How socioeconomic disadvantages get into the brain across the lifespan

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Overview

• What is socioeconomic disadvantages (SED)?
  – Focus on poverty

• How does poverty get into the brain?
  – Target for intervention

• When does poverty get into the brain?
  – Best time to intervene
What is Socioeconomic Disadvantages?

• Indicators
  – Income
  – Education
  – Occupation
  – Composite index: socioeconomic status (SES)
  – Neighborhood Deprivation

• For adults, individual’s own background
• For children, factors for the parents
What percentage of children in the US is living in low-income families?

1) 15%
2) 25%
3) 35%
4) 45%
What is Poverty?

• Based on income
  – income-to-needs ratio < 1
  – Federal Poverty Level (FPL) Family of four - $23,850 (2014)

National Center for Children in Poverty (2013)
WHO ARE THE POOREST AMERICANS TODAY?

Poverty by Age Group

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percent in Poverty</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>26%</td>
</tr>
<tr>
<td>6-17</td>
<td>20%</td>
</tr>
<tr>
<td>18-24</td>
<td>18%</td>
</tr>
<tr>
<td>25-34</td>
<td>13%</td>
</tr>
<tr>
<td>35-44</td>
<td>11%</td>
</tr>
<tr>
<td>45-54</td>
<td>8%</td>
</tr>
<tr>
<td>55-59</td>
<td>10%</td>
</tr>
<tr>
<td>60-64</td>
<td>11%</td>
</tr>
<tr>
<td>65-74</td>
<td>10%</td>
</tr>
<tr>
<td>75+</td>
<td>14%</td>
</tr>
</tbody>
</table>
• Why does poverty lead to negative outcomes?
Exposure to High, Chronic Multiple Risks

- Exposure to violence
- Family turmoil
- Child separation from family
- Noise
- Housing problems
- Crowding

• How do poverty get into a brain?
Amygdala

Emotional Reactivity
Stress Exposure and Brain

Amygdala

Emotional Reactivity ↑
Neural Substrate of Emotional Regulation

- Emotion Regulation
- Ventrolateral PFC
- Dorsolateral PFC
- Amygdala

Emotional Reactivity
Poverty and Brain

Emotion Regulation

Ventrolateral PFC
Dorsolateral PFC

Emotional Reactivity

Amygdala
Repeated exposure to stress and Amygdala and PFC

- Repeated exposure to stress
  - Synapse loss, Changes in dendritic branching

Davidson & McEwen 2012
Poverty and Brain Development during Childhood

- Family income was associated with smaller cortical surface area, which was further linked to poor cognitive development among children.

Noble et al. 2015 *Nature Neuroscience*
Poverty and Brain during Adulthood

• Among men aged 35-64, high neighborhood deprivation was associated with
• smaller cortical volume and thinning in the language-related Wernicke's and Broca’s areas
• smaller cortical surface area in the frontoparietal regions, which are implicated in cognitive control

Krishnadas et al. 2013 *Psychosomatic Medicine*
• How do childhood poverty get into a brain in adulthood?
Childhood Poverty as a sensitive period

- Childhood socioeconomic disadvantages are associated with childhood and adulthood health outcomes, independent of adult-level SES
  - increased risk of physical illnesses including coronary heart disease (Cohen et al, 2010)
  - increased risk for mental illnesses including mood disorders, and substance abuse (McLaughlin et al 2012)

The aggregate cost of childhood poverty to the US is estimated at $500 billion in 2008
Socioeconomic Health Disparities

Childhood Poverty

Adulthood Poverty

Early-life origins of adult diseases

Health

High mortality
High morbidity
Underlying Neural Mechanisms

- Childhood Poverty
- Adulthood Poverty

Brain

Health
Longitudinal fMRI Study

Childhood
Family Income

Adulthood
Income

Amygdala

VLPFC
DLPFC

Emotion Regulation

Kim, Evans, Angstadt, Ho, Sripada, Swain, Liberzon, & Phan (2013). PNAS, 110, 18442-18447
Emotion Regulation Task (ERT)

• Reappraise
  – voluntarily decrease the intensity of their negative affect by using the cognitive strategy of reappraisal

• Maintain
  – attend to and experience naturally (without trying to change or alter) the emotional state elicited by negative pictures
Maintain
Reappraisal
Reappraise > Maintain

Dorsolateral PFC

Ventrolateral PFC/Insula/Temporopolar Area

Family Income at Age 9
Amygdala

Reappraise > Maintain

p < .05, uncorrected

- Current (adulthood) income was not associated with neural activity
Childhood Family Income

Age 9

? ?

Amygdala ↑ VLPFC↓ DLPFC

Emotion Regulation

Age 24

Adulthood Income

Age 24

Kim et al (2013). PNAS
Childhood Family Income

Childhood Chronic Stress

Amygdala ↑

VLPFC DLPFC ↓

Emotion Regulation

Stress Pathway

Age 9

Age 9-17

Age 24

Kim et al (2013). PNAS
Mediating Role of Childhood Chronic Stress

Dorsolateral PFC

Chronic Stress across age 9-17

-0.65***

Family Income at age 9

0.03 (0.12*)

DLPFC at age 24

-0.13*
Adaptive or Maladaptive Plasticity?

• **Active Calibration Model** (Ellis & Del Giudice, 2014)
  – processes to optimize the individuals adaptation to and resulting fitness for a particular environment, whether threatening or nurturing

• **Allostatic Load Model** (McEwen, 2012)
  – Chronic stress causes disruptions of brain structure and function that are the precursors of later impairments in learning and behavior and chronic physical and mental illnesses
Timing vs. Duration of Poverty Exposure

• Biological embedding model (Finch & Crimmins, 2004; Hertzman, 1999)
  – Developmental timing (sensitive period) of risk exposures and brain development would be valuable for informing interventions

• Accumulative models (Kuh & Ben-Shlomo, 2004)
  – Adversity begets adversity: longer exposure to SED may contribute to an accumulation of chronic stress and lead to more severe damage in neurobiological systems.
Discussion

• **Long-lasting impact of childhood poverty**
  – The significance of childhood family income and stress exposures in predicting neural outcomes in young adults during emotion regulation
  – Concurrent, adult-level income added no additional explanatory power to the prediction of adult neural functioning

• **Prevention for reducing early life adversity**

• **Stress Pathway**
  – Exposure to chronic stressors across ages 9-17 mediated the links between family income at age 9 and reduced DLPFC and VLPFC activity

• **Intervention for adaptive coping strategies**
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