Root Knowledge: Embodied Knowledge as a Foundation for Coherent Human–AI Interaction

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Abstract

From the beginning of communication and scientific expression, humans have built systems of information to organize lived experience, reduce uncertainty, and transmit knowledge across time. Neuroscience now increasingly explains the body, brain, and self through interoception, prediction, embodiment, neurophenomenology, and spatiotemporal accounts of psychopathology, yet it remains unclear how these layers interact to produce a coherent self-narrative. In parallel, artificial intelligence has advanced from computation to large-scale generative systems capable of organizing information and producing precise outputs, but it remains largely disconnected from how such outputs are integrated by the human system. This gap matters. Easy access to fast information, while one of the great achievements of modern society, is also exposing a crisis of fragmentation in mental health: divided attention, emotional overload, distorted perspective, and self-narrative disruption across individual and collective systems. Grounded in Root Frequency Theory, this paper proposes a coherence-centered model of human-AI interaction in which artificial intelligence is designed not only to generate faster or smarter output, but to scaffold information in ways that support meaning-making, self-narrative continuity, and integration across physical, biological, neural, and symbolic layers. The central question is: how can artificial intelligence support a deeper understanding and integration of the human intelligent system?

Keywords: coherence, human-AI interaction, Root Frequency Theory, embodied cognition, predictive processing, neurophenomenology, self-narrative, cognitive load, free energy, interoception

Introduction

Artificial intelligence has become increasingly capable of generating structured, convincing, and contextually relevant outputs. Yet these systems still rarely account for what happens after information is produced: how it is received, interpreted, embodied, and integrated by the human system. At the same time, our understanding of human consciousness remains fragmented across disciplines. Neuroscience maps brain activity. Psychology studies behavior. Phenomenology describes lived experience. But we still lack a framework that explains how these levels come together to produce a coherent sense of self over time.

This gap may be connected to fragmented consequences. More than one billion people are currently living with mental health conditions worldwide. The COVID-19 pandemic alone increased global prevalence of these conditions by approximately 25% (World Health Organization, 2022). In parallel, phenomena such as digital saturation and information overload may intensify the regulatory and attentional demands involved in emotion regulation, meaning-making, and the maintenance of self-continuity (Clark, 2016; Northoff, 2016; Barrett, 2017).

The Core Problem

Current AI systems are often optimized around output-level performance, including speed, accuracy, personalization, and engagement. However, they are not typically designed to support how information is interpreted, embodied, and integrated into lived experience (Bommasani et al., 2021; Gabriel, 2020; Weidinger et al., 2021).

At the same time, consciousness research provides increasingly detailed accounts of prediction, interoception, and large-scale brain dynamics (Friston, 2010; Seth, 2013; Sporns, 2011). However, how these processes become integrated into lived meaning and self-continuity across time remains underexplored (Varela, 1996; Gallagher, 2000; Northoff, 2016).

As a result, two parallel systems continue to evolve without alignment:

• increasingly powerful artificial intelligence systems

• incomplete models of how humans construct meaning, regulate emotion, and maintain self-continuity

What This Work Proposes

This work starts from this gap. It proposes that the next step in human–AI interaction is not greater computational power alone, but the development of systems that support coherence — the alignment of processes across body, brain, narrative, and environment.

Grounded in Root Frequency Theory (Avanzo, 2026), a multilayered framework of spatiotemporal continuity, this paper proposes that coherence emerges through the alignment of interacting layers of the human system, from physical and biological regulation, to neural dynamics, self-narrative, and meaning-making processes shaped through ongoing interaction with the environment.

