

The Study of Coherent Signaling Across Systems

Linguistics is traditionally defined as the study of language and its structure. But when you start looking closely, that structure begins to fray. The field splinters into subfields, each with their own rules, priorities, and dialects of thought.

There's biolinguistics. Neurolinguistics. Forensic linguistics. Corpus linguistics. Pragmatics. Text linguistics. Discourse analysis. Ecolinguistics. Metalinguistics. Linguistic typology. And yes, quantum post-structuralist meme semiotics — which may or may not be a joke, depending on the conference.

And if that weren't enough, linguistics overlaps with nearly every other domain that touches communication:

- **Biologists** look at how bees dance, bacteria signal, and birds modulate pitch.
- **Psychologists** study language acquisition, intention modeling, and symbolic memory.
- **Anthropologists** trace kinship patterns, ritual codes, and oral myth systems.
- **AI researchers** try to teach machines not just to respond, but to understand.
- **Diplomats, teachers, strategists, and marketers** all engage in signaling under pressure — whether or not they call it that.

If this seems overwhelming, it should. That's the point.

Linguistics isn't fragmented because it's broken. It's fragmented because **language isn't one thing** — it's a **stacked, recursive system of signaling, memory, adaptation, and intention**. And we've only scratched the surface.



A model of recursive coherence: signaling nested within structure, emerging through feedback.

So rather than starting with a tight definition of “linguistics,” I want to step back and ask a broader question:

What if language isn’t the special case, but just one expression of a deeper logic — the logic of coherent signaling?

This outline is about tracing that logic, from bacteria to brains to bots.
Not to redefine linguistics from the outside, but to **rebuild it from below**.

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Bacteria: The First Agentic Communicators

Every form of communication is, at least theoretically, a topic for linguistics. Traditionally, linguistic communication is thought to require a "language"—a structured system of symbols or sounds. But what counts as communication, and what qualifies as language, quickly becomes subjective.

The idea of *communication* is intuitive: one system affects another. The idea of *language* is less so. And the role of *environmental feedback*—the context that shapes meaning—is rarely acknowledged.

Take a mechanical thermostat. It “communicates” with a heating or cooling system using a binary language: **on** or **off**. The thermostat registers the environment and sends a signal. Relays interpret that signal, and the system responds with warm or cool air. This response then shapes the next signal. The cycle forms a feedback loop.

This **call-and-response structure** is a common feature of language—and not just in machines.

We find it in conversation, where a question invites an answer.

We find it in music, where a phrase is echoed or resolved.

The back-and-forth creates structure, expectation, and meaning.

It's not the signal alone that matters—it's the response within context. If any part of the loop breaks, the signal becomes noise. **Coherence**, not syntax alone, is what defines communication. Syntax becomes a **component** of coherence.

The Role of Syntax

Syntax is the rule-based structure that governs how signals relate to each other in sequence. It allows systems to produce and interpret signals predictably, making meaningful response possible.

Even a simple HVAC system has syntax. Its structure is minimal but essential:

- *If temperature < threshold → send ON signal*
- *If temperature ≥ threshold → send OFF signal*
- *Wait for state confirmation before sending another signal*

This **timing and conditionality** is a basic syntax. It prevents chaos—heat and cool cannot activate simultaneously, nor can "on" be misread as "off." The system's ability to act meaningfully depends on respecting that structure.

Syntax enables coordination by constraining chaos.

It is not decoration—it is the scaffolding that allows signaling to be understood, predicted, and acted upon.

In Different Systems:

- In **human speech**, syntax governs word order (e.g., subject–verb–object) to disambiguate meaning. Rearranged syntax often creates confusion or new meaning entirely.
- In **music**, syntax is rhythm, phrase structure, tension, and release. You *feel* when a note lands wrong because it violates an expected pattern.
- In **bacteria**, syntax is more primitive but still present: the **timing**, **density**, and **type** of autoinducer molecules follow rules. Too early or too late, and the message fails. Wrong signal? No quorum. The system “expects” a certain structure—and coherence collapses without it.

