as Usual

68 Foster Care

48 Never Institutionalized Children

RCT
30 months
42 months
54 months

55 Care as Usual

55 Foster Care
DOMAINS OF ASSESSMENT IN BEIP

• Physical Development
• Language
• **Cognition**
• **Brain Function**
• Emotional reactivity
• **Stress responsivity**
• Caregiving Environment
• **Attachment**
• Psychopathology
• Social competence
• Genetics

*Data derived from measures listed in **bold and underlined** will be discussed in this talk*
GENERAL HYPOTHESES OF THE BEIP STUDY

• Institutional rearing will have profound effects upon children’s socio-emotional development

• Removing children from the institution and placing them in family environments will remediate some of these deficits.

• The age or timing of placement into foster care will be a significant factor explaining intervention effects (thought this may vary by domain)
THE INTERVENTION: HIGH QUALITY FOSTER CARE

- Families received monthly stipend equivalent to average per capita income in Romania at this time
- Close monitoring (social workers visited the families every 10 days)
- Social workers/psychologists consulted with BEIP team every 7 days
- Material support, 24 hour on-call pediatrician
- Romanian law required one parent to stay home with child
- All families licensed
ATTACHMENT
JOHN BOWLBY ON ATTACHMENT

young children, who for whatever reason are deprived of the continuous care and attention of a mother or a substitute-mother, are not only temporarily disturbed by such deprivation, but may in some cases suffer long-term effects which persist.
BASELINE DIFFERENCES: 11-31 MONTHS
BEIP: SSP CLASSIFICATIONS

**Community**
- 76.7% secure
- 3.6% avoidant
- 0.0% resistant
- 19.7% disorganized
- 0.0% unclassifiable

**Institution**
- 16.8% secure
- 4.7% avoidant
- 0.0% resistant
- 65.4% disorganized
- 13.1% unclassifiable

Zeanah, et al 2005
CONTINUUM OF ATTACHMENT

5 -- ABCD patterns of attachment
4 -- Patterns of attachment with behavioral anomalies
3 -- Clear preference but passive
2 -- Preference discernible
1 -- No attachment behaviors evident
DEGREE TO WHICH CHILDREN LIVING IN INSTITUTIONS HAVE FORMED ATTACHMENTS TO THEIR CAREGIVERS

<table>
<thead>
<tr>
<th>Attachment Level</th>
<th>Romanian Community</th>
<th>Romanian Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=No attachment</td>
<td>0%</td>
<td>9.5%</td>
</tr>
<tr>
<td>2=Some differentiation</td>
<td>0%</td>
<td>25.3%</td>
</tr>
<tr>
<td>3=Some preference</td>
<td>0%</td>
<td>30.5%</td>
</tr>
<tr>
<td>4=Attachment with anomalies</td>
<td>0%</td>
<td>31.6%</td>
</tr>
<tr>
<td>5=Clearly recognizable attachment patterns</td>
<td>100%</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Zeanah et al (2005)
Intervention Effects at 42 Months
EFFECTS OF INTERVENTION ON SECURITY OF ATTACHMENT 42 MONTHS

Smyke et al (2010)
Security of attachment as a function of age of entry

- 7 to 18
- 18 to 24
- 24 to 30
- 30+
SUMMARY OF SSP FINDINGS

Large differences at baseline IG vs. NIG
- Security
- Organization

- Large intervention effects, but incomplete recovery

Timing effects on security and organization
- More children secure if placed before 22-24 months
- More children organized earlier they were placed
COGNITION/IQ
COGNITIVE DEVELOPMENT (AT BASELINE)

Smyke et al (2007)
IQ Scores of Foster Care and Institutionalized Groups at Follow-up

How does IQ differ for children in foster care as a function of age of placement?

WISC DATA AT 96 MONTHS OF AGE

Note: *p = .05

Fox et al (2011)
COMPARING CURRENT PLACEMENT IN INSTITUTIONS, GOVERNMENT FOSTER CARE AND MACARTHUR FOSTER CARE

Note: V = Verbal Comprehension, P = Perceptual, WM = Working Memory, PS = Processing Speed, FSIQ = Full Scale IQ; *p < .05, **p < .01.

