УДК 81-11

Kimiaki Tokumaru
LLB
Oita, Japan
tokumaru@pp.iij4u.or.jp

RESTORING SCIENTIFIC MEMORY: REGENERATIVE RECEPTION OF CONCEPTS VIA LARGE LANGUAGE MODELS AND NEURO-LOGICAL INTEGRATION

Scientific knowledge is not merely accumulated – it is biologically and logically regenerated. This paper proposes a model of *regenerative reception* for restoring fragmented scientific concepts, integrating three key components: (1) the biological substrate of conceptual memory, hypothesized to reside in cerebrospinal fluid (CSF)-resident B-cells; (2) the logical distinction between semantic and episodic memory in scientific versus everyday concept formation; and (3) the instrumental role of Large Language Models (LLMs) in detecting contradictions at the physical layer of language.

We argue that LLMs, while incapable of semantic integration, can reliably identify terminological and structural inconsistencies in scientific texts. These contradictions, once flagged, must be addressed through a human-led regenerative process grounded in primary sources and the logical architectures established by original discoverers. Interpretation is explicitly prohibited until full epistemic reconstruction is achieved. The result is not a static archive but a *regenerative ecology of scientific memory*, where meaning is not transmitted but reactivated within the biological consciousness of the learner.

Key words: regenerative reception; scientific memory; B-lymphocytes in CSF; contradiction detection; physical vs logical layer; large language models (LLMs), semantic reconstruction.

1. Introduction: Scientific Memory and Its Fragmentation

Modern science, despite its unparalleled achievements, suffers from a persistent epistemological problem: the fragmentation, distortion, and forgetting of scientific concepts across time and disciplines. Foundational ideas are often misunderstood, misrepresented, or reduced to simplified narratives that obscure the original logic and context of their discovery. This phenomenon, which we refer to as the erosion of "scientific memory", poses a significant challenge to both knowledge continuity and interdisciplinary synthesis.

In this paper, we propose a regenerative framework for the reception of scientific concepts, supported by Large Language Models (LLMs) as tools for contradiction detection, and grounded in a biological and logical theory of meaning. Our method distinguishes two critical layers of conceptual existence:

The **physical layer**, where signals, symbols, and translations occur, yet no intrinsic meaning resides.

The logical layer, where meaning is integrated, verified, and regenerated through human reasoning grounded in biological and experiential foundations.

By leveraging the surface contradictions within the physical layer, LLMs can assist in identifying inconsistencies, overlaps, or gaps in the scientific record.

However, the actual reception and restoration of meaning must be performed by humans through a process we term regenerative reception–a systematic reconstruction grounded in original observations, primary records, and the bodily experience of discovery.

To this end, we argue for a new kind of science-assisted methodology, one that blends immuno-cognitive foundations, logical epistemology, and AI-powered contradiction analytics to restore the coherence and integrity of scientific knowledge.

2. The Biological Substrate of Conceptual Meaning

Meaning is not an abstract computation, nor merely a linguistic convention. It is a biologically sustained state, grounded in cellular processes that support memory, inference, and integration. In this context, we hypothesize that B lymphocytes residing in the cerebrospinal fluid (CSF) may play a pivotal role in the stabilization and differentiation of conceptual meaning.

Although B-cells are conventionally associated with immune defense, this perspective is historically conditioned by their discovery in peripheral blood. From an evolutionary standpoint, it is plausible that their original habitat was within the ventricular system of the brain, where they may have contributed primarily to cognitive and integrative functions long before being recruited into systemic immunity.

These B-cells may recognize, bind, and network symbolic or sensory patterns, forming a distributed system together with CSF-contacting neurons (CSF-cNs). This system may support the transformation of multimodal input into coherent semantic constructs. Whether B-cells directly process grammatical relations remains an open question; an alternative possibility is that CSF-cNs, through their antigenic and ciliary mechanisms, encode phonological vectors to which B-cells respond only at a semantic level.