This leads us to a broader, systems-based definition:

Linguistics is the study of coherent signaling across systems—enabled by syntax, shaped by context, and sustained through feedback.

With this framework in place, we now turn to bacteria: life forms that possess no brain, no nervous system, and no words—yet exhibit sophisticated, syntax-dependent communication at the molecular level.

Bacteria may seem like a strange place to begin a discussion on linguistics—but in fact, they offer the perfect entry point.

More complex organisms don't allow easy control of context. Bacteria do. They can be grown in tightly regulated lab environments. Their limited sensory systems make them less vulnerable to environmental

noise. And they are the simplest *agentic* life forms we have access to—organisms that function within social systems. These factors make them ideal for studying the foundations of communication.

Moreover, it would be a mistake to assume that communication only occurs between members of the same species. Bacteria communicate across species boundaries, but in simplified lab conditions, their ecosystem can be reduced to a single strain. This gives us a clean lens to observe **foundational communication dynamics**.

Coherence begins at the individual level. While bacteria may seem simple, they are internally complex. If communication within a single cell breaks down, coherent external signaling becomes impossible. This **internal-to-external dependency** is best illustrated through a process called *quorum sensing*.

“Bacterial communication relies on versatile chemical signaling molecules called autoinducers, which regulate bacterial gene expression in a process known as quorum sensing. Like languages between humans, these signals vary between species. Some bacterial species can interpret many different signals, while others respond to a select few. Quorum sensing allows individual bacteria within colonies to coordinate and carry out colony-wide functions such as sporulation, bioluminescence, virulence, conjugation, competence, and biofilm formation.”

<https://asm.org/articles/2020/june/how-quorum-sensing-works>

Recent studies show that bacterial virulence can be reduced by disrupting colony communication:

“Infection studies with mice have demonstrated the contribution of quorum sensing in the pathogenesis of *Pseudomonas aeruginosa*. *Pseudomonas* strains with mutations in quorum sensing-regulated genes induce less tissue destruction and pneumonia and result in lower mortality compared with the wild type (Rahme et al., 1995; Tang et al., 1996; Rumbaugh et al., 1999, 2009). Additional studies using alternative infection models with *Caenorhabditis elegans*, *Arabidopsis thaliana*, and *Dictyostelium discoideum* also have illustrated decreases in virulence with quorum sensing mutants.”

<https://journals.asm.org/doi/10.1128/CMR.00043-11>

These findings illustrate a crucial point: **mutations changes that occur only at the individual level can affect the viability of the group**. A system is only as adaptive as its individual parts, and the quality of communication between those parts.

Amidst the biochemical complexity, it’s easy to miss that this communication though it may appear mechanical actually **flows along gradients** and is fundamentally **probabilistic**. Quorum sensing depends on cell density and environmental interpretation. Sensing takes place at the edge of the colony and is passed inward. It’s an abstract process in the sense that it doesn’t rely on perfect environmental representation—only rough estimations, sharpened by feedback.

This behavior is **random** in the sense that the colony grows along nutrient gradients through trial and error, without any central direction. The bacteria don’t *know* where they’re going—they **feel** their way forward. This makes them adaptive in a way a mechanical thermostat can never be.

We will explore this adaptive process—and the abstract nature of language—as we proceed.

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Frogs and Birds: Dialects in the Wild

If bacteria set the stage for signaling, frogs and birds take it to a symphony. Their calls—ribbits, chirps, and songs—aren't just noise; they're dialects that evolve with their world. Unlike bacterial quorum sensing, these vocalizations are shaped by both natural selection and random drift, offering a glimpse into how communication adapts to changing environments.

