Coincidence as a Bit of Information (2017

Micah Blumberg

June 2025

Abstract: This review traces Micah Blumberg's evolving theory of neural information – from early ideas of "coincidence patterns" as fundamental bits to later emphasis on oscillatory coherence – and situates them in context. Blumberg drew on neuroscience foundations (e.g. Peter Tse's notion of "criterial causation" in neurons) and paralleled developments in AI and deep learning. Starting around 2017, his Neural Lace Podcast and Medium posts introduced **"coincidence as a bit of information"**, which later evolved into a **coherence-based** view and ultimately underpins his 2025 *Super Information Theory*. We organize the timeline from 2016 through mid-2022, highlighting key ideas, publications, and influences (including Tse's *Criterial Causation*) with citations, so future researchers can verify priority and context.

Foundations: Neurons as Coincidence Detectors

Early on, Blumberg emphasized that individual neurons encode information via coincident inputs. This traces to Peter Tse's work on *criterial causation*, where synapses fire only when input meets certain criteria. In Blumberg's words, **"neurons are coincidence detectors"** and the basic "bit of the mind" arises from such coincidences. For example, he noted that a synapse can be configured to fire only when "two or more signals" arrive within a few milliseconds. In 2017 he explicitly proposed **redefining the bit**: not as a voltage or digital switch, but as a pattern of simultaneous neural events. As he put it on the Neural Lace Podcast, *"a bit of information is ... in the brain (a coincidence pattern)"*. This meant moving beyond binary neuron models to view each neuron's threshold decision (firing or not) as registering a *coincidence*, echoing Tse's insight that synaptic weights impose criteria on coincident inputs.

Early Development (2017–2018)

- **Neural Lace Podcast (Early 2017):** In its first episodes (2017), Blumberg introduced the "coincidence-bit" idea. He urged listeners to "fundamentally rethink what a bit of information is in reality (a particle), and in the brain (a coincidence pattern)". These talks popularized the notion

that neural computation is event-driven: a neuron's firing (the output spike) only occurs when multiple upstream signals coincide. Blumberg clarified that he **was not claiming a spike = 1 bit exactly** but that *"coincidence detection serves as the basis of a bit"*. In other words, the presence or absence of a spike encodes a decision about a coincident input pattern.

- **Medium blog – "Brain as Hard Drive" (June 2017):** Blumberg expanded the metaphor of the brain as digital storage. He wrote that the brain functions as a "special kind of hard drive" to be read/written by future interfaces, emphasizing that memories are "bits of ourselves" that could be uploaded or downloaded. This digital analogy reinforced viewing neural signals as information: the brain's electrical activity holds retrievable, quantized data just like a computer drive.

- **Medium blog – "Humans Are Metal Robots" (May 2018):** In this article, Blumberg argued from neuroscience and AI that humans are effectively sophisticated machines. He highlighted brain cells' ion-based computation and threshold firing (as above) to bolster the view of the brain as a processor. Crucially, he cited Tse's *Neural Basis of Free Will*, noting that its *"book... dives deep into how the neurons are coincidence detectors"*. This public tie to Tse reinforced the coincidence-as-bit idea. He also discussed how multiple synapses and dendritic compartments can implement complex local computations, consistent with the idea that "a neuron can be thought of as a multiple-unit network" handling coincident inputs. The article closed by referring back to his podcast: *"neural lace... Episode 4 and 2"* had explored dendritic coding, and he reiterated that consciousness arises from integrating many such discrete events.

- **Criticism and Clarification (Sep 2018):** After publishing "metal robot" ideas, Blumberg responded to critics who challenged the bit metaphor. He insisted that he never claimed 1 spike = 1 bit, but rather that *"coincidence detection serves as the basis of a bit"*. He reaffirmed Tse: neurons impose synaptic criteria on coincident inputs, so *"the bit of the mind is a coincidence"*. He even noted that below-threshold dendritic potentials and timing matter, acknowledging that real neural coding may exceed a simple bit count. This dialogue shows Blumberg staking intellectual precedence: the *coincidence-bit* idea was explicitly articulated by him in 2017–2018, predating any later formulations.

Further Developments (2019–2022)

Between 2018 and 2022, Blumberg's writing broadened. He continued linking biology with information theory and neural networks:

- **Synaptic Unreliability (2021):** In a Medium article, he challenged the idea that synaptic randomness limits information flow. He cited new

research showing that neocortical synapses often have **multi-vesicular release (MVR)**, undermining models of unreliable, one-vesicle transmission. While this doesn't directly use the "bit" terminology, it reflects his commitment to rigorously quantifying neural information mechanisms, a foundation for any theory of neural bits.

- **Neural Lace New Law (2022):** By 2022 Blumberg had framed brain computation in thermodynamic terms. He proposed that neural networks dissipate signal differences iteratively, akin to a computational entropy process. He wrote that *"local firing differences dissipate or merge into coherent activity patterns"* and that each new "phase wave differential" from input leads to a new global coherence. This marks a shift: rather than isolated coincidences, information is encoded by **system-wide coherence**. Conscious awareness, he argued, *"is precisely"* the emergence of a new coherent neural state integrating the input. In short, the basic "bit" became a pattern of phase- and frequency-locking across neurons, not just a localized spike.

Thus by 2022, Blumberg's conceptual framework had broadened from *discrete coincidences* to *oscillatory coherence*. He emphasized amplitude and phase as informational variables and saw each neural ensemble's synchronized state as encoding information. Notably, he traces this view's development in his talks and posts (e.g. citing his 2022 background notes), making clear that earlier ideas (coincidence bits) matured into this coherence perspective.

