The brain is an organ that adapts its anatomy and function during pregnancy. Dramatic changes in maternal physiology and neuroplasticity of the maternal brain during pregnancy and lactation prepare the mother for the challenges of motherhood and contribute to the survival of the offspring. In the last decades, numerous neuroimaging studies have investigated the changes in the maternal brain during pregnancy and lactation.

The first study

Alterations of the brain neural network during pregnancy

The authors from the Netherlands used different types of neuroimaging, including magnetic resonance imaging (MRI), resting-state functional MRI (fMRI), diffusion-weighted imaging, and 1H-nuclear magnetic resonance spectroscopy to investigate the modifications in the organization of the neural network and the structure of white or gray matter in the human brain during pregnancy.

This prospective cohort study included 40 pregnant women and 40 control nulliparous women. Women were followed from the preconception to the late postpartum period. The hormonal changes were assessed every four weeks during pregnancy.

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Results

The results showed that the volume of gray matter was significantly reduced in pregnant women compared to nulliparous women. This reduction primarily affected the anterior and posterior cortical midline and specific sections of the bilateral lateral prefrontal and temporal cortex. The changes in gray matter volume correlated with myoinositol levels, the marker of glial cells.

Despite the highly pronounced changes in the structure of the gray matter, there were no significant changes in the white matter diffusion metrics or volume between the pregnant and nulliparous women. The authors concluded that the structure of white matter in the maternal brain remains relatively stable throughout this period.

However, the results showed that pregnancy caused selective and robust changes in neural architecture and neural network organization, mainly pronounced in the Default Mode Network (DMN), a group of highly interconnected brain regions that are most active in the absence of a specific task. DMN reflects the brain’s baseline activity and is involved in autobiographical memory, self-perception, and social processes, like social cognition, social assessment, and empathy.

The resting state fMRI data demonstrated a selective increase in DMN coherence in pregnant women compared to controls. DMN coherence increased in the cuneus, which plays a crucial role in visual processing and integration of visual information with working memory, attention, and reward expectations. According to the authors, structural and functional plasticity of the DMN associated with pregnancy indicates changes in the baseline activity of the maternal brain.

During the third trimester, the observed neural changes correlated with the gonadal hormone levels, specifically estradiol levels. The researchers noted that marked changes in the gray matter structure and insignificant changes in diffusion metrics or white matter volume could be due to a particularly strong sensitivity of gray matter to fluctuations in gonadal hormones.

The scientists also investigated whether observed neural changes in pregnancy remained persistent throughout the postpartum period. The results showed that changes in the structure and plasticity of the maternal brain were partially reversed during the postpartum period. Moreover, the duration of breastfeeding correlated positively with the extent to which the increased DMN coherence was restored in the postpartum period.

These results showed marked and selective changes in the structural and functional plasticity of the maternal brain during pregnancy, which is crucial for the mother-infant dyad.

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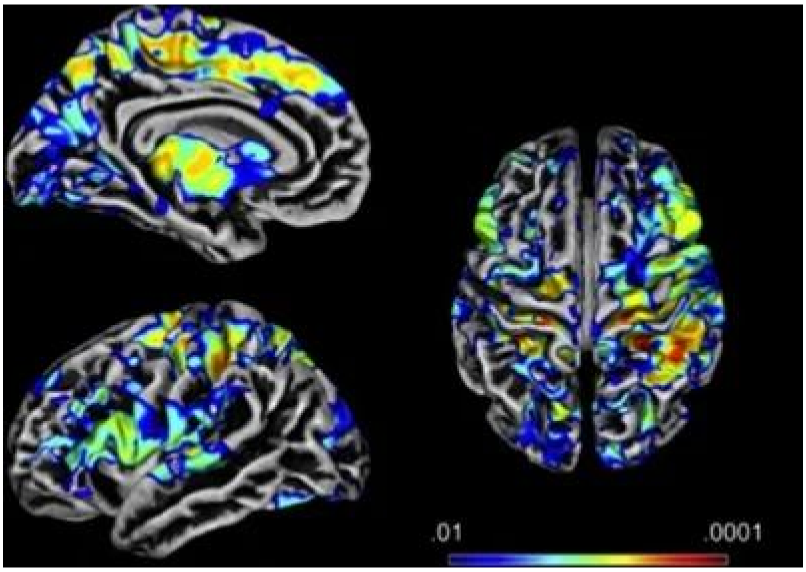

The second study

A decrease in the cortical volume during pregnancy follows an increase in the cortical volume in the postpartum period

In this MRI study, the Spanish authors investigated the changes in the cortical structures of the maternal brain during the peripartum period. They hypothesized that neuroplastic processes would have the opposite effects on the cerebral cortex during pregnancy and the postpartum period and that a decrease in cortical volume across multiple brain networks during pregnancy will follow an increase in cortical volume during the postpartum period.

The study included 110 mothers aged 24–43 years. They were examined at the end of the third trimester of their first pregnancy and during the first month postpartum. A control group of 34 age-matched nulliparous women was assessed at the same time intervals.

The MRI scan demonstrated a decreased global cortical volume and thickness across all functional networks before childbirth. These widespread differences included midline regions like the medial prefrontal gyrus and the anterior and posterior cingulate, as well as lateral areas, like the precentral and postcentral sulci, the dorsolateral prefrontal cortex, and the temporoparietal junction.

The authors emphasized that reductions in cortical volume during pregnancy are mostly confined to DMN, a key system for self-referential processing and social cognition.

In the early postpartum period, mothers still had a lower cortical volume and thickness than controls, although some changes observed during late pregnancy were attenuated. However, a widespread increase in cortical volume started in the early postpartum period, primarily affecting midline regions, like the posterior cingulate, the paracentral gyrus, and precuneus, and lateral regions, like the precentral and supramarginal gyri and the superior temporal gyrus.

Importantly, the increase in DMN volume and the fronto-parietal network was less than expected in the early postpartum period, suggesting a longer persistence of their reductions. Indeed, reductions in DMN cortical volume were reported at one, two, or six years postpartum.

This study has shown that reductions in most networks adjust or recover during the early postpartum period, except for those affecting higher-order cognitive networks, such as DMN. This indicates that reductions in the cortical networks that occurred during pregnancy were attenuated in the postpartum period at a different rate.

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