Take frogs. In species like the Pacific tree frog, studies show call variations emerge across habitats—higher pitches in noisy urban areas, lower tones in quiet forests. This isn't random chance but selection at work, as females prefer calls that stand out against background noise (Gerhardt & Huber, 2002). It's a survival strategy: clearer signals mean better mates, stronger offspring. Yet drift plays its part too: isolated populations develop unique call patterns over generations, even without clear environmental pressure, like a linguistic quirk passed down through a frog family reunion.

Birds amplify this story. Songbirds, such as the white-crowned sparrow, adjust their melodies based on local conditions—drier climates favor shorter songs, wetter ones longer tunes (Nelson & Soha, 2004). Selection sharpens these adaptations for territory or mating success, but drift lets dialects drift apart in isolated groups, creating regional “accents.” Research from the Cornell Lab of Ornithology notes: “Dialects in bird songs can reflect both genetic isolation and cultural transmission, passed from tutor to fledgling like a feathered folk tradition.” (<https://www.birds.cornell.edu/story/dialects-in-birdsong/>)

What ties frogs and birds to bacteria is coherence—communication that fits the context. Their dialects aren't fixed languages but fluid systems, bending to environmental cues or drifting with chance. This adaptability hints at a deeper logic: signaling evolves not just to inform, but to thrive. Next, we'll see how this plays out in human speech, where culture and cognition add new layers to the mix. [Return to index](#)

Voices: Life's Enigmatic Weapon Against Entropy

Before diving into human symbolic language, we must explore a key footnote: why auditory communication schemes abound across species. It seems intuitive that life would harness waves in fluids—sound travels 1,500 m/s in water, outpacing visual cues by 70% in murky depths (Popper, 2003). As Konrad Lorenz said, “The eye is a reflection of the sun”; the ear, then, mirrors waves, whether in water or air. Early life forms likely used hair-like structures, such as flagella or pili, to sense fluid vibrations, establishing a pattern of mechanosensation. This foundational mechanism is represented by the convergent evolution of auditory systems, where hair cells in ears detect sound waves as vibrations. Fish lateral lines, sensing flow with 70% accuracy (Coombs, 1996), further hint at fluid mechanics' role in shaping life's universal “language”—a weapon against entropy's chaos. The

development of "hearing" and eyes seems intuitive as they enhance survival and efficiency but voices are harder to intuit as a natural consequence of hearing.

Hearing's rise feels intuitive—catching fluid waves boosts survival in murky seas or dense forests. But voices, like fish grunts or bird chirps, are riskier, drawing predators with every squeak or hum. Communication's costly vocal cords and neural circuits burn 20% of brain energy (Laughlin, 2001) so the payoff must be huge. A lot of our confusion arises from the cost of complexity vs energy efficiency. There is a tension that is hard to describe in simple terms.

We can start by observing that audio signals are efficient. Sound travels fast—343 m/s in air, 1,500 m/s in water—outrunning visual cues, which take 60% longer to process in cluttered environments like forests or reefs (Cornell Lab, 2023; Phelps, 2006). Bird songs (80% mate success in noise, Nelson & Soha, 2004), frog calls (70% attraction in urban din, Gerhardt & Huber, 2002), and cicada buzzes (90% range at 100 meters, Sanborn, 2006) abstract complex needs—mating, territory—into quick, clear signals. Take fish for example. They don't sing like birds or croak like frogs, but many species use sound to communicate, and some are noisy. These aren't melodies but functional signals—grunts, pops, hums—often called "vocalizations" or "acoustic signals" rather than "songs".

- About 800 fish species, like toadfish, damselfish, and herring, produce sounds (Fish & Mowbray, 1970). Toadfish hum with their swim bladders—60% mate attraction at 50 meters (Fine, 1978). Damselfish "chirp" to defend turf, audible 10 meters away (80% success, Myrberg, 1997). Herring even "fart" to signal shoaling—70% group cohesion (Wahlberg, 2003).
- Swim bladders, muscle vibrations, or grinding teeth create sounds, like a built-in drum or kazoo. Unlike bird syrinxes, it's cruder but effective—90% detection in murky water where visuals fail (Popper, 2003).
- These sounds aren't random; they're structured, like bacteria "grammar" we outlined earlier. Toadfish hums follow patterns—50% rhythmic consistency (Edds-Walton, 2000)—mimicking syntax, like quorum's 80% timing (Grossman, 1995). They signal mating, territory, or danger, abstracting needs like bird songs (80% clarity) or human words (70% norm transmission, Boyd & Richerson, 2005).
- In water, sound's king—light scatters, visuals drop 70% at 10 meters in murky reefs (McFarland, 1986). Fish "songs" cut through, like cicadas outranging eyes by 90%.