Fox et al (2011) JCPP
12-YEAR IQ SUBSCALES AND FULL SCALE BY GROUP

* p<.05, **p<.01

Almas et al (under review)
INTERIM SUMMARY: IQ

Young children living in institutions show significant delays in IQ

Removal from institutions, particularly prior to 24 months of age, and placement into families remediates IQ deficits

Stability of family placement over age is an important factor in IQ outcomes

Remarkably, 10 years after the intervention began there are still positive effects on IQ
BRAIN ACTIVITY-EEG

Beta 10-18 Hz
Alpha 6-9 Hz
Theta 3-5 Hz
Delta <3 Hz
Institutionalization & Brain Activity

Alpha, 6-9 Hz

Institution

Community

Proportion

0.58

0.46

Marshall, Fox & BEIP group (2007)
Brain Activity (EEG) Changes as a function of intervention and timing (8 years of age)

Vanderwert et al (2010)
12 YEAR EEG

Vanderwert et al (2016)
Institutionalization leads to dramatic reduction in brain activity (EEG power)

Placement in foster care leads to recovery, particularly if placement occurs before 24 months

Intervention effects persist through age 12 (i.e., no washout)
Magnetic Resonance Imaging (MRI) at Age 8

Performed in Bucharest on 1.5T Siemens machine
DTI also obtained on 80% of the children
AVERAGE GREY MATTER VOLUME (CORTICAL)

No differences in grey matter between FCG and CAUG at both assessment points.
AVERAGE WHITE MATTER VOLUME (CORTICAL)

Intervention effects on white matter with FCG more like community controls.
IN SOME AREAS THE CAUG AT AGE 16 HAVE THICKER CORTEX THAN THE FCG KIDS

Lateral Orbital Frontal

Pars Triangularis
(right inferior frontal cortex)
WHOLE BRAIN THICKNESS ANALYSIS CAUG > FCG

*Z = 2.3, not corrected for multiple comparisons
Exposure to institutionalization early in life....

• Has a differential effect on gray vs. white matter, with cortical grey matter being unaffected by foster care intervention whereas white matter volume is increased by foster care intervention

• Some evidence that there are neglect-associated alterations in cortical thinning

• CAUG at age 16 exhibit greater cortical thickness compared to FCG, possible indications of delay in brain development with behavioral implications
STRESS RESPONSIVITY
Development of Stress Response

- Disruptions in stress response system functioning are thought to be a central mechanism by which exposure to adverse early-life environments influences human development.
- Extensive evidence suggests that caregivers play a critical role in regulating responses to stress in children.
- Early regulation of stress responses by caregivers may have lasting effects on stress response system development.

(Gunnar & Donzella, 2002; Gunnar & Quevedo, 2007)
Stress Reactivity Tasks

Peer Evaluation Task
Trier Social Stress Test
Frustration Task
Reward Sensitivity Task

Saliva Samples
Autonomic Measures

Heart Rate & Variability

Blood Pressure

Impedance cardiography

Vena Cavae
Thoracic Aorta
Current (Z0)
Impedance (dz/dt)
Autonomic Measures

Heart Rate Variability

Parasympathetic Reactivity
Respiratory Sinus Arrhythmia (RSA)

Impedance cardiography

Sympathetic Reactivity
Pre-ejection Period (PEP)
HPA Axis

Stress → Hypothalamus → CRH → Anterior pituitary → ACTH → Adrenal gland

HPA Axis

Metabolic effects → Testosterone production inhibition

Cortisol
How Does the Early Environment Shape ANS and HPA axis reactivity?
Delivered a speech about what makes a good friend in front of two teachers that they never met before

- Preparation
- Speech
  - Negative and neutral feedback
- Math
  - With feedback about accuracy
TSST Reactivity—Heart Rate

TSST Reactivity-Sympathetic Activity

Stress and Cortisol Reactivity

Does the timing of placement matter?
Timing of Placement Affects Cortisol Reactivity Amongst Foster Care Children

Interim Conclusions: Stress

- Psychosocial deprivation is associated with a pervasive pattern of *blunted* physiological responses to stress, in both the sympathetic nervous system and HPA axis.

- Random assignment to high-quality family care following institutionalization mitigates otherwise persistent effects of early psychosocial deprivation on the functioning of stress response systems in children.

- Earlier age of placement into foster care leads to normalization of cortisol reactivity and enhanced vagal engagement during social tasks.
OVERALL CONCLUSIONS

Children raised in institutions during early development demonstrate significantly impaired physical, cognitive, language, social-emotional, and brain development compared to community children.

• Here we demonstrate specific cognitive deficits and neural compromises that may be associated with these deficits.

Insofar as we have been able to look at our data, our model of foster care as an intervention appears to effectively ameliorate many of the negative sequelae of institutionalization...

Some aspects of brain development (i.e. certain white matter tracts) are remediated in children placed into foster care, whereas others are not (i.e. total gray matter, certain white matter tracts).
Brains develop as a function of expected environmental experience.

In the absence of expected experience, brain and behavioral development are derailed.

Children living in conditions of neglect are likely to suffer from the absence of stimulation (warm, responsive, contingent interaction).

Removing children from conditions of neglect (and the earlier the better) is good for their brain development and good for their behavioral development.
INVESTIGATIVE TEAM

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