Commentary

Brain Initiative Roadmap: Building the Next Decade of NeuroAI

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The exchange between neuroscience and artificial intelligence has reshaped both fields over the past decade. Two perspectives now organize the conversation about what NeuroAI should build next. The "Convergence" perspective points to a methodological alignment: scaled models trained on naturalistic data can predict neural responses across sensory cortices (Yamins et al., 2014; Richards et al., 2019; Schrimpf et al., 2020) and drive or suppress responses in higher-level human language networks (Tuckute et al., 2024). The field is extending those successes into digital twins, brain foundation models, and connectome-grounded mechanistic networks (Aldarondo et al., 2024). The "Process" perspective asks what it would take for our models to capture what brains actually do as closed-loop controllers of bodies in environments, operating on time and energy budgets unmatched by silicon-based digital computing (Cisek, 2019; Brunton and Tuthill, 2025). The two views are not opposed but differ in priorities about what the field should build next (see Monaco, Brunton, and Mineault, this issue). Here, the National Institutes of Health's *Brain Research through Advancing Innovative Neurotechnologies* (BRAIN) Initiative sets out scientific goals for the next decade, building on its Research Roadmap (NIH BRAIN Initiative, 2025).

Received Sept. 9, 2026; accepted Sept. 9, 2026.

Author contributions: J.D.M, J.D.K., R.L.M., and G.M.H. wrote the paper.

We thank the members of the NIH BRAIN NeuroAI Working Group and the Federal NeuroAI Funders Working Group. The findings and conclusions presented in this paper are those of the authors and do not necessarily reflect the views of the NIH or the U.S. Department of Health and Human Services.

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https://doi.org/10.1523/JNEUROSCI.1542-26.2026

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What the BRAIN Initiative Means by NeuroAI

NeuroAI, in the Initiative's framing, is a bidirectional and biologically grounded scientific exchange between natural and artificial intelligence. Biological principles inform new architectures for adaptation, learning, and inference; computational platforms reveal new mechanisms of brain function. This framing emerged from discussions at the 2024 BRAIN NeuroAI Workshop (NIH BRAIN Initiative, 2024), reflected in the NIH BRAIN Director's roadmap overview (Ngai, 2026). Three research priorities were identified. Interpretability through biological grounding maps computational mechanisms onto identifiable neural features, circuits, dynamics, and cell types. Neuromorphic and brain-inspired computing develops energy-efficient hardware and learning algorithms that emulate the organizing principles of nervous systems (Bartolozzi et al., 2022; Indiveri, 2025). Embodied intelligence and brain–body systems bridges AI and the real-world capabilities of living organisms in their environments. The test, in each case, is whether the AI side is substantively advanced by engagement with biological principles, and neuroscience gains new mechanistic or theoretical impact in return.

Two Perspectives, from Data to Biology

The Convergence program has advanced computational (representational and algorithmic) understanding by coupling large-scale neural datasets to increasingly capable models in a self-reinforcing cycle: neural foundation models, large-scale benchmarking (for a critical re-evaluation, see Mineault, 2024a), digital twins (Aldarondo et al., 2024), and connectome-grounded mechanistic networks. It delivers interpretability at the algorithmic level (Marr's middle level), where computational functions can be mapped onto identifiable network operations. The Process program begins with the biology of what brains do as closed-loop controllers of bodies in environments (Cisek, 2019; Brunton and Tuthill, 2025): whole-organism biomechanical simulations (Vaxenburg et al., 2025), connectome-grounded simulations for identifying functional circuits (Pugliese et al., 2025), artificial embodied circuits with vertebrate visuomotor structure (Liu et al., 2025), and neuromorphic platforms benchmarked on embodied tasks (Bartolozzi et al., 2022; D'Angelo et al., 2026). In this emerging view, embodiment is constitutive, not incidental, and is shaped by ecological approaches, embodied cognition, and rising theoretical pressure against neuro-computationalism (Monaco and Hwang, 2024; Brette, 2026). The two views differ in both level of analysis and priorities for how the field should build a bridge from data and predictive models to real-world impact grounded in biology.

BRAIN's Enabling Role

BRAIN's data archives host over fourteen petabytes across tens of thousands of datasets, including peta-scale imaging, multi-omics, connectomics, neurophysiology, human recordings, and brain–behavior data (NIH BRAIN Initiative, 2026). Datasets at this scale remain a recognized gap (Ngai, 2026), requiring community-driven data standards and cross-modal, cross-species coordination; these neural and behavioral data resources are public goods made possible by federal investment. Two of the four Innovation Domains (IDs)

offered by the BRAIN Initiative's Research Roadmap are relevant here (NIH BRAIN Initiative, 2025). The Knowledgebase ID is envisioned as a unified data-to-knowledge engine, designed for AI-readable, interoperable, federated, queryable access across BRAIN's data platforms. The NeuroAI ID articulates the priorities described here. The two are coupled: the Knowledgebase furnishes the data that NeuroAI research consumes, and NeuroAI tools will in turn shape how that knowledge engine is built (Ngai, 2026). These ambitious ideas extend beyond the NIH. In 2025, the Initiative convened the *Federal NeuroAI Funders Working Group*, which focuses on the science (not funding efforts) to share scientific perspectives across federal agencies whose missions intersect NeuroAI: computing infrastructure, energy-efficient devices, autonomous systems, adaptive neurotechnologies, and clinical regulation.

Why This Matters Beyond Neuroscience

The stakes for NeuroAI extend beyond neuroscience. Adaptive brain–computer interfaces, closed-loop neuromodulation devices, and assistive and restorative technologies for sight, audition, and motor function require models that account for sensorimotor delays, biomechanical coupling, and the real-time adaptive dynamics of nervous systems in living bodies (Zador et al., 2023; Brunton and Tuthill, 2025; Hwang et al., 2026). Brain-informed AI carries safety, robustness, interpretability, and adaptability properties that pure-scaling approaches have not delivered (Mineault, 2024b). Potential applications extend to robotics for health care, prosthetics, clinical decision support, and national infrastructure including energy distribution and secure communications. Neuromorphic platforms enable devices that operate at biological timescales and energy budgets, addressing sustainability and performance (Bartolozzi et al., 2022; Hwang et al., 2026). Leadership in this work carries economic and security stakes, including manufacturing capacity for neurotechnology and a NeuroAI-fluent workforce (Zador et al., 2026).

The Path Forward for NeuroAI and BRAIN

The next decade of NeuroAI rests on choices of the scientific community and its stakeholders. For its part, the BRAIN Initiative's Research Roadmap reflects three key priorities that can potentially provide a foundation for the NeuroAI effort. The Knowledgebase ID will launch a federated data-to-knowledge engine, building on a decade of BRAIN investment in large-scale, cross-disciplinary tools and data for neuroscience. The NeuroAI ID proposes to support the bidirectional research exchange that catalyzes new opportunities for brain-inspired AI architectures, neuromorphic computing, and adaptive neurotechnologies for health. The *Federal NeuroAI Funders Working Group* will continue to share scientific perspectives with other agencies with complementary missions and capabilities. The scientific community will ultimately reconcile the Convergence and Process perspectives. The BRAIN Initiative is looking forward to the next decade of NeuroAI.

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