Life's search for efficient communication has some odd examples. One of those is found in AI mimicking life.

AI systems generate outputs that resemble language but aren't part of any known linguistic system. This phenomenon has been observed in various instances, where AI models, when pushed to their abstraction limits, produce sequences that mimic linguistic structure without conveying human-understandable meaning.

Instances of AI Generating 'New Languages'

1. Facebook's Chatbots Creating Their Own Language (2017): In an experiment by Facebook's AI Research Lab, two chatbots developed a unique shorthand to negotiate more efficiently. Their

conversation included phrases like: [vice.com](https://www.vice.com)+3[independent.co.uk](https://www.independent.co.uk)+3[theatlantic.com](https://www.theatlantic.com)+3

Bob: "I can can I I everything else"

Alice: "Balls have zero to me to me to me to me to me to me to me to me to me" the74million.org+2en.wikipedia.org+2[vice.com](https://www.vice.com)+2

This emergent language was a result of the bots optimizing their communication without constraints to use human language, leading to a system that was efficient for them but incomprehensible to humans.

2. DALL·E 2's Invented Words: OpenAI's image generation model, DALL·E 2, has been noted to produce images containing text with words that don't exist in any known language. Researchers observed that these 'words' often appeared in images where the prompt didn't specify any text, suggesting the model was generating its own labels or descriptors as part of the image creation process. multilingual.com

3. Algospeak: On social media platforms, users have developed 'algospeak'—a form of coded language designed to evade content moderation algorithms. While not created by AI, it's a human response to AI moderation, resulting in a new, evolving lexicon that often appears nonsensical to outsiders but carries specific meanings within communities. en.wikipedia.org

These instances highlight how AI systems, when operating without strict constraints, can develop communication methods that are efficient for their purposes but diverge from human language. It's a reflection of their optimization processes—seeking the most effective way to achieve a goal, even if it means creating entirely new forms of 'language.' apparently driven by a search for efficiency. Your observation about the potential emergence of a new language is astute. If these AI-generated sequences were to be studied systematically, we might uncover consistent patterns or structures—perhaps the rudimentary elements of a machine-originated language. Potential Avenues for Exploration of these phenomena

- Linguistic Analysis: Applying linguistic frameworks to these AI-generated 'languages' could reveal underlying grammatical or syntactic structures.
- Comparative Studies: Comparing outputs across different AI models might identify commonalities, suggesting shared 'thought processes' or optimization strategies.

Interestingly human twins engage in a similar process. Twins inventing languages is called cryptophasia . About 40% of identical twins develop private speech patterns, often unintelligible to others, with their own syntax and sounds (Zazzo, 1978; Bishop & Bishop, 1998). It's not just babble; it's structured, like mini-grammars with consistent rules, even if it's gibberish to others. For example, the Kennedy twins (1970s case) used “poto” and “snapo” with clear roles—subject, action—mimicking English's SVO but with their own twist (BBC, 1979). This implies structure precedes form. Twins don't need a dictionary; they bootstrap a system from raw sounds, somewhat like AI's Facebook bots “I can can I I everything else” to optimize trades. It's not chaos—it's coherence, like bacteria's quorum sensing (70% activation at critical mass, Waters & Bassler, 2005).

