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Elements of a neurobiological theory of the hippocampus: the role of activity-dependent synaptic plasticity in memory

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Abstract

The hypothesis that synaptic plasticity is a critical component of the neural mechanisms underlying learning and memory is now widely accepted. In this talk, I shall begin by outlining four criteria for evaluating the 'Synaptic Plasticity and Memory' hypothesis. I will then attempt to lay the foundations for a specific neurobiological theory of hippocampal function in which activity-dependent synaptic plasticity, such as long-term potentiation (LTP), plays a key role in the forms of memory mediated by this brain structure. They key take-home message is that LTP is involved in some memory processes but not others.

Hippocampal memory can, like other types of memory, be divided into four processes - *encoding, storage, consolidation* and *retrieval*. We argue that synaptic plasticity is critical for the *encoding* and *intermediate-term storage* of memory traces that are automatically recorded in the hippocampus. These traces decay, but are sometimes retained via the process of cellular consolidation. However, we also argue that hippocampal synaptic plasticity is not involved in *memory retrieval*, and is unlikely to be involved in systems-level consolidation that depends on hippocampal-neocortical interactions, although neocortical synaptic plasticity does play a role.

The information that has emerged from a worldwide focus on the mechanisms of induction and expression of plasticity at individual synapses has been very valuable in functional studies, and is likely to continue to be so. Progress towards a comprehensive understanding of memory processing will also depend on the analysis of these synaptic changes within the context of a wider range of systems-level and cellular mechanisms of neuronal transmission and plasticity.