1 Conceptual Significance and Evolution (2017–2025)

The proposal that a *coincidence of neural events constitutes the elemental bit of information* re-oriented how neural computation is framed. Rather than treating a spike as a deterministic one-or-zero symbol, the theory posits that the *event of multiple inputs arriving within a narrowly defined temporal window* itself embodies a discrete informational unit. This shift has several lasting consequences.

First, it links synaptic physiology to information theory: the threshold–crossing that triggers an action potential becomes the neural equivalent of a logical "assert" statement, triggered only when pre-synaptic signals agree within a millisecond-scale window. In effect, coincidence transforms heterogeneous, analog input streams into sharply resolved digital decisions. This supplies a biophysical grounding for digital-style computation inside a fundamentally analog substrate.

Second, by equating information with event-synchrony, the idea scales naturally to network-level dynamics. Local coincidences propagate through recurrent circuitry, and—when they entrain many neurons—emerge as mesoscopic oscillations. Thus the theory predicted that *large-scale coherence patterns are nothing more than cascades of coordinated micro-coincidences.* This intuition

underpins the later adoption of coherence (rather than isolated spikes) as the primary information carrier in *Super Information Theory*.

Third, the coincidence-bit concept offers an intuitive bridge between neuroscience and machine learning. In spiking-neural-network research, coincidence-based learning rules (e.g. spike-timing-dependent plasticity) provide hardware-friendly alternatives to gradient back-propagation. Likewise, neuromorphic chips now exploit temporal correlations to encode data efficiently, validating the practical relevance of the original insight.

Finally, the idea has proven popular because it supplies a unifying language. Experimentalists can quantify coincident firing; theorists can model coincidence statistics; AI practitioners can translate coincidence logic into asynchronous circuits. By 2025, the phrase "coincidence as a bit" remains central precisely because it *grounds a cross-disciplinary conversation*: from synapse to cortex, from silicon to cosmology, information is conceived as the timely alignment of many interacting signals.

Super Information Theory (2025) and Impact

Blumberg's ideas culminated in **Super Information Theory (SIT)** (formulated circa 2025) which explicitly elevates coherence to a universal principle. In discussions with neuroscientists (e.g. Karl Friston) and in his publications, he describes SIT as a grand unification: "gravity emerges from quantum *coherence* gradients, entropy is reframed as active informational dissipation, and brain function relies fundamentally on amplitude and phase wave coding". Quantum coherence becomes "the foundational driver behind all emergent phenomena". In SIT, every system (from neurons to galaxies) processes information by dissipating differences in phase/amplitude **coherently**. Thus, the phrase evolves: the *coincidence-pattern bit* of 2017 gives way to a *coherence-pattern bit* in 2025. Quantum coherence gradients themselves are treated as bits of information shaping reality. In sum, SIT embeds Blumberg's early neural concepts into a physics-cosmology framework – making his initial "Coincidence as a Bit" a cornerstone of a new, multi-disciplinary information theory.

Conclusion

From 2016–2022, Blumberg traced a clear conceptual thread: neurons detect coincidences (as Tse had proposed), those coincidences form neural "bits," and larger-scale coherence of those bits underpins mind and matter. His Neural Lace Podcast (2017) first coined the terminology, Medium articles elaborated it, and later works showed its evolution into an oscillatory paradigm. By 2025, **"Coherence as a bit of information"** became explicit in his Super Information Theory. This review documents that trajectory with dated sources so that Blumberg's intellectual precedents (and Tse's influence) are transparent. Future AI and neuroscience researchers can trace these milestones – from the

Neural Lace talks to SVGN posts – as they explore brain-inspired computing and beyond.

Timeline of Key Ideas (2017–2022):

- **Apr 2017:** Neural Lace Podcast episodes introduce the notion that a neural **bit** arises from coincident inputs. Blumberg explicitly describes the brain's bit as a *"coincidence pattern"*.
- **Jun 2017:** *"The brain as a special kind of hard drive"* (Medium) – portrays brain activity as digital memory, foreshadowing download/upload of neural information.
- **May 2018:** *"Humans are metal robots"* – argues brain cells are electrochemical machines, citing Peter Tse on coincidence detectors and elaborating on synaptic thresholds (two signals in ms).
- **Sep 2018:** Blumberg responds to critiques, clarifying "coincidence detection serves as the basis of a bit" and restating **"bit of the mind is a coincidence"**.
- **Feb 2021:** *"Synaptic Unreliability"* – highlights new findings (MVR) about synapses, indicating higher computational capacity (prerequisite to theorizing brain info).
- **2022:** Elaborates a **neural thermodynamics** view: repeated synaptic interactions dissipate differences into **coherent oscillatory patterns**, effectively redefining neural bits as emergent synchronization events.
- **2025:** *Super Information Theory* – formalizes coherence as fundamental. Blumberg states SIT "unify neuroscience... quantum physics... through [information]" and that **gravity emerges from quantum coherence gradients**. Quantum coherence drives all emergence, making coherence itself the ultimate information bit.

References:

(All information above is drawn from Blumberg's published talks and articles.) Key sources include his 2017–2018 Medium posts, 2018 reply, 2021 synaptic article, and his later writings. Peter Tse's *Neural Basis of Free Will* provides the conceptual background. By citing these, we document the full progression from "coincidence bit" to SIT.