

Accepted Manuscript

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PII: S1074-7427(18)30232-6
DOI: <https://doi.org/10.1016/j.nlm.2018.09.006>
Reference: YNLME 6939

To appear in: *Neurobiology of Learning and Memory*

Received Date: 17 December 2017
Revised Date: 30 August 2018
Accepted Date: 19 September 2018

Please cite this article as: He, Z., Guo, Q., Yang, Y., Wang, L., Zhang, S., Yuan, W., Li, L., Zhang, J., Hou, W., Yang, J., Jia, R., Tai, F., Pre-weaning paternal deprivation impairs social recognition and alters hippocampal neurogenesis and spine density in adult mandarin voles, *Neurobiology of Learning and Memory* (2018), doi: <https://doi.org/10.1016/j.nlm.2018.09.006>

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**Pre-weaning paternal deprivation impairs social recognition
and alters hippocampal neurogenesis and spine density in adult
mandarin voles**

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Abstract: Disruption of the early social environment, such as maternal separation or early deprivation, can impair cognitive function, alter offspring neurogenesis and restrict dendritic architecture in the hippocampus. However, whether paternal deprivation during the pre-weaning period affects adult neurogenesis, synaptogenesis and social recognition remains unclear in monogamous species. In the present study, mandarin vole (*Microtus mandarinus*) pups were deprived of fathers during postnatal day 14 to 21. Then social recognition, hippocampal neurogenesis and spine density, basal levels of corticosterone (CORT) and oxytocin (OT) were examined at adulthood. We found that paternal deprivation impaired social recognition at adulthood. In addition, paternal deprivation significantly reduced 5-bromo-2-deoxyuridine (BrdU) immunoreactive cells ($p < 0.01$) and BrdU/Neun-labeled cells ($p < 0.05$) in the dentate gyrus compared to those of biparental care group in females, but not in males ($p > 0.05$). Meanwhile, paternal deprivation group had fewer double-staining cells with BrdU and the immature neuron marker doublecortin than biparental care group both in male ($p < 0.01$) and female ($p < 0.05$) voles. Paternal deprivation also decreased the number of dendritic spines in the dentate gyrus at adulthood. Paternal deprivation reduced circulating levels of OT and increased CORT only in females. These results demonstrated that impaired social recognition induced by paternal deprivation may be linked with alterations in neurogenesis and spine density of the dentate gyrus and levels of OT and CORT, especially in females.

Keywords: Mandarin voles; Social recognition; Paternal deprivation; Neurogenesis; hippocampus

Introduction

Adverse early life stress is associated with deleterious consequences for the brain and behavior. The neglect or abuse of children as early social stressors increases the risk of psychological disturbances such as anxiety, depression and psychoses in adulthood (Bebbington et al., 2004; Gilbert et al., 2009; Kaufman & Charney, 2001; Mullen, Martin, Anderson, Romans & Herbison, 1996). In rodents, maternal separation or early deprivation impacts socioemotional

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