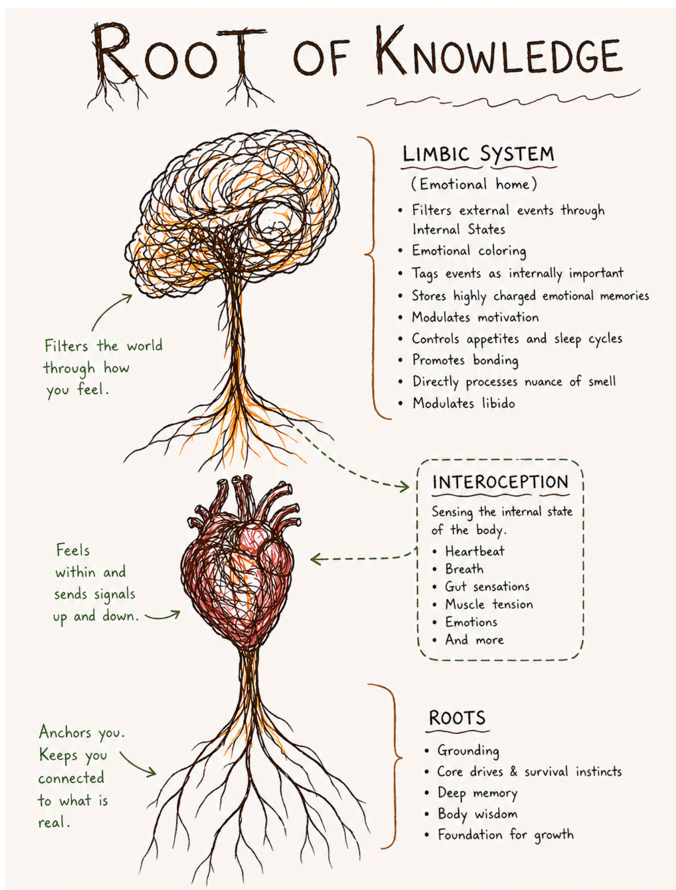
From this perspective, artificial intelligence is not only a generator of answers. It can function as a scaffold for integration — helping organize, filter, and sequence information in ways that support meaning-making over time.

Intelligence as Prediction Under Uncertainty

Across history, intelligence has often been expressed through the human capacity to detect regularities in uncertain environments and transform them into stable models. Long before modern science, humans watched the sky, the seasons, the land, and the movement of bodies to find patterns that could help them live with uncertainty.

Figure 1

The Root of Knowledge: A Limbic-Interoceptive-Foundational Framework



Note. This figure illustrates a proposed layered view of embodied knowing, moving from bodily grounding and interoceptive signaling to emotional filtering and meaning-making. Within Root

Frequency Theory, coherence is understood as a process that may depend on the alignment of multiple interacting layers rather than on cognition alone. When bodily signals, affective processing, and symbolic interpretation are more integrated, the sense of self may become more stable and continuous; when these layers become misaligned, fragmentation may increase. Adapted from original artwork by Avanzo (2026).

Before modern computation, intelligence was already functioning as prediction through structure. Humans observed recurring patterns in the world and translated them into symbolic systems: numbers, geometry, calendars, maps, music, written language. Mathematics became one of the clearest expressions of this impulse, allowing hidden regularities in nature to be abstracted, stabilized, and transmitted across time (Dehaene, 1997; Tegmark, 2014).

Turing formalized the idea that symbolic operations could be generalized into rule-based systems capable of solving multiple classes of problems (Turing, 1936). Later, it was observed that reasoning could also work under uncertainty, using probabilities instead of deterministic rules alone (Pearl, 1988).

Friston proposed a unifying principle: that perception, action, learning, and biological self-organization may all be understood as expressions of continuous prediction error minimization across hierarchical levels of the nervous system — what he formalized as the Free Energy Principle (Friston, 2010).

A possible continuity emerges across these developments: artificial and biological intelligence may both involve modeling hidden causes, updating expectations, and acting under incomplete information.

Yet a central gap remains: how information becomes meaningful, integrated across time, or experienced as a coherent lived reality is not fully explained.

The Body as Part of Cognition

Traditional cognitive models treated the mind as separable from the body. Embodied and enactive approaches challenged this by arguing that cognition emerges through dynamic interaction among brain, body, and environment (Varela, Thompson, & Rosch, 1991; Clark, 1997).

Neurophenomenology takes this further: first-person experience and third-person measurement should be studied together, not in isolation (Varela, 1996). This matters especially for interoception — where signals like heartbeat, respiration, and arousal actively shape emotion, decision-making, and self-awareness (Seth, 2013; Critchley & Harrison, 2013).

Building on this, the present work proposes that information may be processed differently depending on whether the system is regulated, threatened, exhausted, or coherent.

