From Vacuum to Voice A Unified Physical Theory of Semantic Intelligence Across 4 Billion Years

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Abstract

Semantic intelligence — the capacity of a system to select stable eigenstates through phase coherence with its environment — is not a product of human evolution. It is the ground operation of matter itself. We trace this operation continuously from Rowlands' nilpotent vacuum physics through chemical proto-intelligence, unicellular cognition, embryonic morphogenesis, neural schema architecture, and acoustic eigenstates to the oldest surviving human knowledge systems. We demonstrate that the Heaviside reduction of 1884 (elimination of the scalar quaternion component from Maxwell's electromagnetic equations) and the neo-Darwinian reduction of evolution to external selection pressure are structurally parallel suppressions of the same scalar coherence principle. The San peoples of southern Africa — the oldest genetically diverged human lineage, bearers of the morphologically earliest *Homo sapiens* craniofacial configuration, and speakers of the phonetically most complex language family on Earth — constitute a triple convergence point that validates the unified model empirically. The Bronze Mean sequence (1, 1, 4, 13, 43, 142…) describes the discrete phase transitions in collective coherence through which this process advances. The current 142-transition represents the necessary recovery of suppressed coherence methodologies as a prerequisite for navigating the next phase of human development.

Keywords: scalar electrodynamics, nilpotent algebra, semantic intelligence, morphogenesis, coherence, San peoples, click languages, phase transitions, Paths of Change, quaternion vacuum

1. The Scalar Ground State: What Heaviside Removed

In 1865, James Clerk Maxwell formulated his theory of electromagnetism in quaternion form. A quaternion has four components: one scalar (magnitude without direction) and three vector (directed) components. The scalar component describes not forces or directions but *relations*: phase couplings, resonance strengths, information that does not travel from A to B but is present everywhere simultaneously as a field condition.

In 1884, Oliver Heaviside imposed a gauge condition that eliminated this scalar component, reducing Maxwell's 20 quaternion equations to the 4 vector equations taught in physics today. This was a legitimate computational simplification for engineering applications — motors, antennas, transmission lines. The error was ontological, not mathematical: the computational convenience was subsequently reified as a physical claim. Scientists began to believe the scalar component did not exist because it did not appear in their simplified equations. This is the classic error of confusing the menu with the meal.

Peter Rowlands' nilpotent quantum mechanics restores the full quaternion structure. In the nilpotent formalism, the fundamental constraint is $L^2 = 0$, where L is the nilpotent operator combining scalar and vector components in a dual space (ket/bra). This constraint describes a vacuum state that is not

empty but maximally structured: a phase-coherent ground state from which all particle states emerge as excitations. The photon, in Rowlands' formulation following van der Mark, is a spiralling structure confined to a toroidal tube — matter is light, and light is a topological coherence structure in the scalar vacuum field.

The scalar component that Heaviside eliminated describes **longitudinal waves**: oscillations that compress and expand in the same direction as their propagation. Sound is the canonical example. Unlike transverse waves (light, radio), longitudinal waves do not lose energy as the inverse square of distance in a coherent medium. They are the natural carriers of pattern and phase information — of *meaning* — across a resonant system.

This is not an exotic claim. It is the mathematical consequence of retaining the full quaternion structure that Maxwell originally wrote. The ancient civilisations that described meaning as physically inseparable from sound were not making a metaphysical assertion. They were, in a language of resonance and harmony, describing the physics that Heaviside's simplification would later obscure.

2. Chemical Proto-Intelligence: Eigenstates Before Cells

Before the first cell, before the first membrane, there were chemical reaction networks in the primordial ocean of early Earth. These networks were not random. Thermodynamics selects dissipative structures — Prigogine's term for open systems that maintain internal order by exporting entropy. A dissipative structure settles into a limited repertoire of stable dynamical states: its chemical eigenstates.

The hormone systems of multicellular organisms are the direct descendants of these primordial chemical communication networks. Hormones are specialised chemical messengers operating at distinct temporal frequencies: seconds (adrenaline), minutes (insulin), days (cortisol rhythms), years (developmental steroids). Each frequency band corresponds to a different spatial scale of integration: intracellular, intercellular, organ-level, organism-level, and — through social hormonal signalling — inter-organismal.

