RESEARCH SUMMARY

When Mothers go Wrong: Likely Neural Undercurrents Related to Poor Parenting

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The system of survival that all mammals, including humans, have developed through evolution begins with a truth that can be summarised as “life must learn to care for life”. Mammals, as a group of organisms, are defined by the fact that they suckle their young; the very word “mammal” is derived from the Latin for “teat”. For young mammals to reach adulthood, it is first of all necessary for their mothers to learn to provide the necessary care. This transition in the female mammal from a focus on self to a focus on care-giving to others, specifically to her own young, is now known to be associated with a range of changes in the brain. These range from changes in the amount and type of proteins produced in the brain cells or neurons (known as gene expression patterns) to modifications in the activity of the neurons and even visible changes to the size and shape of specific structures in, and regions of, the brain.

This system, however, is not perfect. In animal species as well as in humans, not every female is able to act as a “good” mother. It appears that it is possible for the biochemical and physiological changes in the brain that are associated with the development of nurturing instincts to be incomplete or faulty. And “faulty” motherhood in humans can cause shocking acts of cruelty. Susan Smith, who killed her two young sons by driving them into a lake in South Carolina in 1994, and Andrea Yates, who drowned her five children in the bathtub in 2001, are only two of the more notorious examples that could be cited.

Scientists and doctors have been asking whether studies of the neurological changes brought on by motherhood in non-human animals’ brains might shed light on what happens when normal human maternal responsiveness goes so badly wrong. One good place to start is with a gene named *fosB*. The protein that is encoded by this gene is a transcription factor, which means that it controls the expression of proteins by other genes. Female mice in which the *fosB* gene has been “knocked out” or prevented from functioning are generally normal but lack maternal responsiveness and nurturing behaviours severely enough to affect the survival of their pups. This gene is expressed in part of the hypothalamus in the brain known as the preoptic area (POA) and reduced neural activity in one part of this area has also been associated with poor maternal behaviour. Reductions in the volume of the frontal lobes of the brain in human mothers have been associated with a reduction in positive thoughts towards their children. It appears that all these behaviours are directly related to the nature of interaction between mother and offspring; *fosB*-deficient mice seem to be unable to respond to cues in the infant that normally elicit nurturing behaviour.

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These results in rodents led scientists to investigate whether a similar system applied in humans, and whether similar genetic and neurological differences in human mothers could lead to a greater likelihood of neglect or abuse. Structural changes in the human female brain that arise soon after giving birth have been studied using the technique of magnetic resonance imaging (MRI). Images of maternal brains in the first months of motherhood show increases in volume of certain parts of the brain, and larger increases in the volume of grey matter in the hypothalamus, substantia nigra, and amygldala have been associated with more positive perceptions of the baby by the mother.

It is important to ask what determines how the brain of an individual mammal, whether animal or human, will respond to motherhood. Both animal experiments and human experience suggest that females who experience defective mothering will themselves have difficulty showing maternal behaviour, and that this may be mediated through deficiencies in the way the brain develops. Female rat pups who experience more licking and grooming will tend to lick and groom their own pups more assiduously as adults and long-term maternal separation in infancy is known to lead to both neurological and behavioural changes in adult rats. Knowing this, it is instructive to read that both Susan Smith and Andrea Yates had difficult childhoods, including, at least in the case of Smith, serious abuse.

Taken together, these results suggest that the changes in the brain of female mammals that are associated with “learning” the role of nurturing infants are not automatic, but are actively built up and can be interfered with. Studying the brains of females in which this process appears to have gone awry should be instructive and may even help us learn how this neuronal development can be encouraged.

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