The Role of Pregnancy on Cognition

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Introduction

Parenthood is typically considered a major milestone in life. With the addition of a new family member, many adaptations need to occur. For humans, this could include adapting to a new sleep schedule and prioritizing the needs of the new child. Interestingly, these changes are also reflected in the brain. There are both anatomical and cellular changes that help parents adjust to the new needs that entail parenthood. Primarily, this review will focus on the brain adaptation and cellular mechanistic changes that occur when a woman transitions from pregnancy to motherhood. The various social and physical changes that arise from the transition into motherhood highlight the critical need to understand how pregnancy and the postpartum period impact the brain and consequently, the cognitive health of mothers.

From Matrescence to Motherhood

Alongside the development of an embryo, there are structural and functional alterations in the brain that allow mothers to adapt to pregnancy, and later, to adapt to the role of raising a child. Matrescence refers to the pregnancy and postpartum periods of a woman's life while motherhood refers to a woman's mid-life and late-life stages after giving birth and raising a child or children (Orchard et al., 2023). During pregnancy, the brain undergoes morphological changes including monthly volumetric reductions of 0.09 mm^3, decreased cortical thickness, surface area, local gyrification index, sulcal depth, and sulcal length. Width has no observable change (Carmona et al., 2019). These changes help prepare the mother-to-be with the necessary adaptations to take on a new role. At around three to four months postpartum, the areas of the brain associated with maternal behaviors - like the amygdala, hypothalamus, and prefrontal cortex - experience an increase in grey matter volume (Kim et al., 2010). For example, rodent research has shown changes to the medial preoptic area, an area associated with regulating maternal behavior such as licking and grooming of the young (Barba-Muller et al. 2018).

Interestingly, during pregnancy, the brain also experiences changes in areas of the brain associated with learning and memory, such as the hippocampus (Barba-Muller et al., 2018). Changes to areas like the hippocampus could suggest that the matrescence and motherhood stages of a woman's life can lead to prolonged changes to cognition. Furthermore, fMRI scans of mothers illustrate higher activity in areas such as the anterior cingulate and medial prefrontal cortex when they hear a baby cry. Damage to these parts of the brain during the stage of motherhood causes disruptions to the mothers' responsiveness given the same stimuli (Pawluski et al. 2016). In this case, physical alterations to parts of the brain are associated with higher cognition and emotions. Overall, matrescence and motherhood are seen to entail physical changes to the brain which then lead to behavioral alterations.

Cognition During Pregnancy and Throughout Motherhood

Along with the anatomical transformations the brain experiences during pregnancy and postpartum, there are also critical changes that occur at the cellular level. Generally, human and rodent literature have shown that women have impaired spatial learning during pregnancy and early postpartum, which is later improved during late postpartum and middle age. Specifically, signaling in the hippocampus could give insight into the long-term effects pregnancy has on cognition and neuroplasticity.

To better understand the impact of the anatomical transformations of the brain during matrescence, it is important to understand the cognitive and neuroplastic changes that occur during this time. Here, cognition refers to the mental processes from which knowledge is acquired from experiences and stored in the brain to guide future behavior (Cambridge Cognition, 2015). Given that pregnancy and raising children involves learning new skills and managing a prolonged stressful environment, it is important to understand the underlying neuronal mechanisms that coincide with these changes. Research on rodents has shown that female primiparous rats show enhanced spatial performance. During pregnancy, though, these rats have impaired spatial performance. After weaning, primiparous rats once again showed better working and reference memory compared to their nulliparous counterparts (Duarte-Guterman et al. 2019). As for the cellular changes that occur at this time, primiparous rats express lower levels of doublecortin (DCX) - a neurogenesis marker - when compared to their nulliparous counterparts. Additionally, later in life, female rats with a reproductive history showed similar levels of DCX when compared to the nulliparous rats while younger female rats had less DCX (Eid et al., 2019). The age at which rats were pregnant also plays a role in the amount of growth of new neurons in the hippocampus of these rats (Puri et al. 2024). Generally, research continues to show how cognition and neurogenesis fluctuate depending on the stage of matrescence or motherhood a woman is at. These fluctuations show how complex pregnancy and raising children can be for a woman.

Cognitive Health

The anatomical and cellular changes during pregnancy and into motherhood are also able to provide insight into the health of a mother's brain. Research has shown that the environmental complexity that a child brings could pose as an enriched environment, which helps protect the brain against pathology and aging (Orchard et al. 2023). Despite the protective role childbearing can bring, there are mixed studies regarding the impact of age, socioeconomic status, income, and education on the extent to which the brain is protected (Orchard et al. 2023). Interestingly, a higher number of childbirths is linked to less brain aging in the striatal and limbic regions like the hippocampus and amygdala (de Lange et al, 2020). Alongside the idea of pregnancy and its protective role, a higher number of cumulative months pregnant can help lower a woman's risk of developing Alzheimer's Disease later in life (Fox et al., 2018). The connection between pregnancy, motherhood, cognitive health, and disease risk further emphasizes the need to understand the mechanism behind the protective role of childbearing.

Conclusion

In sum, matrescence and motherhood can cause significant social, anatomical, and cellular changes. The complex interactions between cellular changes and the environment in which pregnancy occurs are also seen to impact the neuroprotective role pregnancy plays in a woman's life. Alongside these changes, future research should also consider the impact of hormones and the immune response that occurs during matrescence and motherhood. Despite the research mentioned today, literature should also consider the role parenthood has on men in comparison to women. Regardless, it is important to continue research on the neuroprotective role pregnancy and motherhood have on women.

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