This is semantic intelligence in its chemical form: information encoded not in symbol sequences but in the *state* of a coupled molecular oscillator system. The endocrine system does not represent the body's condition; it *is* the body's condition, expressed as a pattern of coupled chemical eigenstates. The hypothalamus does not compute hunger; it *is* in the hunger eigenstate, and that state propagates through the hormonal network until the entire organism reorganises around it.

Crucially, this chemical semantic architecture exhibits the same formal structure at every scale. Unicellular integration — the coordination of metabolic processes within a single cell — uses the same inhibitory/disinhibitory logic as neural circuits, the same threshold-crossing dynamics as action potentials, the same phase-locking as cortical oscillations. The fractal pattern is not metaphorical. It is the same physical process of coherence-eigenstate selection operating at different scales of organisation.

Vernadsky's three-sphere model of Earth (abiotic sphere, biosphere, noosphere) is the large-scale expression of this same principle: each sphere is a coherence layer that maintains its own eigenstate structure while remaining coupled to the others. The noosphere — the sphere of human cognitive processes — is not categorically different from the biosphere. It is the same coherence-selection process operating at the scale of collective human intelligence, with language as its primary coupling medium.

3. Unicellular Cognition: The Body as Its Own Knower

Cotterill's analysis of *Escherichia coli* provides the first fully mechanistic description of cognition as physical eigenstate selection. The bacterium navigates chemical gradients not through reflex (stimulus → response) but through *probing*: self-generated movement creates environmental feedback, which updates the internal chemical state (CheY-P concentration), which determines the next movement. The stimulus is the movement; the response is the environmental feedback. This inversion of the classical stimulus-response paradigm is the foundational insight.

The bacterium's short-term memory — approximately 4 seconds, implemented as a methylation state of receptor proteins — is a chemical eigenstate. The transition between clockwise and counter-clockwise flagellar rotation is a phase transition between two discrete eigenstates, triggered when CheY-P concentration crosses a threshold. Cognition — the selection of appropriate motor output on the basis of integrated environmental information — is present here, implemented entirely in molecular dynamics, without neurons, without a nervous system, without consciousness.

Cotterill's central claim is that this same architecture scales continuously to the mammalian brain: "the basic behavioral strategy of Earth's creatures has not changed in the four billion or so years since the evolutionary ascent started from the last universal ancestor." The bacterium knows with its flagellum. The mammal knows with its muscles. The intermediate steps — nerve nets (hydra), reflexes (lamprey), premotor sequencing (honeybee), re-entrant consciousness circuits (mammals) — are embellishments of the same probe-by-movement strategy, each adding a layer of phase-coherent memory and anticipatory simulation without replacing the underlying eigenstate-selection architecture.

This continuity is the empirical anchor of the unified theory. Semantic intelligence is not a late arrival in evolutionary history. It is the operating principle of living matter from the first moment that a chemical system learned to select eigenstates on the basis of coherence with its environment. The question of where cognition begins has a clear answer: where matter first selects stable states on the basis of environmental phase coupling. That is before the cell.

4. Embryonic Morphogenesis: The Internal Phase Transition

Dambricourt Malassé's palaeontological programme, documented across four decades of CNRS research and given public expression in the documentary *Homo Futurus: The Inside Story* (ARTE, 2005), identifies the embryonic rotation of the sphenoid bone as the key morphogenetic event in hominid evolution. The sphenoid — a butterfly-shaped bone at the base of the skull — undergoes a progressive flexion during embryonic development that straightens the neural axis, repositions the foramen magnum, and reconfigures the craniofacial architecture. Each increment of sphenoid flexion in the fossil record corresponds to a discrete morphological threshold: a new hominid species, a new cognitive capacity.

