Impact of Gestational Period Stress and Early Life Stressors on Child Development

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Abstract

Neurobiological/neuroanatomical differences that impact development often manifest from physical defects, genetic diseases, physical trauma, and other internal factors. However, external factors have also been discovered to have a significant effect on brain structure, brain function, cognition, and emotion. This paper in particular will focus on the way gestational period stress on the mother can negatively impact a child's development in connection with the increased neurotrophic factors, depressed development, and social anxiety that forms within the child. To continue, children who undergo early life stressors, whether that be in the form of a traumatic disorder or the struggles of low socioeconomic standing show developmental changes in brain anatomy that hinder memory, emotional control, and reward pathways. Furthermore, the consequences of early childhood/prenatal stressors on development are most modulated by maternal nurturing.

Introduction

Prenatal stressors are experienced by the fetus through the intermediate of the placenta, a fetal organ with dramatic endocrine properties. While prenatal stress can enhance child development, it is the nature, magnitude, chronicity, timing of the stress, and the pregnant mother's biological/psychological response to the stress that will determine it as deleterious or not (Buss et al., 2012). During a high stress pregnancy, an increased presence of maternal cortisol can lead to a dysregulation of a placental enzyme by the name of 11-B hydroxysteroid dehydrogenase type 2 (11B-HSD2). This enzyme converts the cortisol to cortisone, thus inhibiting the amount of cortisol that crosses the placenta and reaches the developing fetus. Thus, dysregulation of this enzyme can expose the developing fetus to greater levels of cortisol (Nieves et al., 2020). Furthermore, these elevated cortisol levels that not only influence the developing fetus, but also young children who are exposed to high stress environments, act on glucocorticoid receptors that are richly abundant in areas of prolonged postnatal development, such as the hippocampus and prefrontal cortex (Pechtel et al., 2010). The glucocorticoid receptors can impair neural plasticity in these specialized brain structures, leading to deficits in cognition in specialized areas such as language, aspects of memory, executive function and emotions (Katsnelson, 2015). The relationship that children have with their caregivers is also imperative in modulating stress hormones in the early years of life.

Discussion

To begin, mothers who suffer from high stress levels in the gestational period tend to release increased placental corticotropin releasing hormone (CRH) and maternal cortisol, which in turn results in impaired fetal maturation, infant mental/motor development, and infant temperament (Buss et al., 2012). These damaging impairments include neuroendocrine dysregulation, social anxiety, and internalizing behaviors (problematic internal feelings, such as anxiety, sadness, reticence, fearfulness, and oversensitivity). A reduction in gray matter volume due to high levels of cortisol inhibiting the growth and differentiation of the developing nervous system, consequently leading to detriments in executive function, attention, learning, memory, motor control, balance, precision, coordination, is further examined in fetuses whose mothers experienced high levels of anxiety in the second trimester of pregnancy (Buss et al., 2012). The children of women who experienced high pregnancy specific anxiety levels during the early second trimester showed volume reductions in the prefrontal cortex, premotor cortex, medial temporal lobe, lateral temporal cortex, and cerebellum. These brain structures are imperative for a variety of cognitive functions such as reasoning, planning, attention, working memory, some aspects of language, and social and emotional processing including recognition and semantic memory (Buss et al., 2012). Furthermore, a study by Francheska M. Merced Nieves and colleagues suggest a potential disadvantageous effect of maternal stress on visual attention. Increased neuroendocrine responses might also condition the fetus and eventual child to have heightened enhancement for predator detection and avoidance mechanisms. While this response can prepare the fetus for any external socioeconomic stressors it may face, such as an unstable family and dangerous neighborhood, it can also increase a child's susceptibility to mental disorders such as PTSD and depression (Buss et al., 2012). To continue, elevated levels of maternal anxiety and depression have been related with an increased prevalence of fearful temperament among infants (Buss et al., 2012).

While maternal stress can negatively impact the developing fetus in a plethora of ways, stress experienced in childhood, whether due to severe traumatic events or socioeconomic standing, can also be detrimental to development. The amygdala, in particular, is highly susceptible to sensitivity due to early life stressors that these children experience. Furthermore, children who experience early life stressors show significant deficits in the affective domain and in brain regions with extended postnatal development such as the hippocampus, amygdala, and prefrontal cortex (Pechtel et al., 2010). Early life stressors seem to interfere with the neurogenesis, synaptic overproduction, and pruning of synapses/receptors, thus impairing neural plasticity and growth in the critical brain areas listed above

(Pechtel et al., 2010). To continue, dopamine cell bodies in the ventral tegmental area project to the nucleus accumbens, therefore firing reward and unpredictable rewards. Chronic stressors and early hostile rearing environments contribute to anhedonia-like behavior, low energy, and apathy in a child, and in turn resulting in blunted mesolimbic dopamine transmission. This disrupted mechanism leads to dysfunction in reward related brain activation in children exposed to early life stress (Pechtel et al., 2010). Researchers also recognized deterioration in the cerebellum as a result of early life stress to children, resulting in impaired motor learning, balance, coordination, language, visual spatial learning, and working memory (Pechtel et al., 2010).

To continue, maternal love/caregiving support has an extreme impact on reducing stress levels in young children and in preventing adverse brain changes. The detrimental effects of poverty on a child's hippocampus can be mediated by this caregiving support. Reduced hippocampal volume in children can also be attributed to a lack of maternal compassion and love (Luby et al., 2013). To continue, children with a healthy and stable relationship with their caregivers have a controlled stress hormone reaction to frightening or upsetting stimuli. Contrarily, children who are devoid of such stability and are subject to an insecure and disorganized relationship with their parents experience high cortisol levels even after the incidence of mild stressors. To continue, those who live in conditions of chronic poverty and thus experience a culmination of unfortunate conditions (such as separation from parents, family turmoil, etc.) show even more elevated stress hormone levels. Even after moving to a safer home,
young children who are neglected and abused still show abnormal patterns of cortisol production. Certain components of prenatal care, including parental discipline, parent child verbal communication, and sensitivity to the needs of the child can mediate the effects of socioeconomic standing on emotional and cognitive functioning in children.

Conclusion

The detrimental effects of gestational stress on the developing fetus, and external stress on young children (as represented by early life stressors, trauma, or socioeconomic conditions), have intense adverse effects on emotional regulation, reward response, memory, brain plasticity, and gray volume matter in the brain. However, these negative consequences can be overturned with proper maternal/parental care, support, and nurturing. Therefore, it is essential that resources to inspire and endorse support for both expectant mothers and parents that are in impoverished communities are readily available to create an enriching and supportive environment for the healthy development of the fetus and child.

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