STRESS IN EARLY CHILDHOOD

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OVERVIEW

- What circumstances lead to severe stress in early childhood? How common are they?
- What are the mechanisms by which stress & deprivation impact the nervous system?
- Which nervous system structures are most affected by early stress?
- What cognitive, emotional, and behavioral challenges are most closely associated with early stress?
- What are some implications for intervention that seeks to alleviate effects of early stress?
What circumstances lead to severe stress in early childhood?

**Normative Stress** – mild stressors buffered by parent support can provide sense of mastery and self-efficacy
What circumstances lead to severe stress in early childhood?

Severe, and/or prolonged stressors — often co-occur making it difficult to disentangle specific effects
How common is severe stress in childhood?

- Studies examining *Adverse Childhood Experiences* (ACE)
  - CDC and Kaiser Permanente ACE study
    - Emotional Abuse
    - Physical Abuse
    - Sexual Abuse
    - Emotional Neglect
    - Physical Neglect
    - Parental Loss/Separation
    - Parental Substance Abuse
    - Parental Mental Illness/Suicidality
    - Parent Imprisonment
  - Philadelphia ACE study
    - 9 from Kaiser study
    - Neighborhood Safety
    - Bullying
    - Witness Violence
    - Racism
    - Foster Care
**How common is severe stress in childhood?**

| Table 3. Abuse and Neglect Indicators among Philadelphia Urban ACE Survey and Kaiser ACE Study |
|-----------------|-----------------|-----------------|
|                 | Philadelphia ACE Survey | Kaiser ACE Study |
|                 | (N=1,784)          | (N=17,337$^3$)  |
| Emotional abuse$^4$ | 33.2% (n=1,190)   | 10.6% (n=1,838) |
| Physical abuse$^5$  | 35.0% (n=624)     | 28.3% (n=4,906) |
| Sexual abuse       | 16.2% (n=289)     | 20.7% (n=3,589) |
| Physical neglect$^6$ | 19.1% (n=340)     | 14.8% (n=2,566) |
| Emotional neglect$^7$ | 7.7% (n=136)      | 9.9% (n=1,716)  |

Data Source: Philadelphia Urban ACE Survey, 2013 and Felitti et al., 1998
Data Prepared by: The Research and Evaluation Group at PHMC
How common is severe stress in childhood?

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Philadelphia ACE Survey (N=1,784)</th>
<th>Kaiser ACE Study (N=17,337)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance abusing household member</td>
<td>34.8% (n=620)</td>
<td>26.9% (n=4,664)</td>
</tr>
<tr>
<td>Mentally ill household member</td>
<td>24.1% (n=429)</td>
<td>19.4% (n=3,363)</td>
</tr>
<tr>
<td>Witnessed domestic violence</td>
<td>17.9% (n=319)</td>
<td>12.7% (N=2,202)</td>
</tr>
<tr>
<td>Household member in prison</td>
<td>12.9% (n=229)</td>
<td>4.7% (n=815)</td>
</tr>
</tbody>
</table>

Data Source: Philadelphia Urban ACE Survey, 2013 and Felitti et al., 1998
Data Prepared by: The Research and Evaluation Group at PHMC
How common is severe stress in childhood?

- Severe stressors are often co-morbid

![Figure 2: Distribution of Standard and Urban ACE Scores](image.png)

Data Source: Philadelphia Urban ACE Survey, 2013
Data Prepared by: The Research and Evaluation Group at PHMC
How common is severe stress in childhood?

- Poverty serves as marker for increased risk for childhood stressors

Table 12. Top Five Philadelphia Zip Codes with the Highest Percentage of Families with Children Below the Poverty Level, 2013

<table>
<thead>
<tr>
<th>Rank</th>
<th>Zip code</th>
<th>Percentage of Families with Children Below the Poverty Level</th>
<th>Percentage of population with 4 or more ACEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19133</td>
<td>61.8%</td>
<td>45.1% +</td>
</tr>
<tr>
<td>2</td>
<td>19121</td>
<td>61.6%</td>
<td>30.1%-45%</td>
</tr>
<tr>
<td>3</td>
<td>19134</td>
<td>56.3%</td>
<td>30.1%-45%</td>
</tr>
<tr>
<td>4</td>
<td>19122</td>
<td>53.0%</td>
<td>Insufficient # of respondents</td>
</tr>
<tr>
<td>5</td>
<td>19140</td>
<td>46.4%</td>
<td>45.1% +</td>
</tr>
</tbody>
</table>

Data prepared by the Research and Evaluation Group at PHMC
What are the mechanisms by which stress & deprivation impact the nervous system?

