Trauma and Stress: Neurobiology and the Impact on Development

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Why is This Topic Important?

- Research suggests that the long term consequences of early childhood stress and trauma are enormous.
- Many of these long term negative consequences are preventable by decreasing exposure to stress and trauma.
- New research in the area of resiliency may lead to better treatments for those who are traumatized.

Models of Stress/Trauma

- Psychological
  - Psychosomatic
  - Defense
  - Transactional Model
- Physiological
  - Nervous system changes
  - Endocrine changes

Models of Stress/Trauma

- Developmental
  - Age at the time of exposure
  - Disruption/impact on normal processes
- Sociological
  - Resilience/ risks
Psychological

- Psychosomatic model
  - Your mental state impacts your physical state
  - Your mind impacts how your body will cope

- Diathesis model
  - Explores the causes of a condition and the degree of your vulnerability to the situation
  - These vulnerabilities are the diathesis which can be psychological or biological

Physiological models

- Sympathetic and parasympathetic changes
- Neuroendocrine changes
  - Hypothalamic-pituitary axis

Developmental Models

- These theories emphasize the developmental stage at the time of the insult or trauma
  - Include prenatal and perinatal time periods as well
Age of Traumatisation as a Predictor of PTSD or MDD

- Women aged 18-45 years of age were interviewed
- Had experienced a childhood trauma
- Divided into two groups, those who had the trauma before the age of 12 and those 13 and older
- Early trauma showed rates of PTSD and MDD of 17%/23%
- Later trauma, 13.3%/6.5%
- Concluded that early trauma increased risk for MDD

Sociological Models

- Focus on qualities and characteristics that may be influenced by social forces around us
  - Resilience
  - Role

The Importance of Reducing Trauma

- A Little Stress is Good
What Happens with Severe Stress

**Stages of Acute Trauma Response**

- **Reat:** "Deer in headlights" response. This is an orienting reflex meant to assess the threat. Short-lived.
- **Fight and Flight:** sympathetic nervous system response increases blood flow to heart and muscles, pulse and breathing increase, skin grows cold, digestion is inhibited
- **Flag:** This phase results in collapse, helplessness and despair caused by parasympathetic shut down. Voluntary actions become difficult including speech, vision may blur, dissociation continues.
- **Faint:** Heart rate and BP drop and fainting occurs. Evolutionary purpose may be to increase blood flow to the brain when you assume a horizontal position.

**Three distinctive stages:**

- **Stage 1: Alarm reaction (AR)**
  - The immediate reaction to a stressor (physical or psychological)
  - The body releases adrenaline and a variety of other psychological mechanisms to combat the stress and to stay in control that is, to bring about the fight or flight response.

- **Stage 2: Stage of resistance (SR)**
  - Might also be named the stage of adaptation, instead of the stage of resistance
  - During this phase, if the stress continues, the body adapts to the stressors it is exposed to
  - Changes at many levels take place in order to reduce the effect of the stressor

- **Stage 3: Stage of exhaustion (SE)**
  - The body has run out of its reserve of body energy and immunity
  - Mental, physical and emotional resources suffer greatly
  - Body experiences "adrenal exhaustion"
  - Blood sugar levels drop as the adrenals become depleted, leading to worsened stress tolerance, progressive mental and physical exhaustion, illness and collapse
  - In both stages, your body can not adapt & thus exhaustion follows.
Effects of Lifelong Stress

Breaking it Down by Systems

- Limbic-Hypothalamic-Plutitary-Adrenal Axis (LHPA)
- The locus ceruleus/norepinephrine/sympathetic nervous system
- The serotonergic system
- The oxytocin system
- The immune system
- The impact on cognition
- The impact on brain development

LHPA System

- The Biological Effects of Childhood Trauma
  - De Bellis and Zisk, Child Adolesc Psychiatric Clinics of n Am, 2014, April

- Studies show age of trauma and chronicity of trauma result in different types of cortisol dysregulation
- LHPA response may determine symptoms
  - Studies suggest interling symptoms are associated with elevated cortisol response and internalizing symptoms with lowered cortisol levels
  - Early abuse and more severe and persistent abuse is associated with greater disruption of the LHPA axis
- Single nucleotide polymorphisms (SNPs) changes result in changes in the CRH type 1 receptors
  - Early studies suggest the polymorphisms in certain haplotypes may impact the risk for PTSD or other symptoms after trauma