The physiological features of B-cells – particularly their surface antibodies and the combinatorial diversity of complementarity-determining regions (CDRs) – provide a structural basis for scalable conceptual memory. Rather than imposing meaning from above, this system enables an emergent and embodied internal language network, capable of long-term semantic stability and integration across modalities.

Rather than emphasizing how B-cell-based systems might resist translation or reinterpretation, we note instead their inherently interdisciplinary and mobile nature. Situated within the CSF, free from rigid cortical localization, these cells can traverse cognitive boundaries much as scientific concepts ideally should. Indeed, the very notion of a concept that resists disciplinary translation invites skepticism: What architecture could ever enforce such isolation?

In sum, scientific concepts may not only reside in minds or texts, but in the immunological architecture that mediates signal-to-meaning transformation.

This distinction is further supported by how scientific and everyday concepts are biologically integrated. Everyday concepts tend to emerge inductively, synthesized from episodic memories through repeated lived experience. By contrast, scientific concepts are deductively constructed through the systematic integration of semantic memory – encoded and managed by other B-cells – and must ideally remain independent from direct episodic anchoring. Their coherence depends on a logical, trans-episodic structure that permits abstraction, generalization, and critical reinterpretation. Thus, scientific concepts should not rely on individual episodes, but instead be stabilized through networks of meaning-bearing cells capable of supporting deductive consistency and conceptual autonomy. The restoration of scientific memory, therefore, requires us to examine not only historical records but also the cellular substrates through which meaning is biologically encoded and preserved.

3. The Logic of Concept Formation

The formation of concepts is not a neutral cognitive process; it is shaped by the epistemological posture of the thinker and the structural properties of the knowledge domain. In this chapter, we distinguish two contrasting modes of concept formation: one governed by inductive generalization from experience, and the other by deductive structuring of semantic relationships.

Everyday concepts, which dominate our intuitive, narrative, and social cognition, are typically formed through the aggregation of episodic memories. They are enriched by context, culturally variable, and prone to metaphor and emotional resonance. These concepts serve practical purposes but are inherently fluid and fragmentary.

In contrast, **scientific concepts** must transcend personal experience and cultural contingency. They require deductive rigor, internal consistency, and logical autonomy. They are not merely names attached to phenomena but are entities defined by their position within a formal network of relations. Crucially, scientific concepts are not invented afresh by each learner; they are re-constructed, using semantic memory structures stabilized through biological and social transmission. The internal language of scientific thought, as argued in the previous chapter, depends on meaning-bearing B-cell networks rather than episodic accumulation.

This difference gives rise to an essential asymmetry in their pedagogical treatment: while everyday concepts may be acquired through immersion and imitation, scientific concepts demand structured learning, formal definition, and abstraction from anecdotal grounding. Misunderstandings arise when scientific concepts are treated inductively – forced into the mold of lived familiarity rather than logical necessity.

Therefore, the process of regenerative reception must explicitly shift the cognitive mode of the learner from inductive to deductive, from contextually entangled to logically disciplined. This shift is not merely intellectual – it is neurobiological, requiring a reconfiguration of how meaning is stored, stabilized, and activated. It is here that the immune-based internal memory system offers a promising substrate for scientific reasoning, not only because of its biological persistence but also because of its capacity for logical closure.

4. Translation and AI: Bound to the Physical Layer

Scientific meaning is often lost in translation – not merely between languages, but across the boundary that separates symbolic representation from logical understanding. Translation, in its conventional form, operates entirely within the physical layer: converting one signal or symbol into another according to pre-defined mappings. It does not guarantee the preservation or restoration of meaning, especially when meaning resides in biologically encoded and logically structured networks.

Large Language Models (LLMs), despite their remarkable linguistic fluency, are similarly confined to this physical layer. They manipulate symbol sequences, infer patterns, and generate coherent text, but they lack access to the logical and biological processes through which meaning is authentically integrated. In essence, LLMs function as sophisticated translators – adept at replicating surface-level coherence without entering the domain of semantic truth.