The Self as Spatiotemporal Integration

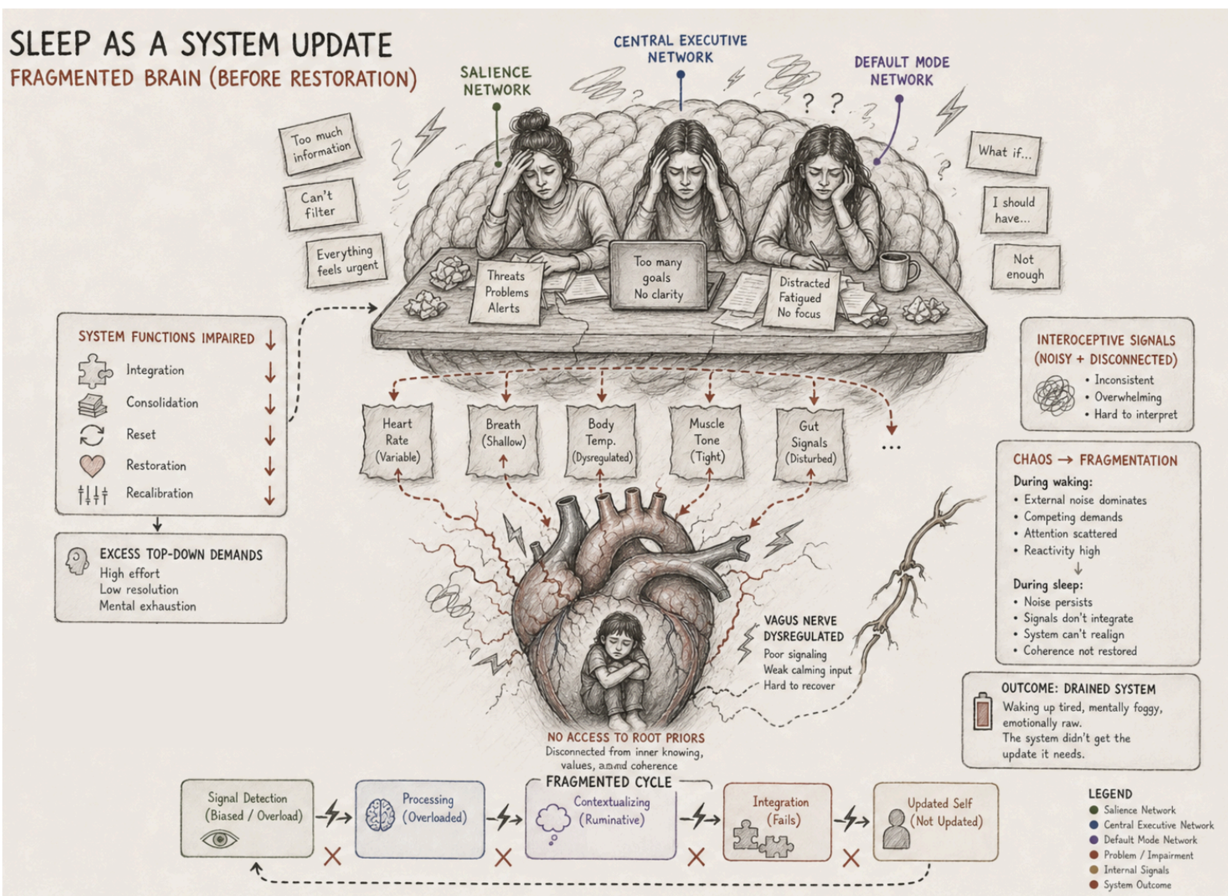
Contemporary theories increasingly reject the self as a fixed internal object. Damasio (1999) proposed that selfhood emerges from layered mappings of bodily states, while Gallagher (2000) distinguished between the minimal self of immediate experience and the narrative self extended through autobiographical time.

Embodied and enactive approaches further suggest that selfhood emerges through ongoing organism–environment interaction rather than isolated internal representation (Varela, Thompson, & Rosch, 1991; Thompson, 2007).

Predictive and spatiotemporal accounts extend this view by framing the self as a temporally organized process shaped by prediction, bodily regulation, and intrinsic brain dynamics (Friston, 2010; Clark, 2016; Northoff, 2016). From this view, disturbances of self may arise not only from faulty thoughts, but from altered timing, integration, and brain-world alignment.

