

SYNAPTIC PLASTICITY

Mothering without smothering



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Parents want the best for their children and shield them from negative experiences whenever possible. Indeed, many studies, in both animals and humans, have shown that adverse events that occur early in life can have long-term effects, such as hyper-responsivity to stress. However, Champagne *et al.* now show that adult rats that received relatively little maternal care as pups displayed enhanced synaptic potentiation and better learning under stressful conditions, signifying the adaptive value of experience-dependent plasticity.

The authors compared adult rats that had received either high or low levels of active maternal care during the first week of life, specifically licking and grooming (LG). They first investigated the effects of maternal care on hippocampal morphology. Both the dendritic length and the spine density of CA1 pyramidal cells were reduced in low-LG rats compared with high-LG rats. Furthermore, low-LG rats had lower levels of hippocampal glucocorticoid and mineralocorticoid receptors, which mediate the effects of the stress hormone corticosterone.

To determine whether these morphological differences had any functional consequences, the authors measured long-term potentiation (LTP) in hippocampal slices of low- and high-LG rats. Under baseline conditions, only slices from high-LG rats showed LTP. However, bathing the slices in corticosterone (at a concentration comparable to that in the plasma of a stressed rat) impaired LTP in high-LG rats but greatly enhanced it in low-LG rats, indicating that the effects of maternal care on CA1 excitability depend on the context in which it is measured.

As LTP is thought to underlie learning and memory, the authors also measured contextual fear conditioning, a highly stressful learning

paradigm in which a rat receives an electric shock upon being placed in a test chamber. The length of time for which the animal freezes when it is next exposed to the chamber is used as a measure of fear learning. Low-LG rats showed significantly longer freezing than high-LG rats in a hippocampus-dependent version of the paradigm, in which delivery of the shock was delayed to allow the rats to develop a spatial representation of the test box. This finding indicates that low-LG rats had better contextual fear learning.

Although this study did not directly address whether the effects of maternal care on hippocampal morphology and corticosteroid receptor levels were functionally related to the effects on LTP and learning, it did show that the changes that are induced by the early-life environment might be adaptive: moderate levels of deprivation and stress during development might prepare individuals for a tough life, allowing them to cope better in stressful circumstances.

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ORIGINAL RESEARCH PAPER Champagne, D. L. *et al.* Maternal care and hippocampal plasticity: evidence for experience-dependent structural plasticity, altered synaptic functioning, and differential responsiveness to glucocorticoids and stress. *J. Neurosci.* **28**, 6037–6045 (2008)