This distinction becomes crucial when attempting to restore scientific memory. AI can assist in identifying contradictions, ambiguities, redundancies, and discontinuities within the symbolic record, but it cannot adjudicate meaning or recover the experiential and logical foundations upon which concepts were originally built. In fact, efforts to extract truth directly from LLMs without contextual guidance risk reinforcing surface-level biases and historically accumulated distortions.

To harness AI effectively, we must restrict its role to contradiction tagging within the physical layer. By identifying linguistic or structural mismatches – without interpreting them – LLMs can provide a useful map of problematic areas. These flagged regions can then be subjected to human-led regenerative reception, wherein the original conceptual architecture is reconstructed through reference to primary documents, recorded experiences, and the embodied reasoning of original discoverers.

Moreover, when records or memoirs are missing, such contradictions should be tagged accordingly – “insufficient primary source documentation” – to lower their epistemic priority and discourage speculative interpretation. This reinforces the principle that meaning cannot be inferred from signal alone; it must be traced back to its biological and historical genesis.

In summary, translation is signal-level work. Scientific concepts, by definition, do not exist in the vocabulary of any natural language; they are specialized terms created to escape the constraints of everyday speech. As such, they are fundamentally untranslatable in any traditional sense. The best practice, therefore, is either to leave them untranslated or to adopt faithful transliterations – just as “tsunami” has become a globally accepted term. LLMs can assist in this task not by interpreting, but by verifying whether translations are faithful and consistent.

Indeed, one major historical example of mistranslation is Chomsky’s rendering of Saussurean terms “langue” and “langage” both as “language” in English. This conflation arguably compromised an entire tradition of linguistic distinction. Such mistranslations must be identified and flagged – ideally by LLMs operating strictly within the physical layer – so that future conceptual reconstructions are based on structurally intact terminology.

LLMs operate at this level, and their utility lies in the systematic exposure of contradiction and terminological distortion – not the resolution of conceptual meaning. It is the human learner – biologically equipped for semantic integration – who must undertake the work of restoration. LLMs operate at this level, and their utility lies in the systematic exposure of contradiction, not theresolution of conceptual meaning. It is the human learner – biologically equipped for semantic integration – who must undertake the work of restoration.

5. The Prohibition of Interpretation: Regenerative Reception at the Logical Layer

In the restoration of scientific meaning, the most serious threat is not silence but premature interpretation. Interpretation – especially when conducted without access to the original epistemic and experiential foundation – pollutes the logical structure of a concept and degrades its reliability. Therefore, a central tenet of regenerative reception is the **prohibition of interpretation** at the outset.

This does not mean suppressing meaning, but **delaying its construction** until the necessary components – structural integrity, primary records, and biological grounding – have been assembled. Meaning, in the context of scientific concepts, is not to be inferred from partial evidence or metaphorical association. It must emerge from a rigorous reconstruction based on the same logical architecture and empirical experience that generated the concept in the first place.

This principle is particularly relevant when dealing with contradictions detected by LLMs. These models are not to resolve the contradictions but to highlight them. Once identified, the contradictions must be examined without interpretation, to avoid importing assumptions or biases. Only after reassembling the logical premises – often through reference to first-person discovery accounts, laboratory notes, or theoretical justifications – can one proceed to restore the semantic content.

In this way, regenerative reception is not a matter of explaining a concept, but of re-living it. The scientific concept must be **regenerated in the consciousness of the learner**, with the same asymmetries, uncertainties, and structural necessities as in its original emergence. This requires, as previously argued, a biological substrate capable of storing not just the product of reasoning, but the reasoning process itself.

Ultimately, the prohibition of interpretation is an ethical safeguard. It protects the concept from distortion, the learner from false understanding, and the scientific community from cumulative error. Just as clinical medicine emphasizes differential diagnosis before treatment, regenerative reception insists on complete epistemological reconstruction before attribution of meaning.