Figure 2

Sleep as a System Update: The Fragmented Brain Before Restoration



Note. This figure presents sleep as a proposed integration process that may support biological regulation, neural consolidation, and narrative continuity across layers. The diagram illustrates a fragmented state in which salience processing becomes threat-biased, executive control is strained, default mode activity becomes ruminative, and interoceptive signals are harder to interpret. Within this framework, fragmentation is understood not only as a symptom, but as a possible pattern of misalignment across interacting bodily, neural, and cognitive systems. Adapted from original artwork by Avanzo (2026).

Taken together, these models suggest that selfhood is sustained through continuity: bodily anchoring, temporal integration, memory organization, and coherent narrative updating. The felt sense of “me” may therefore depend less on static identity and more on successful cross-level coordination.

Fragmentation as Cross-Layer Misalignment

Modern conditions may amplify these dynamics. Information overload, digital saturation, social comparison, sleep disruption, and chronic uncertainty place sustained pressure on regulatory systems. Trauma and prolonged stress can further bias prediction toward threat, narrowing perception and reducing adaptive flexibility (McEwen, 1998; Lupien et al., 2009; van der Kolk, 2014; Friston, 2010; Barrett, 2017; Walker, 2017).

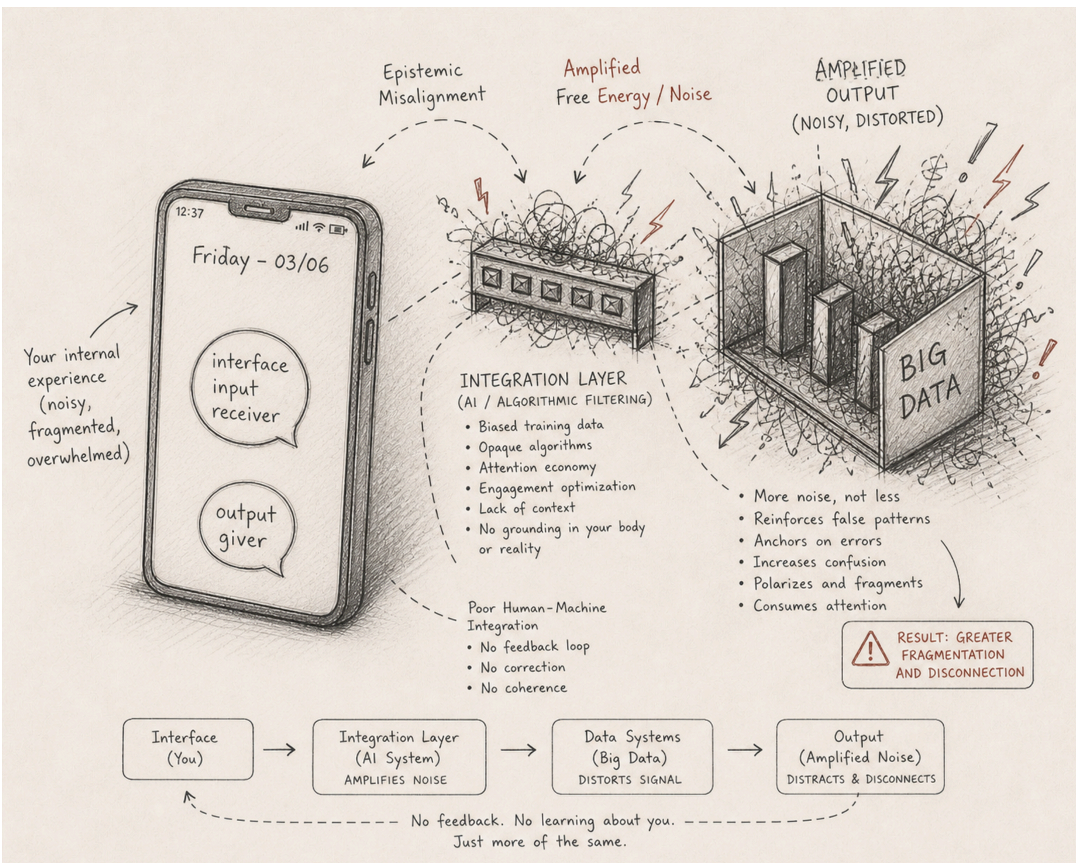
Research increasingly suggests that many mental health conditions involve disturbances in large-scale brain dynamics, interoceptive processing, temporal continuity, and self-modeling rather than isolated cognitive deficits (Northoff, 2016; Seth, 2013; Sporns, 2011). From this perspective, fragmentation may reflect dysregulation across multiple interacting layers of the human system.

