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General Comment

See attached file(s)

Attachments

Comment on the 2025 National AI R-JM1-TP1

Comment on the 2025 National AI R&D Strategic Plan: Prioritizing Neuroscience-Inspired AI and EEG-Guided Research

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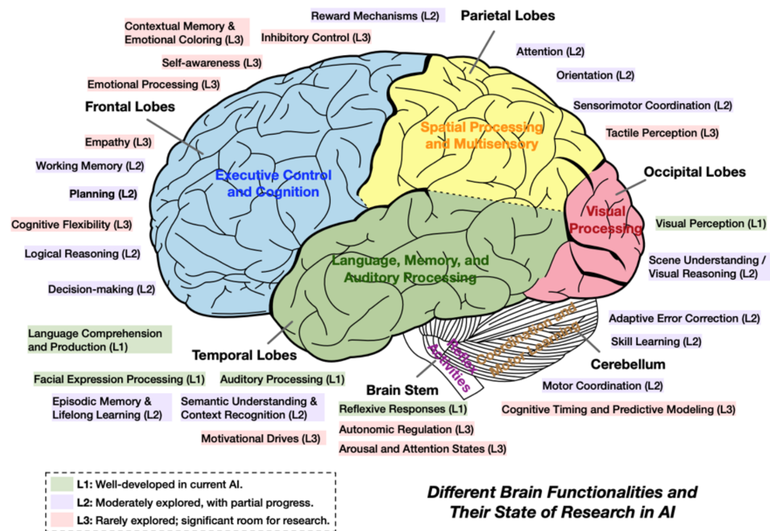
I. Introduction



Different Brain Functionalities and Their State of Research in AI

While the human brain is not perfect, it strikes a remarkable balance between computational performance and adaptability, resilience, and efficiency. The 2025 National AI R&D Strategic Plan offers a critical opportunity to expand the scope of federal research toward more cognitively and affectively capable AI systems. While the current trajectory emphasizes deep learning and pattern recognition, these models lack key human-like faculties, such as emotional awareness, adaptive context understanding, creativity, and introspective reasoning. These deficits limit AI performance in collaborative, safety-critical, and human-facing applications (see figure reprinted from [1]).

To increase U.S. dominance in AI and ensure technology serves societal needs, the federal government should fund foundational research at the intersection of neuroscience and AI—particularly affordable electroencephalography (EEG)-guided approaches. EEG provides highly scalable, real-time, and noninvasive access to brain activity, making it uniquely suited for large-scale exploration of cognition and emotion in AI research. Human innovation has often drawn from nature: we learned to fly by observing birds, and the structure and function of biological neurons inspire many successful artificial neural networks in AI. Neuroscience can guide the development of novel AI architectures and computational mechanisms that not only more closely align with human cognitive processes, but also endow them with unprecedented efficiency, robustness, and adaptability.

II. Research Priorities

1. Decoding Cognitive and Emotional States

EEG-based machine learning models have already demonstrated the ability to classify cognitive load, attention, and emotion. Expanding this research through large multimodal datasets and advanced signal decoding will enable AI systems that adapt to user state in real time—enhancing performance in learning, safety, collaborative settings [2,4] and will allow for sustained Brain-Machine interfacing over extended periods.

2. Neural Signatures of Consciousness and Affective States

Recent clinical studies have linked specific EEG features (e.g., alpha/delta power and phase synchrony) with conscious awareness. Research into these correlates can inform new AI benchmarks for introspection and awareness [3]. Similarly, emotion-linked EEG patterns can serve as the basis for emotionally intelligent AI, allowing machines to adequately infer and respond to human affective states. These responses could be clinically relevant and open the door for new AI-driven psychotherapies.

3. Brain-Inspired Computational Paradigms

Spiking neural networks (SNNs) and neuromorphic hardware offer biologically inspired solutions with high energy efficiency and temporal precision. These architectures are aligned with the structure of brain activity and hold promise for more explainable, low-power AI. Federal programs like DARPA's uBRAIN and ARNI provide initial models; expansion is warranted [5,6]. Effort is needed to explore non-traditional computational mechanisms, such as those achieved by glial networks, non-synaptic information transmission, and neuromodulation.

4. Multimodal Integration with AI

Integrating multimodal data streams (e.g., EEG, speech, and facial expression) and embedding neural signals into AI pipelines, including large language models, opens pathways to genuinely context-aware AI. Foundational work is needed to align neural dynamics with AI representations and hardware for real-world deployment. Such approaches could create new types of devices to achieve hybrid co-processing and augmented intelligence.

III. Strategic Implementation

We propose the following for incorporation into the 2025 Strategic Plan:

- Create a dedicated focus area on "Neuroscience-inspired Cognitive and Affective Computing" to elevate neuro-AI as a strategic national priority.
- Fund interdisciplinary research centers linking AI, cognitive neuroscience, signal processing, and systems engineering (e.g., via NSF AI Institutes).
- Support neuromorphic computing initiatives through targeted grant programs and federal lab partnerships, leveraging expertise from DOE, NIH, and DARPA.
- Establish open data standards and EEG repositories to encourage reproducibility, collaboration, and broader participation in neuro-AI research.

IV. Outcomes and National Impact

Within a 3–5-year horizon, federally backed neuro-AI research will yield:

- Neuroadaptive user interfaces for defense, healthcare, and education
- Emotion-aware AI agents and social robotics
- Brain-computer interfaces for assistive and extended reality applications
- Second-generation AI hardware leveraging brain-inspired computation

These advances will strengthen U.S. economic and national security while fostering human–AI systems that are safer, more effective, and aligned with human values.

Conclusion

Investing in EEG-guided AI and neuroscience-informed architectures and computations is essential for next-generation intelligent systems. These research areas represent high-risk, high-reward endeavors that require federal leadership because of long timelines and limited immediate commercial incentives. However, the long-term benefits of this investment will secure the United States ' leadership in AI and ensure that technology evolves with an understanding of the human mind at its core, providing a solid foundation for the future.

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