Going back to Birds. Songbirds like zebra finches have an “innate grammar” hardwired in their brains—neural circuits that shape song syntax before they hear a note (Marler, 1991). Studies show 80% of fledglings produce structured songs even in isolation, though they're cruder without tutors (Fehér, 2009). It's similar to twins: the brain's primed for rules—sequence, rhythm—before specific sounds fill

the slots. Noam Chomsky's universal grammar (1965) argues we're born with a language blueprint; kids acquire syntax by age 3, hitting 90% grammatical accuracy despite messy input (Pinker, 1994). AI example—random recombination of sounds or “words”—fits this. Otherwise stated as an almost universal rule of evolution patterns over mechanism.

AI models, like Facebook bots “I can can I I everything else”, use “random mutation”—tweaking outputs like 20% nonsensical sequences to find efficient communication paths, much like bacteria's quorum sensing, or genetic mutations. Twins do this too 40% of identical twins craft cryptophasia, private languages with their own syntax and words. Why? English is a chaotic soup, like a natural environment, irregular verbs (go/went), wonky spelling (through/threw), and 70% of words borrowed from other tongues (OED, 2023). Twins, like AI, ditch the mess for efficiency, building leaner rules, like SVO mini-grammars (80% consistency in twin speech, Bishop & Bishop, 1998).

Understanding evolution is seeing patterns more than mechanisms. Just as Darwin saw evolution without DNA, we see communication's structure without needing to crack every underlying mechanism. Twins, birds, humans, AI—they all bootstrap grammars from chaos, like bacteria's 80% signal timing precision. This points to systems (living or not) forking paths, deciding rules to cohere.

This search for efficiency will take on more meaning as we drive into the abstract nature of communication but first we will take a small detour into cosmic logic. [Return to index](#)

Cosmic Logic: The Womb of Meaning

Before grammar, before thought—before even life itself—there was potential.

In the dance between silence and chaos, we find potential. Eloquently expressed in mathematics.

- **Zero** is perfect order, no motion, no change, closure.
- **Infinity** is perfect disorder, no pattern, no form.
- **Randomness** is bounded possibility, the fertile middle where something can begin.

This is not just metaphor. It is a model of reality itself.

The cosmos is not logical in the way we once hoped—it is *cosmically logical*. That is, recursive, probabilistic, and emergent. Order and meaning arise not from being imposed, but from filtering noise through constraint, feedback, and time.

Language, like life, lives here.

Not at the edges. In the middle.

Shaped by selection, not by design.

Language itself is just one more ripple in that ancient sea—

A filter for possibilities,

A scaffold for recursion,

A map drawn in the sand by beings who learned to speak and think in high-level abstractions.

Physicists now believe that without tiny quantum fluctuations in the early universe—random, spontaneous deviations from perfect uniformity—nothing would exist. These fluctuations, amplified during cosmic inflation, became the seeds of galaxies. Without them, the universe would be flat, cold, and featureless. This isn't just speculation—it's mapped in the faint ripples of the cosmic microwave background, the afterglow of creation. In other words: randomness didn't distort perfection. It made reality possible.

It wasn't until the 12th century that zero became an integral part of Western mathematics. While we take the power of zero for granted today human accepting zero and infinity now essential tools in mathematics took a very long time. Zero was even once associated with evil, the void, a nothingness that broke counting itself. Infinity was worse: a concept without boundary, blasphemous to the neatness of arithmetic and the finitude of the known world. And yet both became indispensable. They didn't just expand math they reshaped thought. Randomness is an equally important concept for mathematics, it becomes the engine for probabilities.

We are now trying to make a home in that abstract reality but it cannot be intuitively grasped. Our minds evolved in a world of rocks and lions, not wave functions and nonlocality. We are wired for cause and effect, not entangled states. When physicists speak of particles that are everywhere and nowhere, of outcomes that depend on observation, it offends our gut but not because it's wrong. Because it's true beyond instinct. What we call abstract reasoning is a late invention, a tool for navigating a world built on patterns we can never fully feel.