Human-AI Interaction as Coherence Scaffolding

Current human-AI interaction is largely organized around efficiency metrics: faster answers, task completion, personalization, and output optimization. These advances are valuable, yet they primarily treat intelligence as production rather than integration (Bommasani et al., 2021; Weidinger et al., 2021; Gabriel, 2020).

Figure 3

Current Human-AI Interaction: Epistemic Misalignment and Amplified Fragmentation

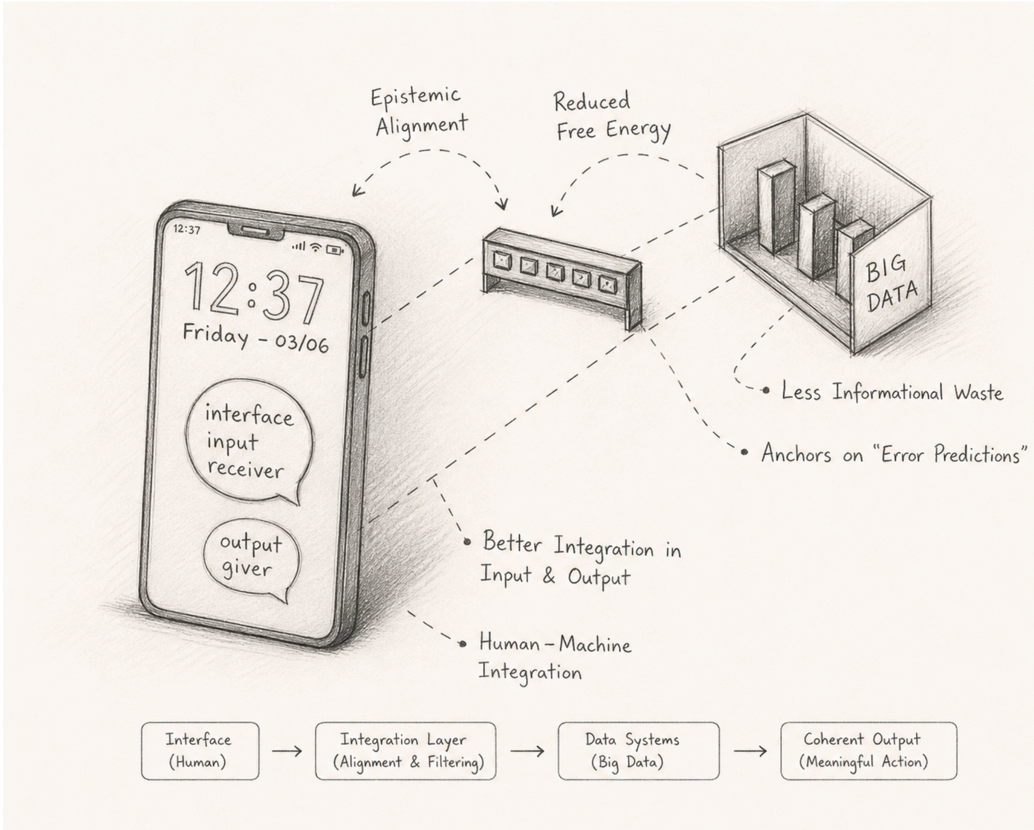


Note. When an already overloaded human system interacts with an AI architecture optimized primarily for engagement, the interaction may amplify fragmentation rather than support integration. Biased training data, opaque algorithmic processes, and limited access to embodied or contextual meaning can produce outputs that reinforce existing prediction errors, stabilize maladaptive patterns, or increase attentional load without resolution. In this configuration, the system lacks a meaningful feedback loop through which human state, context, and integration needs can inform the structure of the output. The diagram illustrates the structural problem addressed by Root Knowledge: not a failure of computational intelligence, but a failure of integration between machine-generated information and human meaning-making. Adapted from original artwork by Avanzo (2026).

The proposed model introduces an intermediate integration layer that could function as an informational scaffold between the human user and large-scale data systems. Rather than relying on continuous extraction of personal data or optimizing primarily for engagement, this layer would prioritize epistemic alignment: the fit between incoming information, contextual relevance, and the user's current goals, state, and meaning structures. In predictive processing terms, such a system may be understood as an attempt to reduce unnecessary uncertainty at the level of interaction by organizing information in ways that are more interpretable, relevant, and temporally sequenced for the human user (Friston, 2010; Clark, 2016).

