Semblance Hypothesis – A Summary

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Conventional neuroscience has largely relied on correlating observations across multiple organizational levels of the nervous system with a surrogate output measure, behavior, to study higher brain functions. Although this approach has yielded extensive empirical findings, it has provided limited structural insight into the mechanistic operation of the system responsible for generating first-person properties such as perception and memory.

The present work adopts an alternative strategy. Instead of beginning with behavior and working backward through correlations, it compiles constraints from all available findings and attempts to solve the system in a manner consistent with observed behavior. If a coherent solution emerges, one can then examine the solution, or its immediate operational vicinity, for features capable of generating internal experiential phenomena.

Application of this approach identified the inter-postsynaptic functional linkage (IPL) as a candidate solution. IPLs represent a spectrum of interactions between abutted postsynaptic terminals (dendritic spines) of different neurons at locations where associatively learned sensory inputs converge. These interactions frequently involve functional changes rather than readily visible structural alterations. Hence the term inter-postsynaptic *functional* linkage.

IPLs were not discovered accidentally, for understandable reasons. Their operational effects are embedded within the overall functioning of the nervous system and are indirectly reflected in diverse empirical findings, allowing their derivation from system-level constraints. Consequently, confirmation of IPLs requires proactive experimental investigation. Such investigations must address both: a) the functional interactions between abutted spines of different neurons receiving convergent associative inputs, and b) the physical mechanisms capable of stabilizing these interactions for long-term storage of associatively learned information. The functional mechanisms underlying IPL formation are also expected to involve supporting biochemical changes, making targeted investigation of these processes essential for experimental verification.

Most variables within the framework are empirically grounded. In contrast, IPLs remain experimentally unverified, rendering the hypothesis directly falsifiable. Specifically, the hypothesis predicts that:

1. IPLs should be detectable as reversible spine-spine functional linkages.
2. Experimental manipulations affecting IPL formation or maintenance should selectively alter associative recall.
3. Lateral activation through IPLs should occur independently of direct presynaptic activation.

A conceptually analogous mode of operation can be observed in the attention heads of transformer architectures used in large language models (LLMs). Attention heads dynamically link and propagate activity among distributed units, selectively reinforcing relevant associations without necessarily altering underlying connection weights. Analogously, IPLs may provide a biological mechanism for rapid and selective lateral interactions among postsynaptic elements, enabling reactivation of distributed neural patterns on millisecond timescales.

Just as attention heads allow transformers to functionally integrate widely distributed representations within a multidimensional space, IPLs may link postsynaptic terminals to recreate associative patterns that support behavior consistent with memory retrieval. However, unlike LLMs, lateral activation of interlinked spines is proposed to evoke units of first-person properties, termed *semblances*, which are further integrated by oscillatory neuronal activity. The capacity of IPLs to generate first-person experiential properties therefore suggests an operational capability absent in current artificial systems. The behavioral analogy with LLMs nevertheless illustrates how IPL-mediated interactions could enable efficient and high-fidelity integration of distributed information within neural circuits.

The IPL framework also aligns conceptually with Marvin Minsky's K-line theory, which proposes that memory consists of patterns of reactivatable "mental agents" capable of reconstructing aspects of prior cognitive states. IPLs may provide a biological instantiation of this concept by enabling distributed postsynaptic reactivation while simultaneously generating internal semblances of experience.

Because the semblance hypothesis attempts to explain both memory storage and the internal experiential content of memory while introducing only a single major unknown variable, the IPL, the framework remains comparatively tractable, falsifiable, and experimentally high-leverage. Systematic investigation of IPLs may therefore offer a rare opportunity to directly connect neural circuitry with subjective experience, providing a potential pathway toward a mechanistic understanding of first-person properties that could substantially transform neuroscience.