- Early genetics may impact the LHPA system
  - Early genetics refers to changes that occur due to modification of gene expression rather than alteration of the genetic code itself
  - Most commonly studies is the methylation of DNA at cytosine rings found at CG direct intramer pairs
  - Methylation impacts the ability of DNA to concert genetic information into the messenger RNA necessary for gene function
  - Early trauma influences methylation of the genes encoding the glucocorticoid receptor and the neuropeptide vasopressor

LHPA System

- Early trauma exposure can dysregulate the LHPA system but the literature is very inconsistent
  - Studies measuring cortisol and cortisol responses show hyperreactivity, hypo-reactivity and no change
  - Acute trauma increases CRF and CRH, over time with chronic stress however, cortisol levels and ACTH response attenuates and there is down regulation of CRF receptors
  - CSF CRF levels are higher in adults with childhood trauma histories
  - Chronically elevated CRF is associated with anxiety, aggression, hypervigilance (PTSD) and inhibition of feeding and sexual behaviors (Depression)

LHPA System

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Male and female differences exist. Men exposed to early trauma have a greater impact on the CRF system than women. Abused girls had higher urinary oxytocin than nonabused girls, and no difference was found in boys. Strong social supports seem to improve the regulation of the LHPA axis. Daycare studies suggest that higher quality daycare is associated with less LHPA dysregulation.

The amygdala activates the LC/NE system. Activation increases the release of NE throughout the brain, increases the activation of the entire sympathetic nervous system, and fight-freeze responses. Sexually abused girls with dysthymia showed greater levels of 24-hour urinary cortisol than nonabused girls. Maltreated boys and girls with PTSD had higher urinary catecholamines than nonabused children with GAD.

Serotonin neurons project diffusely from the central serotonin raphe nuclei. Serotonin pathways in human brain:
- arousal
- sleep
- stress
- attention
- sexual behavior
- mood regulation (e.g., aggression)
- processing of sensory information in cerebral cortex

Serotonin and Trauma:
- Children homozygous for the short allele of the serotonin transporter gene had increased risk of depression but only if they were maltreated.
- Children with the 5′ allele who were bullied had increased expression in adolescence, compared to the 5′ or L allele groups.
- Other studies have not replicated these findings and do not show clear associations.
Oxytocin and Trauma

- Decreased levels of oxytocin have been found in women exposed to maltreatment, more significant if the abuse was emotional.
- In the ACEs study early trauma increased promiscuity.
- May be due to disruption of any toxin regulation in early childhood resulting in problems with relationships later in life favoring fast and indiscriminate attachments.
- In a study of adults with a specific allele of the oxytocin receptor gene OXTR who were exposed to early stress resilience to stress was increased but only if they had a positive family environment.

The Immune System and Trauma

- Immune system activation involves the production of cytokines which then promote an inflammatory response.
- Proinflammatory cytokines are found to be increased in depression.
- One study found increased cytokine levels in sexually abused girls.
- In women with early trauma who were sexually abused, the immune system response was increased.

Childhood Trauma and Cognition

- Cross-sectional studies and twin studies have associated exposure to maltreatment/early trauma and lower IQ.
- Children with prolonged neglectful institutionalization may have defects in visual attention, learning and memory but not in auditory learning or executive functioning.
- Neglected children with PTSD due to witnessing interpersonal violence had lower scores on tasks measuring memory for faces than those children who were neglected and did not develop PTSD.
- Neuropsychological testing in maltreated children with or without PTSD showed impaired compared to nonabused controls.

Childhood Trauma and Brain Development

- Pediatric imaging studies show total cerebral and cerebellar volumes are smaller in abused and neglected youth.
- Brain volumes are positively correlated with the age of onset of PTSD, trauma, and negatively correlated with the duration of abuse.
- Research suggests youth with PTSD do not show the age expected increase in total corpus callosum area and the splenium area of the CC.
- Splenium myelination in adolescence is important in reward circuits.

Resilience

- The single most important factor predicting resilience is the presence of at least one stable and committed relationship with a supportive parent, caregiver or other adult.
- Positive outcomes are further facilitated by:
  - A sense of self-efficacy and perceived control.
  - Having opportunities to strengthen adaptive skills and self-regulation.
  - Maintaining and mobilizing community resources that provide hope and embody faith and cultural traditions.
Practical Implications

- Increased efforts should be put into identifying stress and cultivating resilience.
- Research indicates that a range of both biological and environmental risks due to stress can be influenced by applying interventions.
- Social connections are the single most important intervention!