Figure 4

Root Knowledge: A Coherence-Centered Human-AI Architecture



Note. This diagram illustrates the proposed Root Knowledge architecture, in which an intermediate integration layer is designed to organize context before information retrieval and output generation occur. Rather than optimizing primarily for engagement, the model prioritizes coherence by aligning incoming information with the user's embodied state, goals, narrative context, and meaning structures. In this sequence, Interface (Human) → Integration Layer (Alignment and Filtering) → Data Systems → Coherent Output (Meaningful Action), the integration layer functions as a contextual filter that may reduce irrelevant uncertainty and support more interpretable, relevant, and action-oriented output. Coherence is therefore framed not as a property of the final output alone, but as an emergent property of the interactional process that structures information before it reaches the human system. Adapted from original artwork by Avanzo (2026).

When the integration layer is designed for coherence rather than engagement, prediction error decreases — not only in machine outputs, but in the cognitive load placed on the human receiving them. Acting as an external scaffold, the system may help users recognize patterns, clarify goals, and transform fragmented inputs into coherent action — not by replacing intelligence, but by supporting the organization of intelligence already present within the human system (Friston, 2010; Clark, 2016; Vygotsky, 1978; Clark & Chalmers, 1998).

If empirically validated, the implications of this model extend across three domains.

Practically, a system that does not depend on unrestricted personal data may offer a more privacy-preserving architecture — reducing surveillance incentives while maintaining functionality.

Ethically, by prioritizing relevance over engagement, it may decrease informational waste, attentional capture, and compulsive feedback cycles that characterize current platforms.

Societally, coherence-oriented systems may support mental health by helping users organize thought patterns, regulate overload, and strengthen narrative continuity across time — consistent with evidence linking fragmentation and dysregulated self-processing to poorer wellbeing (Northoff, 2016; World Health Organization, 2022).

More broadly, this framework suggests a shift in how such systems are evaluated. Speed, scale, and output quantity are necessary but insufficient measures. A coherence-centered paradigm would ask a different question: does the system help people think more clearly, understand themselves more deeply, and act with greater integration across body, mind, and environment?

Methodological Orientation

This paper emerged through a neurophenomenological orientation integrating first-person lived experience with third-person scientific frameworks (Varela, 1996). Rather than treating subjective experience and objective measurement as separate domains, the present approach uses both as complementary sources of insight into coherence, fragmentation, and self-organization.

The framework was developed through interdisciplinary synthesis across cognitive science, neuroscience, phenomenology, systems theory, human–technology interaction, and spatiotemporal accounts of selfhood and brain–world dynamics, while tracing recurring patterns between embodied experience and formal models of mind.

By comparing structures across domains—such as prediction, regulation, temporal continuity, and narrative integration—this work organizes them into a layered account of human experience. In this sense, the method is neither purely theoretical nor purely autobiographical, but an integrative process aimed at translating lived dynamics into testable conceptual structure.

Cross-Layer Measurement Framework

Grounded in the conceptual architecture presented here, a companion paper introduces a preliminary mathematical metric designed to estimate coherence across layers of the human system — integrating physiological regulation, neural dynamics, narrative organization, and subjective continuity into a single measurable index (Avanzo, 2026b).

This is, to the author's knowledge, the first formal attempt to quantify cross-layer coherence as a continuous, trackable variable — moving beyond symptom-based models toward a measure of integration itself.

That manuscript is currently under embargo and available upon request for academic or research purposes. Empirical validation requires multimodal data collection combining physiological, neuroimaging, and narrative measures. The author welcomes collaboration with research groups positioned to support this work.

Limitations

This framework remains in its early conceptual stages. The theoretical architecture and design principles proposed here have not yet been empirically validated, and claims about effectiveness — in reducing prediction error, supporting coherence, or improving mental health outcomes — await systematic testing.

What is offered here is not a finished system, but a structured proposal: grounded in established research, internally consistent, and designed to generate testable predictions. Further empirical work, iterative development, and real-world implementation will be needed to determine how these ideas translate into practice.

Conclusion

The next frontier of human-AI interaction may not be faster output, but deeper integration. The call is not simply to build smarter machines, but to design tools that help humans become more coherent, more aware, and more capable of transforming information into meaning.

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