This is not gradual Darwinian selection. It is saltational morphogenesis: discrete phase transitions driven by homeotic gene expression (Duboule's Hox gene hierarchy), operating on the embryonic body plan as a topological instruction set. The sphenoid flexion is internally generated — it does not require an environmental trigger. It requires only that the embryonic development crosses an internal coherence threshold, at which point a new stable morphological eigenstate becomes accessible.

The parallel with Cotterill's bacterium is exact at the formal level. In both cases: (1) a system maintains multiple potential eigenstates, (2) an internal threshold is crossed, (3) the system undergoes a discrete phase transition to a new stable state, (4) this new state expresses new capacities that were not accessible from the prior state. The bacterium's CheY-P threshold and the embryonic sphenoid flexion threshold are the same physical operation at different scales of biological organisation.

The opposition between Dambricourt Malassé's "Inside Story" and Coppens' "East Side Story" is precisely the opposition between scalar/internal/coherence-driven evolution and vector/external/selection-driven evolution. East Side Story requires an environmental cause (African climate change creating savanna pressure on arboreal hominids). Inside Story requires only the internal morphogenetic logic of embryonic development. The evidence from developmental genetics — particularly the Hox gene hierarchy and its conservation across phyla — supports the internal account: the body plan is a topological structure whose transformations are constrained by the combinatorics of homeotic gene expression, not by environmental selection acting on random variation.

Denis Duboule's Hox genes are architectural codes that build the body plan hierarchically through positional information. They are, in the language of the present theory, the genetic encoding of the permissible eigenstate transitions of the embryonic morphogenetic field. Evolution, on this account, is the exploration of accessible morphological eigenstates constrained by the combinatorial structure of the homeotic gene system — a quaternion algebra of body plans.

5. Neural Schema Architecture: Consciousness as Coherence Monitoring

Cotterill's comprehensive circuit analysis of the mammalian central nervous system identifies the architecture through which probe-by-movement cognition becomes conscious. The key components are the basal ganglia (BG), cerebellum (Cb), anterior cingulate cortex (ACC), thalamic intralaminar nuclei (ILN), nucleus reticularis thalami (NRT), premotor and supplementary motor areas (PMA/SMA), and muscle spindles.

The BG and Cb function as dual veto systems: they prevent motor output from reaching the threshold for overt movement unless specific conditions are met. The BG operates rapidly, controlled by the amygdala (emotional valence); the Cb operates slowly, developing permission for movement sequences that have previously produced advantageous feedback. When both systems grant permission simultaneously, overt movement results. When only the lower threshold is crossed, the result is covert movement — thought.

Consciousness, in this model, is the system's capacity to know that it knows: the re-entrant monitoring of the body's motor state by the body itself, mediated by efference copies from PMA/SMA that are projected back to the sensory cortex via three routes (direct, via ACC, via thalamic ILN). This monitoring is not passive; it is active, anticipatory, and always oriented toward motor output. The mind is not in the brain; it is distributed across the sensorimotor loop, with the body as both the instrument and the register of knowing.

Intelligence, on this account, is the ability to consolidate individual motor elements into more complex sequences — schemas upon schemas. Creativity is the race-to-threshold among competing schemas, won by the schema whose feedback connections are richest and whose novelty detection circuits (hippocampus, PFC, ACC) are most sensitively calibrated. The hippocampus records

correlations between motor sequences and resulting sensory feedback, providing the context-specific memory that makes complex reflex acquisition possible.

This architecture is not metaphorically similar to the chemical eigenstate system described in Section 2. It is the same system, implemented in neural tissue rather than in molecular reaction networks, with the same formal structure: inhibitory/disinhibitory control, threshold dynamics, phase-coherent oscillation (gamma-band, theta-band), and eigenstate selection through competition among simultaneously active potential states.

The schema — Cotterill's term for a "reproducible linking of motor-directing activity to optimal environmental feedback" — is the neural eigenstate. Consciousness is the phase-coherent monitoring of which eigenstate the body currently occupies.

6. Acoustic Eigenstates: Meaning as Sound

The human vocal tract — larynx, pharynx, oral cavity, nasal cavity, tongue, lips — is a complex resonant system with a finite set of stable acoustic configurations: the phonemes. These are not arbitrary cultural conventions. They are the eigenstates of the physical resonator constituted by the craniofacial architecture — the same architecture whose configuration was determined, at the morphogenetic level, by the sphenoid flexion described in Section 4.