- Brief review of CNS development
What are the mechanisms by which stress & deprivation impact the nervous system?
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- **Impact of Deprivation/Neglect**
  - Lack of expected experiences and low environmental complexity
  - Leads to reduced thickness and volume in association cortex due to overpruning and reduced dendritic branching
  - See greatest effects in areas of the brain that process complex cognitive and social stimuli
What are the mechanisms by which stress & deprivation impact the nervous system?

- **Impact of threat/trauma**
  - Activation of hypothalamus-pituitary-adrenal (HPA) axis results in release of glucocorticoids (such as cortisol) which (if chronic/severe) can lead to changes in brain areas with high concentrations of glucocorticoid receptors
  - Resulting alternations in neural circuits that respond to and modulate stress
What are the mechanisms by which stress & deprivation impact the nervous system?

- **Impact of Attachment**
  - Absence of attachment figure or caregiver instability
  - See earlier maturation of amygdala, resulting in larger size and hyperactivity of the structure (Tottenham, 2010; 2012)
  - Fewer connections form between amygdala and areas that regulate amygdala activity
What are the mechanisms by which stress & deprivation impact the nervous system?

- Impact of malnutrition

- Impact of toxic exposures in utero or in early development (e.g., lead)
  - Lead exposure affects cell functioning in hippocampus and the development of cortex areas in animal models (Verina, 2007; Trope, 2001)
  - Rearing in stressful environment can exacerbate lead associated deficits (Virgolini, 2005)
What nervous system structures are most affected by early stress?

- **Cortex**
  - Institutional rearing associated with thinning in cortex (McLaughlin, et al., 2014; Mehta et al., 2009; Sheridan et al., 2012a) and functional changes across several regions of the cortex (Chugani et al., 2001; Marshall et al., 2008; McLaughlin et al., 2010)

- **Frontal Lobe**
  - Institutionalization results in diffuse connections between frontal lobe and subcortical areas necessary for attention (Behen, et al., 2009)

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*Figure 1: Comparison of the fiber tract pattern originating from the right head of caudate in a control subject (A) and an orphan (B). The corresponding CFD maps (center) show a more diffused projection pattern in the orphan as compared to the control.*
What nervous system structures are most affected by early stress?

- Cortex
- Frontal Lobe cont.
  - Poverty associated with decreased volume in prefrontal cortex (Noble et al., 2012) and more diffuse patterns of activation in cortex that supports executive functioning (Raizada & Kishiyama, 2010; Raizada et al., 2008; Sheridan et al., 2012b)
  - Emotional neglect during childhood predicted diffuse activation in portions of the prefrontal cortex and poorer performance on an inhibition task (Mueller, 2010)
  - Hanson, et al., (2010) found smaller volumes across several areas of the prefrontal lobe in individuals who have been physically abused.
What nervous system structures are most affected by early stress?

- **Temporal & Parietal Lobe**
  - Children with institutional rearing experience show language deficits and **abnormal activation** of language regions (Raizada, 2008; Helder, 2014)
  - **Smaller volumes** in temporal and parietal lobes in children who experienced physical abuse (Hanson, 2010)
What nervous system structures are most affected by early stress?

- Limbic System structures
- Amygdala
  - Abuse associated with greater amygdala response to angry faces, bias to facilitate identification of anger (Pollak and Sinha, 2002, McCrory, 2011; 2013)
  - Orphanage care settings result in greater amygdala activity to negative faces but not positive faces, and children were more distracted by negative faces (Tottenham, 2010)
What nervous system structures are most affected by early stress?

