

Examination of the premises of semblance hypothesis that explains retrieval-efficient mechanism of memory at appropriate time-scales

Kunjumon I. Vadakkan

Neurosearch Center, Toronto, Canada

Objectives: Synaptic plasticity is critical at the stage of encoding of various types of memories. Lack of evidence for similar changes during memory retrieval or systems level consolidation has made it difficult to understand how and where memories are stored. Time-scales of accompanying protein synthesis, modifications and trafficking do not match with those of the acquisition or retrieval of different types of memories. Possible loss of memory by overwriting the established pattern of synaptic connectivity has led to the suggestion of radical modifications of the standard models of memory storage [1].

Here, the objective is to examine how these led to the premises and inductive reasoning steps that led to an alternate hypothesis namely “Semblance Hypothesis” [2]. **Results:** During one learning event, a specific set of postsynaptic membranes along different orders of neurons from the learned item are activated. At a later time, artificial activation of this specific set of postsynaptic membranes (imagined by introducing electrodes to the brain) is assumed to induce memory for the learned event. Deriving from this, memory depends on the subset of postsynaptic membranes that are activated during retrieval out of the set of postsynapses where changes took place during learning. For this, co-activation of fibers from the learned item and the cue stimulus during learning need to induce specific changes that will later allow the cue stimulus by itself evoke activation of the set of postsynaptic membranes that belong to the learned item. This entailed the generation of semblance hypothesis from a definition of memory in terms of synaptic function. *A unit of memory, in the presence of an internal or external cue stimulus, results from the ability to induce specific postsynaptic events at the synapses of neurons from the learned item without the requirement of APs reaching their presynaptic sides.* In the presence of a cue stimulus, the structural patterns of synapses named as “shared postsynapses” and “shared extracellular matrices” can evoke cellular illusion of an AP-induced synaptic transmission from presynaptic terminals belonging to the learned item. The net effect of cellular illusions occurring in a network of neurons results in functional semblance, a virtual sensation of a stimulus in its absence leading to memory.

Conclusion: Semblance hypothesis can explain how memory can be retrieved at physiological time-scales without plasticity changes at the time of retrieval. Each memory has a labile code consisting of the subset of postsynaptic terminals of the learned item that are activated during retrieval, out of the set of postsynaptic terminals that were co-activated with the cue during learning.

References

1. S. Fusi and L. F. Abbott (2007) Limits on the memory storage capacity of bounded synapses, *Nat Neurosci* **10**, 485-493.
2. K. I. Vadakkan (2007) Semblance of activity at the shared postsynapses and extracellular matrices: A structure-function hypothesis of memory, *iUniverse Publishers, Lincoln, U.S.A.*