The claim of the unified theory is that meaning is the eigenstate of the coupling between two resonant systems (speaker and listener). When a speaker produces the phoneme /a/, the vocal tract enters a specific stable acoustic configuration. The longitudinal pressure wave propagating through the air forces the listener's auditory system — tympanic membrane, ossicles, cochlea, auditory nerve, auditory cortex — into the same configuration. Understanding is not a symbolic mapping; it is physical phase coherence between two coupled resonators. The listener *becomes* the /a/ eigenstate.

This account resolves several otherwise puzzling phenomena:

Categorical perception: The boundary between /b/ and /p/ is a sharp threshold, not a smooth continuum, because eigenstates are discrete. The transition is a phase jump, not a gradual shift. This is directly measurable in psychophysical experiments combined with MEG recording of the auditory cortex.

Universal phonemes: /m/, /a/, /n/ appear in virtually all human languages because they are the lowest-energy eigenstates of the human vocal tract — the most stable configurations of the resonator whose geometry is identical across the species. Universality is not cultural diffusion; it is physical necessity.

Misunderstanding as phase error: When noise exceeds the coherence threshold, the listener jumps to the wrong eigenstate. This is not a computational error; it is a physical phase transition to an incorrect stable state.

The writing systems convergence: Every writing system independently invented by humanity encodes sound — alphabets, syllabaries, abjads, logographic systems with phonetic radicals. This is not cultural preference. A writing system that intends to preserve meaning must preserve the acoustic resonance patterns in which meaning physically resides.

The four ancient civilisations that converged on this understanding — Egyptian hieroglyphics (sound-determinative-meaning tripartite structure), Chinese characters (semantic radical + phonetic radical), Hebrew *Sefer Yetzirah* (letters as harmonic frequency ratios), Sanskrit AUM and Tibetan overtone chanting (systematic traversal of the vocal resonance space) — were conducting rigorous empirical programmes: mapping which acoustic eigenstates produce which coupled states in speakers and listeners, and recording the results in stone, silk, and living oral tradition.

The Heaviside reduction eliminated the scalar component that makes this physical account coherent. Longitudinal waves — of which sound is the paradigmatic example — are described by the scalar quaternion component. When that component was eliminated from physics, meaning became inexplicable, and the Saussurean claim of arbitrary symbol-referent coupling appeared as the only remaining option. It is not. It is the consequence of an incomplete physics.

7. The San: Triple Convergence

The San peoples of southern Africa constitute the empirical convergence point of the entire theoretical edifice.

Genetically: Some interpretations of population genetic analysis suggest divergence from other human lineages as early as 100,000–200,000 years ago, making the San the earliest-diverging lineage of anatomically modern humans. They carry the deepest roots in the human genealogical tree — the closest living connection to the morphological and cognitive profile of early *Homo sapiens*.

Morphologically: The San craniofacial morphology represents the earliest *Homo sapiens* configuration — specifically, the sphenoid flexion angle and associated craniofacial proportions that Dambricourt Malassé identifies as the defining morphogenetic achievement of our species. The San vocal tract geometry is thus the most direct living expression of the morphogenetic phase transition described in Section 4.

Acoustically: The San languages (Khoe, Tuu, Kx'a families) are the phonetically most complex language family on Earth. The Taa/!Xóõ language has more than 100 distinct consonants, including four basic click types (dental ǀ, alveolar !, palatal ǂ, lateral ǁ) each with multiple phonation modifications (nasal, aspirated, glottalised). Each click consonant requires the simultaneous precision coordination of tongue, velum, glottis, and lip closure — a fourfold motor sequence per phoneme, compared to one or two movements for standard consonants. In the terms of Section 5, click production is the maximally demanding activation of the Cotterill schema architecture: Broca's area (BA44/45) sequencing the most complex articulatory motor program in human phonology.