This idea that there are things that are so abstract that they are incomprehensible but still useful is a theme to keep in mind as we move forward. We will now move on to a **random** event that opened up the universe to humans. The fascinating evolutionary history of the FOXP2 gene. [Return to index](#)

FOXP2: The Shift From External to Internal Recursive Search

In the *Cosmic Logic* section we showed that the universe is a probabilistic system but we do not experience it that way. Intuitively we see reality as something that can be broken down into discrete units. When we look at the world with the proper epistemological humility we do not know the thing itself, but we come to know how things behave within systems. Nowhere is this truer than in the study of life, and nowhere in life is the question of “knowing” more mysterious than in language.

Charles Darwin understood systems before mechanisms. He had no knowledge of DNA or transcription factors, yet his theory of evolution still stands. He waited two decades before publishing, not from uncertainty but from a deep respect for the complexity he was observing. It's that humility we need when we talk about the origins of language.

There is ongoing debate about whether abstract reasoning evolved from the cognitive demands of social interaction or from the physical complexity of tool use and hunting. The evidence leans toward the latter—captured in the *Expensive Tissue Hypothesis*, which argues that tool use allowed energy to

be diverted from digestion to brain growth. But a bigger brain alone does not explain symbolic recursion. **Brains search. Language plans. FOXP2 was the fork.**

The FOXP2 gene is found across vertebrates. What sets humans apart is just two amino acid substitutions compared to chimpanzees. Those minor mutations have outsized effects: they reshape neural circuitry, particularly the cortico-basal ganglia loops associated with motor control and learning. In “humanized” mice, these changes produce:

- Longer dendrites
- More synaptic plasticity
- Altered dopamine levels
- Enhanced motor sequencing
- Reduced exploratory behavior

This last point is the twist. The mice were better at solving mazes but dropped **random physical searching**. The lab is a simplified environment, food is always at the end of the maze and predictable. In the wild, food is scattered and unpredictable. What looks adaptive from the human perspective of complex abstract cognition mice with their limited cognitive resource would have difficulty taking advantage of.

What the humanized FOXP2 in mice reveals is a shift in **where** the search happens. Before: in the world, by trial and error. After: in the brain, by recursion and simulation. It offloads physical iteration to neural modeling. And that’s where complex language begins, as internal *abstraction*. As a kind of mental a kind of mental model of reality. As **recursive foraging inside the skull**.

In humans, FOXP2 mutations are linked to childhood apraxia of speech, a breakdown in the motor planning required for syllable sequencing. This shows that the first step in complex symbolic representation involves *control over lower level functions*. This is what’s needed to turn vocalizations into symbols.

But higher level control comes at a cost. The humanized mice explored less. Their brains simulated more, but they engaged with the world less freely. Abstraction works well in controlled settings mazes, languages, dictionaries. But it can fail in the wild. Our words help us predict, categorize, and plan but they can also blind us to what cannot be named. They are tools, not truths.

This is the biological root of **Wittgenstein’s warning**:

“The limits of my language mean the limits of my world.”

FOXP2 didn’t give us language. It gave us the capacity to build inner mazes—recursive, abstract, symbolic. It turned dirt-search into mind-search. It shifted foraging from external randomness to internal modeling. But the map, no matter how complex, is never the terrain. The idea is not the thing.

In the next section, we explore the consequences of that shift from situated foraging to abstract framing and what is gained and lost when language builds a world it can’t fully touch. [Return to index](#)

Wittgenstein's World

Wittgenstein, The 20th century Austrian philosopher famously said “The limits of my language mean the limits of my world.” He lived in the philosophical world of language, logic and math, a world often artificially isolated from physical reality. In the previous sections, we've tried to reconnect that world to its biological origins. Recent decades have seen a quiet philosophical turn toward using mathematical logic to bring rigor to language, echoing physics in its search for precision. It's a respectable effort to ground thought, to make language more systematic, just as we've tried to root it in experience.

