A second explanation for the semblance hypothesis

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Historically, we assumed that (1) the operating mechanism occurs at synapses, and (2) a neuron functions as the fundamental operational unit of the system. While these assumptions were necessary to initiate experimentation, decades of research have yet to yield a satisfactory solution. Moreover, brain functions such as memory have predominantly been studied through surrogate markers, including behavior and speech. To truly understand the system's operations, it is essential to determine **where** and **by what mechanism** first-person experiences are generated. There is no shortcut for this inquiry. Even arguments claiming that first-person properties cannot be tested by third-person observers cannot serve as a scientific excuse to avoid addressing the problem rigorously.

Studies of the nervous system have faced three major challenges. First, methodological limitations have constrained researchers to examine memories indirectly through surrogate markers rather than as first-person experiences. Second, much of current research is grounded in a postulate proposed in 1949 by Professor Donald Hebb:

"When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it,

some growth process or metabolic change takes place in one or both cells such that A's efficiency as one of the cell's firing B is increased" (Hebb, D. O., *The Organization of Behavior*, New York: Wiley & Sons).

This postulate, later adapted into the widely known synaptic plasticity thesis, has not provided a mechanistic explanation for how learning-induced changes generate the first-person experience of memory. Third, more recently, researchers have attempted to correlate behavioral markers of memory retrieval with the firing of specific neuronal populations in hopes of uncovering the underlying mechanism.

Evidence indicates that only a small fraction of input signals – approximately 140 signals arriving at various locations on a dendritic tree – out of thousands of input terminals (dendritic spines) can trigger a cortical neuron to fire, generating postsynaptic potentials (see **FAQ** for references). This demonstrates the extreme degeneracy of input signals in neuronal firing. Postsynaptic potentials attenuate as they propagate toward the cell body, and since many neurons remain in a sub-threshold resting state, even a fraction of a single postsynaptic potential can initiate firing. In this context, to avoid information loss, it is reasonable to assume that memory storage occurs at the origin of postsynaptic potentials, i.e., at the very input terminals. This mechanism would also need to account for how first-person internal sensations of memory arise.

Over the past several decades, a vast array of observations has been collected across multiple levels of the nervous system. These findings now provide constraints that can be used to derive a theoretically coherent and testable mechanism for the generation of first-person internal sensations. If successful, such a mechanism would offer a solid scientific foundation, operating in synchrony with the synaptically driven nervous system and within physiological timescales of milliseconds. It would also account for the observed redundancy of input signals capable of triggering neuronal firing. A hypothesis that can explain all these features in principle can then be tested both structurally and through experimentally verifiable predictions. The semblance hypothesis emerged from this approach.