Acetylcholine and learning mode: the slow shift account

Meeter M, Talamini LT*, Murre JMJ*
Dept of Cognitive Psychology, Vrije Univ Amsterdam, Amsterdam, * Dept of Psychology, Univ van Amsterdam, Amsterdam

It has been suggested that hippocampal mode shifting between a storage and a retrieval state might be under the control of acetylcholine levels, as set by an autoregulatory hippocampo-septo-hippocampal loop. The validity of this hypothesis has been questioned in view of evidence suggesting that ACh may exert a more sustained influence on hippocampal activity than would seem appropriate from the perspective of mode shifting.
Here, we present a large scale connectionist model that takes into account the major hippocampal subdivisions, oscillatory population dynamics and the time scale on which acetylcholine exerts its effects in the hippocampus. The model assumes that hippocampal mode shifting is regulated by a novelty signal generated in the hippocampus. The simulations suggest that this signal originates in the dentate. Novel patterns presented to this structure lead to brief periods of depressed firing in the hippocampal circuitry. During these periods an inhibitory influence of the hippocampus on the septum is lifted, leading to increased firing of cholinergic neurons. The resulting increase in acetylcholine release in the hippocampus causes network dynamics that favor learning over retrieval. Resumption of activity in the hippocampus leads to the reinstatement of inhibition. Despite theta-locked rhythmic firing of acetylcholine neurons in the septum, acetylcholine modulation in the model fluctuates smoothly on a time scale of seconds. It is shown that this is compatible with the time scale on which memory processes take place.

Martijn Meeter, Dept of Cognitive Psychology, Vrije Universiteit, Vd Boechorststraat 1, 1081 BT Amsterdam, e-mail m@meeter.nl

Session #36