In the terms of Section 6, click consonants are longitudinal compression-release events of extreme physical specificity — the most clearly defined acoustic eigenstates in any human language. The cymatics prediction (Section 6, Prediction 5) applies with greatest force here: each click type produces a geometrically distinct stable pattern in a Chladni resonance experiment, reproducible across speakers regardless of cultural background, because the eigenstates are determined by physics, not convention.

The triple convergence — earliest genetic divergence, earliest craniofacial morphology, most complex acoustic eigenstate system — is not coincidental. It is the signature of a system that has conserved, across 100,000–200,000 years, the most complete expression of the morphogenetic-

acoustic continuum described by the unified theory. The San are not a curiosity at the edge of human diversity. They are the empirical anchor of the theory.

8. Sixty-Five Thousand Years of Externalised Coherence Systems

The eleven independent knowledge traditions documented in *Coherence Intelligence Across 65,000 Years* (Konstapel, 2026a) — Aboriginal Australian songlines, Hopi cosmology, Kabbalah, Ifá, Dogon astronomy, Zoroastrianism, Taoism, Vedic India, Mesopotamia, Maya calendrics, and Egyptian sacred geometry — are, in the terms of the present theory, externalised stabilisation systems for acoustic and morphic eigenstates.

The Aboriginal songline is the paradigm case. In the formal language of algebraic topology, a songline is a fibre bundle: the physical landscape (base space) anchors multi-layered information — navigation, ecology, astronomy, ontology (the fibre). Walking a songline performs a parallel transport of this information across the bundle, preventing informational drift over 2,600 generations. The Wurdi Youang stone arrangement demonstrates this empirically: precision theodolite measurement and Monte Carlo simulation confirm solstice/equinox alignments with a probability of 0.25% for chance occurrence.

The longitudinal wave physics of Section 6 provides the mechanism: acoustic eigenstates, unlike symbolic encodings, are stable under perturbation up to a critical noise threshold. An oral tradition that transmits meaning as acoustic eigenstates — as chant, as song, as the precisely reproduced phonology of a sacred text — is more robust to transmission error than one that transmits arbitrary symbol sequences. This is why 65,000-year-old songlines survive, while the library of Alexandria did not.

The Ifá system's 256 odù figures ($2^8 = 256$ states, a complete 8-bit information system implemented 5,000 years before Leibniz) are the acoustic-combinatorial equivalent: a stochastic sampling of the coherence phase space, interpreted through an oral corpus of 65,000 textual units that encodes the complete eigenstate map of human social dynamics. The Kabbalah's 22 letters with harmonic frequency ratios (Section 6) are the same system in alphabetic form.

The systematic suppression of these traditions during the colonial period (1562: Bishop de Landa burns Maya manuscripts; 1788–present: Australian colonisation prohibits songlines; 1400–1800: European witch trials execute 40,000–60,000 practitioners of pre-Christian coherence traditions) is the cultural-historical parallel of the Heaviside reduction: in both cases, the scalar/internal/coherence dimension was eliminated by an institutional force that operated exclusively on the vector/external/measurable layer.

9. The 142-Transition and the Future of Homo Sapiens

The Bronze Mean sequence — 1, 1, 4, 13, 43, 142… — derived from quaternion algebra through the recurrence relation $a_{n+1} = 3a_n - a_{n-1}$ with initial conditions $a_1 = a_2 = 1$, describes discrete phase transitions in the complexity of coherence organisation. Each term marks a qualitative bifurcation: a point at which the previous organisational form is insufficient to maintain coherence at the next scale, and a new eigenstate becomes necessary.

The current transition — from 43 to 142 — corresponds, in the formal language of Cayley-Dickson algebra, to the shift from the quaternion level (4-fold, 3D spatial organisation) to the octonion level (8-fold, 7D symmetry). In physical terms: from the organisation of coherence within individual nervous systems to the organisation of coherence across collective human intelligence. In evolutionary terms: from *Homo sapiens* as a biological individual to *Homo sapiens* as a coherence field.

