Pregnancy leads to permanent rewiring of brain, study suggests

Research in mice reveals hormonal changes late in pregnancy trigger parenting instinct and switch in priorities

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Pregnancy leads to a permanent rewiring of neurons, according to research that gives new insights into the influence of hormones on behaviour.

The research, in mice, revealed that their parenting instincts were triggered by changes in the brain that occur in response to oestrogen and progesterone late in pregnancy. Similar changes are likely to occur in the human brain, according to scientists, who said the work could pave the way for fresh understanding into parenting behaviour and postpartum mental health.

Dr Jonny Kohl, who led the research at London's Francis Crick Institute, said: "We know that the female body changes during pregnancy to prepare for bringing up young. One example is the production of milk, which starts long before giving birth. Our research shows that such preparations are taking place in the brain, too."

The findings are consistent with brain imaging research in women showing changes to brain volume and brain activity that endure long after pregnancy. Although Kohl pointed out that "parenting is obviously a lot more complex in humans".

"We have NCT classes, observational learning, all these environmental influences," he added. "We don't have to rely on those hormonal changes to such a degree."

The studies were carried out in mice, which undergo a dramatic shift in behaviour, with virgin females showing no interest in pups, and mouse mothers spending most of their time looking after young. Previously it had been widely assumed that the onset of this behaviour occurred during or just after birth, possibly triggered by hormones such as oxytocin. However, the latest research puts the change at an earlier stage and also suggests that the changes may be permanent.

The scientists used miniature devices attached to the heads of the mice to record directly from a population of neurons in the hypothalamus, which had already been linked to parenting behaviours.

Brain recordings showed that oestrogen reduced the baseline activity of these neurons, but made them more excitable in response to incoming signals. Progesterone rewired their inputs, causing the formation of more synapses so that these neurons were more densely connected up to other parts of the brain – and these changes appeared to be permanent.

“We think that these changes, often referred to as ‘baby brain’, cause a change in priority – virgin mice focus on mating, so don’t need to respond to other females’ pups, whereas mothers need to perform robust parental behaviour to ensure pup survival,” said Kohl. “What’s fascinating is that this switch doesn’t happen at birth – the brain is preparing much earlier for this big life change.”

When the mice were engineered so that the neurons were insensitive to the hormones, they failed to show any switch to parental behaviour even after giving birth, suggesting that there is a critical window in late pregnancy when these hormones take effect.

In humans, hormonal changes are not the only, or even necessarily the primary influence on parenting behaviour. But understanding the changes taking place in the brain could provide new insights into the influences on parental bonding and conditions including postpartum depression and psychosis.

Prof Robert Froemke, of NYU Langone, who was not involved in the research, said: “There is still so much we don’t understand about parenting and hormone signalling in the body and brain – these results are a solid step in that direction. Parenting is among the most complex and difficult set of behaviours we and other animals engage in, and there’s not a lot of room for ‘trial and error’ especially in the earliest days postpartum when infants need a lot of care.

“The hormonal changes documented here seem to help prime the parental brain to respond to infant needs right out of the gate, so that parental rodents, much like new human parents, can do a good job and be sensitive to their babies as soon as possible,” Froemke added.