BCI Memory Retrieval and Encoding at the Cellular Level

Introduction

The cell fate of brain cells introduces complexity in the design of brain computer interfaces. However, control of cell fate might not be necessary to construct a minimal passive memory write system.

Simplified Approach for Minimal Memory Writing System

If the <x, y, z> coordinates (with respect to the brainstem) for all brain cells can be traced, brain cell states and synaptic firing can be modularly controlled, and other processes in the nervous system are controlled then perhaps a passive memory writing system within the brain [2, 3, 4] could be possible to develop. All cells in the nervous system can be represented as nodes in a graph [1] or a vector space.

Improvements

Foundational understanding of the brain and the mind are likely to allow for more robust approaches. An approach that makes use of more natural components and technical iteration could lead to architectural improvements.

References:

1. Hopfield J. J. (1982). Neural networks and physical systems with emergent collective computational abilities. Proceedings of the National Academy of Sciences of the United States of America, 79(8), 2554–2558. https://doi.org/10.1073/pnas.79.8.2554
2. Le Duigou C, Simonnet J, Teleñczuk MT, Fricker D, Miles R. Recurrent synapses and circuits in the CA3 region of the hippocampus: an associative network. *Front Cell Neurosci*. 2014;7:262. Published 2014 Jan 8. doi:10.3389/fncel.2013.00262
3. Sammons RP, Vezir M, Moreno-Velasquez L, et al. Structure and function of the hippocampal CA3 module. *Proc Natl Acad Sci U S A*. 2024;121(6):e2312281120. doi:10.1073/pnas.2312281120

4. Watson JF, Vargas-Barroso V, Morse-Mora RJ, et al. Human hippocampal CA3 uses specific functional connectivity rules for efficient associative memory. Cell. Published online December 6, 2024. doi:10.1016/j.cell.2024.11.022