- Limbic System Structures
- Hippocampus
  - Activation of HPA axis leads to greater expression of corticotropin releasing hormone (CRH) in the hippocampus and damage to hippocampal neurons (Brunson et al., 2001; Ivy et al., 2010)
  - Studies in adults find link between early abuse and reduced hippocampal volume (Andersen and Teicher, 2008; Hart and Rubia, 2012; Teicher et al., 2012) and studies in children find reduced activation of hippocampus during memory task in children who've experienced abuse (Carrion et al., 2010).
What nervous system structures are most affected by early stress?

- Connections between cortex and limbic system
- Areas of the prefrontal cortex have strong connections with the amygdala and hippocampus, help down-regulate them
- With exposure to chronic threat, see less recruitment of the PFC to override amygdala responses resulting in overpruning and less activation of that pathway (Herrings, 2013; Eluvathigal, et al., 2006)
What nervous system structures are most affected by early stress?

- Added layer of complexity
- Effects on nervous system modulated by presence of certain genotypes
  - 5-HTTLPR s/s allele + early adversity/trauma related to structural changes in the amygdala, hippocampus, frontal lobe (Kobiella et al., 2011; Scherk et al., 2009; Everaerd et al., 2012; Frodl et al., 2004; Jedema et al., 2010; Selvaraj et al., 2011)
- Brett, et al., (2014) examined BDNF, COMT, SIRT1 and found that certain combination of alleles within the genoset had smallest prefrontal regions in the context of institutional rearing

![Figure 3. Prefrontal cortex total grey matter volume for 2-3 alleles versus 0-1 alleles for ever institutionalized group and never institutionalized group groups.](image)
What cognitive, emotional, and behavioral challenges are most closely associated with early stress?

- Replicated across studies examining effects of abuse, institutionalization, and poverty, see higher incidence of deficits in..

- Cognition
  - Attention & Executive Functioning (Evans and Schamberg, 2009; Nolin and Ethier, 2007; Gunnar, 2007)
    - High incidence of ADHD (30%; Helder, 2015)
  - Memory (Beers and De Bellis, 2002; Pollak, 2010)
  - Language (Fernald et al., 2013; Pechtel & Pizzagalli, 2010; Helder, 2014)
  - Intelligence and Academic Achievement (Sirin, 2005; Nolin and Ethier, 2007)
What cognitive, emotional, and behavioral challenges are most closely associated with early stress?

Rutter, 1998; O’Connor, 2000; Beckett, 2006
What cognitive, emotional, and behavioral challenges are most closely associated with early stress?

- **Emotional and Behavioral**
  - Initial ACE study (Felitti & Anda, 1998) found 4 to 12 fold increase in risk for substance abuse problems, depression, and suicide attempts in individuals who had experiences 4 or more ACEs.

![Graph showing probability of major depression episode](image)
What cognitive, emotional, and behavioral challenges are most closely associated with early stress?

- Emotional and Behavioral
  - Internalizing challenges: depression and anxiety
  - Externalizing challenges: hyperactivity, conduct problems, aggression
  - DeBellis, 2002; Clark et al., 2003; Putnam, 2003
What are some implications for intervention that seeks to alleviate effects of early stress?

- **Removal from institutional care**
  - Bucharest Early Intervention Project – children in institutions were randomly assigned into treatment as usual (stay in orphanage) or foster care
  - Bick, et al., 2015 found that removal to high quality foster care (around age 2) results in more normative trajectory of limbic pathways 6 years after placement

- Providing **enhanced care** and greater complexity of experiences to those currently in institutional care
  - St. Petersburg-USA Orphanage Research Team – reduced caregiver to child ratios, changed caregiving schedules, trained providers to be more responsive → resulted in improvements on developmental cognitive outcomes
What are some implications for intervention that seeks to alleviate effects of early stress?

- CDC have “Essentials for Childhood Framework” that guides communities for ways to collect data and use that data to make evidence based decisions to reduce maltreatment.

- Early Childhood Interventions that not only address educational objectives, such as school readiness, but also reduce adversity and assist parents in providing sensitive/responsive/complex caregiving.

- Programs that have a parenting component along with child intervention that gradually moves intervention focus from parent to child.

- Interventions that target specific outcomes will be most successful if basic needs, such as secure housing, nutrition, medical care are met first (e.g., Housing First model).

- Ensuring strong, well-funded safety net programs with administrative practices (e.g., reporting, eligibility) that promote family stability.