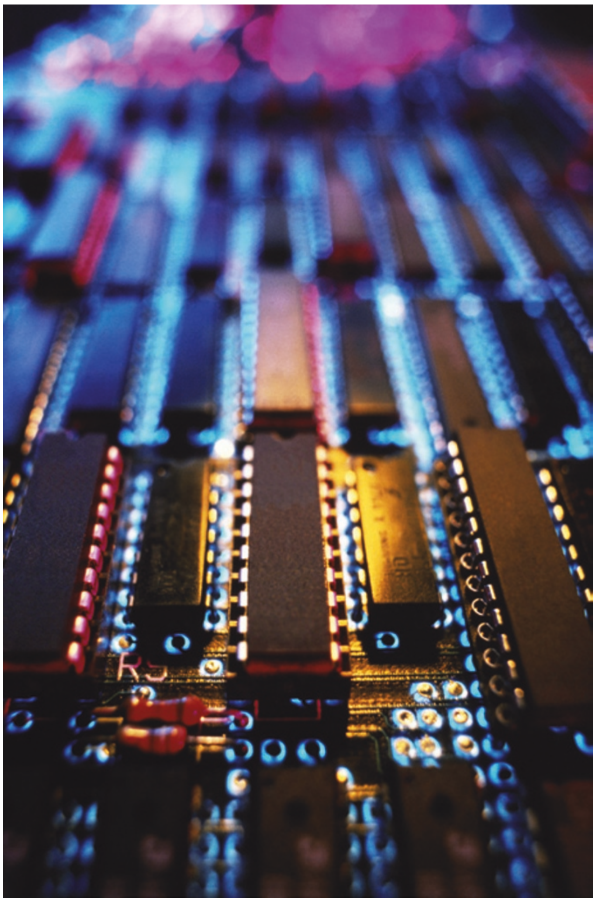
Nature Reviews Neuroscience | AOP, published online 27 July 2011; doi:10.1038/nrn3089

LEARNING AND MEMORY

Parallel processing

Systems memory consolidation involves the stabilization of memory traces — originating in the hippocampus — in the neocortex and is implicated in the formation of long-term memories. Previously, Morris and colleagues showed that such consolidation occurs rapidly when new information is learnt in the presence of relevant established knowledge, challenging the widely held view that systems memory consolidation is a gradual process. Now, these authors show that learning of new paired associates against the backdrop of a schema requires neocortical activity.



Morris and colleagues trained rats to recall the location of food in sand wells on the basis of flavour cues that were provided to them in the starting box of an event arena and in the arena itself. Once this schema of paired associates (that is, flavour cues and locations) was established, seven of the rats underwent four further trials with these paired associates and two trials with two new pairs of flavour cues and locations that could be encoded and assimilated into the schema. By contrast, seven other rats were exposed to six new pairs of flavour cues and locations that, although reflecting greater 'novelty' (which is thought to be an important driver of new learning), were designed in such a way that they would not be incorporated into the schema.

Cued recall tests showed that animals in the first group, but not in the second group, formed memories for the new paired associates. Moreover, histochemical analysis of brain sections revealed that the formation of these new memories was associated with an upregulation of two plasticity-associated immediate early genes (IEGs) in several neocortical regions, including the prelimbic region of the medial prefrontal cortex. These findings suggest that the cortex is sensitive to the process of new learning in the hippocampus when it takes place against the background of relevant established knowledge, and challenge the view that 'novelty' is the only driver of new learning.

The authors went on to examine whether the rise in IEG expression during learning reflected parallel encoding of task-associated memories in the hippocampus and in the neocortex. Strikingly, they found that inactivation of the prelimbic region — through infusion of an AMPA receptor or an NMDA receptor antagonist into this brain region — during new paired-associate learning in rats that were trained in the original schema impaired the consolidation of memory.

Thus, taken together, these data show that the assimilation of new paired-associate information into a cortical schema requires simultaneous encoding in the cortex and in the hippocampus.

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ORIGINAL RESEARCH PAPER Tse, D. *et al.* Schema-dependent gene activation and memory encoding in neocortex. *Science* **123**, 7 Jul 2011 (doi:10.1126/science.1205274)