

Adult neurogenesis in maintenance of the hippocampal learning capacity

Abstract

Saturation of the hippocampal long-term potentiation (LTP), a cellular basis of learning and memory, impairs hippocampus-dependent learning. This impairment recovers in parallel with the LTP decay. However, the driving factor that regulates the recovery of learning capacity remains unclear. Neurogenesis in the brain of adult mammals occurs throughout life and is involved in the decay process of hippocampus-dependency of memories. Here we show that adult neurogenesis plays a crucial role in the maintenance of hippocampal capacity for learning. Delivery of repeated high frequency tetanic stimulation (rHFS) to perforant pathway saturated the dentate gyrus LTP and impaired the learning capacity in contextual fear conditioning, a hippocampus-dependent learning task, whereas it had no effect on the hippocampus-independent learning. The impaired learning capacity completely recovered after 14 days when LTP decayed. Ablation of neurogenesis by X-ray irradiation retained the hippocampal LTP and delayed the recovery of learning capacity from the saturation. Similar results were obtained when repeated maximum electroconvulsive shock was employed to saturate the hippocampal LTP. These results indicate that the learning capacity gradually recovered in parallel with the gradual decay of LTP and decreased neurogenesis delayed the recovery of learning by retaining the rHFS-evoked LTP level. Our findings unravel a new role for neurogenesis, suggesting that adult neurogenesis is crucial for renewal of the hippocampal memory circuits.