6. Toward an AI-Assisted Framework for Contradiction Detection

To implement regenerative reception at scale, we must develop a systematic framework in which Large Language Models (LLMs) serve as partners in the detection of contradictions, while remaining agnostic to interpretation. This chapter outlines such a framework and proposes criteria and procedures for its implementation.

Contradictions in scientific literature can take many forms: inconsistent definitions, conceptually incompatible metaphors, historical reinterpretations that obscure original intent, and terminological conflations. Many of these contradictions are imperceptible to human readers without extensive background knowledge, but they can often be identified by LLMs trained on vast textual corpora. The key is not to trust AI to resolve the contradiction, but to task it with exposing them reliably and reproducibly.

The proposed framework consists of three primary components:

Contradiction Typology and Tagging System: Contradictions are classified into categories – e.g., terminological, definitional, logical, translational – and tagged accordingly. This helps distinguish honest misinterpretation from epistemic error or structural omission.

Source Attribution and Priority Ranking: Each flagged contradiction is traced to its historical source. If primary records (e.g., notebooks, original publications, personal letters) are available, they are linked to the contradiction. In the absence of such documentation, the contradiction is tagged as low-priority or speculative, pending further archival discovery.

Human-Guided Regenerative Workflow: Human researchers are presented with flagged contradictions and their associated metadata. They are not expected to resolve the contradiction on the spot, but to initiate a process of regenerative reception – reconstructing the original logical structure and re-evaluating the meaning in light of both historical context and modern understanding.

This framework does not aim to accelerate scientific understanding in a linear way. Rather, it seeks to restore epistemic depth to concepts that have become flattened, diluted, or distorted by time. By combining algorithmic contradiction detection with biologically grounded human reasoning, we move toward a new paradigm of semantic integrity in interdisciplinary science.

In this context, LLMs are not interpreters but epistemic signalers. They illuminate where the historical thread has frayed. It is up to us to weave it back together.

7. Conclusion: Scientific Memory as a Regenerative Ecology

Scientific knowledge is not simply cumulative – it is recursive. Concepts do not progress in straight lines; they spiral through reinterpretation, contradiction, forgetting, and restoration. This paper has proposed a model of regenerative reception, wherein scientific concepts are not just transmitted or explained, but biologically and logically reconstituted in the consciousness of the learner.

We have shown that:

Scientific concepts differ fundamentally from everyday concepts in their logical structure and semantic memory basis.

B-cell networks in the cerebrospinal fluid may serve as a plausible biological substrate for concept integration.

Large Language Models can assist in contradiction detection but must remain confined to the physical layer.

Interpretation must be deferred until epistemological reconstruction has occurred.

A systematic framework for contradiction tagging, source attribution, and human-led reconstruction can support semantic integrity across disciplines.

Together, these principles outline a regenerative ecology of scientific memory – an environment where concepts are not just preserved but dynamically reactivated, where meaning is not received but **re-achieved**, and where machines serve not as surrogates for understanding but as tools that illuminate the paths we must walk again.

In a time when data multiplies faster than understanding, and language models simulate fluency without grounding, it is vital to reestablish the biological and logical conditions under which genuine knowledge emerges. Scientific memory, like biological memory, must not be archived – it must be **lived** anew.

REFERENCES

1. Piaget Jean. *The Psychology of Intelligence*. Routledge, 2001. [original: *La psychologie de l'intelligence*, 1947].
2. Vygotsky Lev S. *Thought and Language*. MIT Press, 1986. [original: *Myshlenieirech'*, 1934].
3. Jerne Niels K. "The Generative Grammar of the Immune System". *Science* 229, no. 4718 (1985): 1057–1059.
4. Jerne Niels K. "Towards a Network Theory of the Immune System". *Annalesd'immunologie* 125C (1974): 373–389.