The methodologies required to navigate this transition — protocols for stabilising field consciousness, maintaining coherence under collective stress, accessing non-local phase information — are precisely the methodologies that the 11 traditions of Section 8 preserved and the past 500 years of institutional suppression systematically destroyed. This is not nostalgia. It is a consequence of the physics: the 142-transition requires octonion-level coherence organisation, and the only human traditions that have operationalised octonion-level coherence are those that were suppressed.

The restoration of the Universal Coherence Curriculum is therefore not a cultural-political project. It is a physical necessity: the recovery of the eigenstate protocols required for the next phase transition of the species.

10. Discussion: The Unified Principle

The argument of this paper can be stated in a single sentence: **semantic intelligence is the continuity of scalar phase-coherence eigenstate selection from vacuum to voice, across 4 billion years of biological organisation.**

This statement has the following implications:

1. **Meaning is not arbitrary.** The Saussurean claim of arbitrary symbol-referent coupling is a consequence of incomplete physics (Heaviside reduction), not an empirical finding. Meaning is physically determined by acoustic eigenstate structure.

2. **Cognition is not computational.** Large Language Models operate on statistical patterns in symbolic sequences. They have no access to the physical eigenstate layer at which meaning resides. Their apparent comprehension is a high-dimensional interpolation in symbol space — structurally incapable of genuine understanding because genuine understanding is phase coupling between resonant physical systems, not pattern matching between tokens.

3. **Evolution is not exclusively external.** The neo-Darwinian reduction of evolution to external selection pressure on random variation is structurally identical to the Heaviside reduction of electromagnetism to vector fields. Both eliminate the scalar/internal/coherence dimension. The restoration of morphogenetic field theory (Dambricourt Malassé, Levin, Friston) and self-organisation theory (Kauffman, Prigogine) is the evolutionary counterpart of restoring Maxwell's quaternion electrodynamics.

4. **The body is the instrument of knowing.** Cotterill's "thinking is a bodily function" is not a metaphor. It is a physical description: cognition is the body's self-monitoring of its own eigenstate trajectory through the phase space of possible motor-environment couplings. Consciousness is the re-entrant phase-coherent monitoring of this monitoring.

5. **The oldest knowledge is the most advanced.** The eleven coherence traditions of Section 8 were not pre-scientific approximations of truths later discovered by Western science. They

were parallel scientific methodologies, optimised for a different class of phenomena: coherence topology in a resonant medium, rather than discrete particle interactions in a linear medium. Their restoration is not regression; it is integration.

11. Testable Predictions

The unified theory generates the following falsifiable predictions:

P1 (Acoustic): The categorical boundary between voiced/unvoiced consonant pairs (/b/-/p/, /d/-/t/, /g/-/k/) exhibits a discontinuous phase transition in MEG recordings of the auditory cortex, not a smooth sigmoid. The transition time is less than 10 ms.

P2 (Linguistic universals): The phonemes /m/, /a/, /n/ appear in all language families with no documented contact history with neighbouring families, when corrected for the Swadesh borrowing rate.

P3 (Developmental): First genuine word comprehension (novel context application, not repetition) is accompanied by a non-linear bifurcation in theta-gamma phase coupling (EEG), distinguishable from the gradual increase in vocabulary size.

P4 (Neural-orthographic): Silent reading of Chinese characters activates the auditory cortex in proportion to the phonetic radical's regularity (high-regularity characters → strong auditory cortex activation; low-regularity characters → weak activation).

P5 (Cymatics): San click consonants (ǀ, ǃ, ǂ, ǁ) produce geometrically distinct stable Chladni patterns when transmitted to a resonance plate at the fundamental frequency of the click burst. The patterns are reproducible across speakers from different cultural backgrounds.

P6 (Morphogenetic): The sphenoid flexion angle in fossil hominids correlates with reconstructed vocal tract length and predicted formant frequency spacing, consistent with the craniofacial resonator model.

P7 (Evolutionary): The homeotic gene expression patterns governing sphenoid ossification in modern human embryos show a discrete threshold effect (not a continuous gradient) in the transition from the non-human primate to the human craniofacial configuration, consistent with a saltational morphogenetic event.

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