UNC COLLEGE OF ARTS AND SCIENCES
Psychology and Neuroscience

How Early Childhood Adversity Impacts Hypothalamic-Pituitary-Adrenal Axis Functioning in Adults

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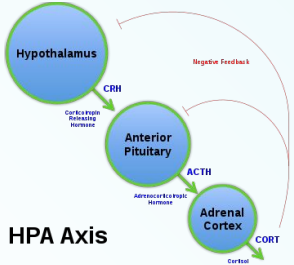
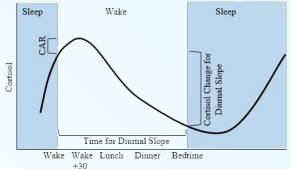
Background

The hypothalamic-pituitary-adrenal (HPA) axis is the primary stress response of the sympathetic nervous system (Smith & Vale, 2006).



The HPA axis is also involved in regulating the diurnal (daily) rhythm of cortisol secretion (Herman et al., 2009.



Childhood adversity impacts mental and physical health, alters stress responses, and affects brain development (Duffy et al., 2008). Early life adversity (ELA) leads to low stress reactivity in adulthood and other HPA axis dysfunctions (Goldman-Mellor et al, 2012; Kuras et al., 2017).

Methodological Approaches

- Investigating the HPA axis involves analyzing cortisol levels from saliva samples and studying diurnal patterns, particularly the cortisol awakening response (CAR).
- Diurnal cortisol slope and area under the curve (AUC) are markers for HPA axis function, reflecting irregular cortisol secretion patterns often influenced by early life adversity (ELA) interactions, which can further elucidate the impact on stress reactivity and health outcomes (Kuras et al., 2017; Knezevic et al., 2023).

Researchers also measure cortisol levels pre and post acute stress tasks like the Trier Social Stress Task (TSST; Kirschbaum et al., 1993).
ELA encompasses adverse experiences, commonly measured through the Childhood Trauma Questionnaire (CTQ), identifying maltreatment types. (Kuras et al., 2017; Knezevic et al., 2023; Kirschbaum et al., 1993; Fink et al., 1995; Karlamangla et al., 2018).

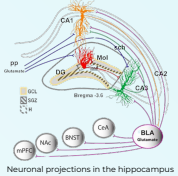
Theory

- The Accumulation Model of Stress (Pervanidou, 2008)
- The Life Cycle Model of Stress (Lupien et al., 2009)
- The Dimensional Model of Adversity and Psychopathology (Sheridan & McLaughlin, 2014; McLaughlin et al., 2014)

Biological Mechanisms & Associations

Genetic Studies
- Multilocus genetic profile scores (MGPS) capture genetic predispositions across multiple genes.
- Longitudinal studies reveal interactions between maternal prenatal perceived stress and HPA axis MGPS, predicting depression (McKenna et al., 2020).
- Animal studies indicate interactions between early life stress and HPA axis genetics, influencing adrenal gland sensitivity and stress reactivity (Van der Doelen et al., 2014).

Cortical Structural Changes
- Blunted cortisol awakening response (CAR) correlates with stress reactivity and smaller hippocampal volume in children (Raffington et al., 2018).
-Institutional deprivation in childhood correlates with smaller total brain volumes in adulthood, influenced by deprivation duration (Mackes et al., 2019).
- Adulthood adversity links to reduced hippocampal projections in various cortical regions, affecting memory function (McCarthy-Jones et al., 2018; Tottenham & Sheridan, 2009).



Neuronal projections in the hippocampus

Buffers

- Childhood SES correlates with increased cortisol secretion; however, adult SES partially mediates this relationship (Franz et al., 2013).
- Individuals removed from harmful environments and placed in supportive ones pre-puberty show gradual HPA axis stress response recalibration (Gunnar et al., 2019).
- In animal models strong male bonds in wild macaques mitigate stress responses while weak social ties associate with heightened stress responses, indicating HPA axis regulatory impairment (Young et al., 2014).

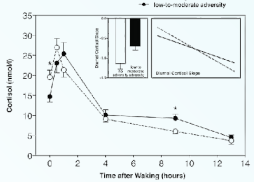
Conclusions

- HPA axis functioning is affected by ELA, evidenced by alterations in diurnal cortisol patterns and blunted stress responses.
- HPA axis dysregulation that's due to ELA heightened susceptibility to high-risk behaviors and potential addictions (Koob & LeMoal, 2008).
- Timing and severity of exposure during critical developmental periods exert varying effects on HPA axis activity (Raymond et al., 2021).
- Lack of standardized measurements makes it difficult to interpret findings across studies.

References

Impact of ELA on HPA Axis Functioning

Impact of ELA on Diurnal Patterns
- Studies which broadly analyzed ELA find flatter CAR, blunted diurnal cortisol slope, and overall compression of cortisol dynamic range (Ortiz et al., 2023; Kuras et al., 2017; Karlamangla et al., 2018).
- Exposure timing to adversity impacts CAR → children exposed to adversity between the ages of 3 and 7 had an increased CAR (Raymond et al., 2021).
- Type of adversity impacts diurnal rhythms differently → physical neglect, physical abuse, and emotional abuse are predictive of a flatter diurnal cortisol slope (Kuras et al., 2017).



Cortisol Response to a Stress Task
- Healthy adults reporting significant childhood maltreatment show suppressed cortisol response after stress tasks compared to non-traumatized adults (Carpenter et al., 2007; Counts et al., 2022)
- Timing of adversity significantly affects cortisol response → adults exposed between ages of 3 and 7 exhibit lower cortisol secretion post-stress compared to other age groups (Raymond et al., 2021)