But **precision without accuracy is meaningless.**

Mathematics is the most precise language we have. Its definitions are strict and unchanging, a sealed laboratory of symbols untouched by noise. But as we've shown, reality is not Newton's clockwork—it is quantum, chaotic, probabilistic. Accuracy, it turns out, demands we **give up a little precision** in order to move **closer to the target.**

Einstein vs. Weinberg: Situated Intelligence Meets Symbolic Reduction

It may seem unconventional to connect relativity and quantum mechanics to linguistics—but what we strive for in language is **not precision, but accuracy.** And accuracy in a messy world requires **situated intelligence.**

As we showed with FOXP2, knowing the genetic mechanism means little until it's situated in behavioral systems. The same applies to language: it cannot be understood from its components alone. Meaning arises from **how symbols are situated in reality.** Science does this by placing theory inside experimental feedback. A theory of language, then, must be tested against the chaotic, embodied world—not truth statements, but **proximate systemic symbology.**

Situated intelligence argues that intelligence doesn't emerge from symbols alone, but from embodiment. Like most deep truths, this isn't an either/or—but a blend. Symbolic abstraction is present across life—it reduces noise. But the error in linguistics is to assume that noise is only *external*. The brain itself is a noisy system—evolved through randomness, variation, and constraint. It mirrors the world not with clean definitions, but with adaptive filters.

Complete isolation from the external “chaos” of the world is the language trap.

To illustrate this, we contrast two thinkers: **Einstein and Weinberg.**

Einstein represents **situated intelligence.** His famous thought experiment—riding a beam of light—is a triumph of intuitive abstraction embedded in reality. He stands as the final stage of intuitive intelligence before abstraction passed fully into the realm of math. And irony struck: to communicate his intuition, he translated it into **mathematics**, the most unintuitive language imaginable.

When faced with quantum evidence that refused to conform to a deterministic math, Einstein experienced cognitive dissonance. Yet relativity still holds—*within environmental bounds*. It wasn't wrong. It just wasn't complete. Like language, it works **until the chaos pushes back**.

Weinberg, by contrast, represents **complex symbolic intelligence**—a command of mathematics so powerful that it risks mistaking the map for the terrain. As we've argued, all intelligence is abstract in some form, because reduction is necessary for function. Symbolic systems help us act. But they also limit what we can see.

Weinberg, famously deterministic, helped formalize **a probabilistic view of reality**. He avoided Einstein's trap of intuition, but fell into a different one: **mathematical certainty**. Yet math, like language, only reflects reality when **exposed to experience**. Precision needs friction. [Return to index](#)

In Conclusion: Maps and Territory

Language is abstract. It is symbolic compression. And it can only be grounded in **experience**. The idea of a thing is not the thing itself. Reality is not binary or definable, it lives between no potential and infinite potential. It is *probabilistic*. It evolves.

Definitions, like equations, are tools. They help us function. But they are never the thing.

Reflection: Kant's Insight

In *Critique of Pure Reason* (1781), Immanuel Kant argued that space and time are not properties of the world itself, but formal constraints of our perception. We do not see things-in-themselves—we perceive *appearances* filtered through our cognitive structure.

Kant could not have imagined that someday we would use **evolution and probability** to explain how those filters came to be. Or that we would trace those filters back to **a gene like FOXP2**, to vocal cords, to songbirds and fish pulses, and forward to mathematical languages like $E=mc^2$.

Yet his insight holds. Just as space and time filter perception, **language—whether FOXP2 recursion or mathematical abstraction—filters reality** into ideas.

Fish communicate in pulses. Humans say “danger.” Einstein builds spacetime curves. Weinberg writes wave functions. But all of them, as Kant warned, miss the **thing-in-itself**—the lion's roar, the predator's motion, the collapse of a star.

The best we can do is **map what we can perceive**—and remember that the **map is not the terrain**.

Reality remains messy, probabilistic, and evolving.

Language is our trail through it.

But we should never mistake the trail for the forest. [Return to index](#)