A ten-minute brain rest lets AI connect the dots across neuroscience

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A short resting snapshot becomes the common language linking experiments, species, and methods

Dr. Masanori Shimono from Keio University highlights the importance of recording spontaneous neural activity in neuroscience and suggests that modern AI techniques can reveal meaningful patterns, offering insights into fundamental brain functions

In recent years, the open sharing of data and code has advanced rapidly within neuroscience, markedly improving both transparency and the pace of discovery. In this invited contribution, I focus on one practice that still lags behind this broader trend of open science: acquiring and publicly sharing spontaneous-activity data. Why is it now essential to record spontaneous neural activity, and in what ways might this habit open entirely new horizons for the field? I invite readers to consider these questions with me.

Spontaneous neural activity

Spontaneous activity refers to the neural events that unfold when the brain is free of explicit tasks or external demands. At the macroscale, its value has been recognized for more than two decades. The discovery of the default-mode network by Marcus Raichle and colleagues [(1)] revealed that the 'resting' brain is anything but idle. Building on that insight, projects such as the Human Connectome Project systematically gathered extensive resting-state fMRI datasets. [(2)] Yet below the mesoscale – at the level of tens of thousands of neurons packed into a single MRI voxel – the importance of recording spontaneous activity remains under-appreciated.

Why spontaneous neural activity matters to research

Today, many investigators do share self-recorded neural datasets openly, and this deserves celebration. Nevertheless, a quick survey of CRCNS, DANDI, and OpenNeuro shows that records containing even ten to 15 minutes of spontaneous spikes constitute less than 10% of all publicly posted datasets. On a global scale, then, the community still treats spontaneous activity as optional rather than essential.

That oversight matters because simply adding a brief 'rest block' to every experiment would make disparate studies far easier to integrate. For example, even when limited to the same animal species, the presence of a 'rest block' becomes critically important when attempting to consolidate neural activity data from individual studies that involve highly diverse tasks and recordings from different brain regions. Mapping resting-state first, then task activity streamlines cross-disease meta-analysis in humans and animal models. Recording rest before and after neural manipulations keeps it linkable to later tasks. Even mega-projects like Allen Brain Observatory or the BBQS program can't sample every behavior in any environment, routine rest logs across many small labs together push the field beyond any single large team's limits. Imagine you are building an immense paper sculpture from thousands of independent pieces. Without adhesive dots, the structure would collapse. In this metaphor, the ten minutes of spontaneous activity serve as the vital adhesive dots. AI then serves as the glue that connects adhesive dots of datasets from various laboratories into a cohesive whole. Once such a culture takes root, each lab's recordings can be aligned on a common baseline, and neuroscientists can work in greater concert toward shared objectives.

Metaphors and anecdotes alone cannot do justice to the experiential and scientific value of spontaneous neural activity. Many of you will have felt its importance firsthand. To begin with, a classic laboratory study [(4)] showed that when people thoroughly learn a creative task and then sleep, especially during REM, their chances of waking up with a sudden insight rise dramatically. Large-scale diary research [(5)] and more recent sleep-intervention experiments [(6)] extend this finding, reporting that creative breakthroughs occur two to three times more often during low-stimulus moments such as bathing, strolling, or REM sleep. Rest, in other words, appears to serve as an 'incubation' period in which learned memories are reorganized. Spontaneous activity thus reflects not only the brain's moment-to-moment state but also the entire history of past experience, so intricate that, to our limited perception, it can easily look like noise.

The role of AI

Modern deep-learning studies demonstrate that AI can extract predictive rules that surpass human intuition. [(3)] When a network is trained on the simultaneous firing of thousands of neurons, it can uncover high-dimensional structures that explain most trial-to-trial variability. [(7)] Recording spontaneous activity under standardized, task-free conditions provides the kind of statistical regularity that AI models are particularly adept at uncovering in stable environments. AI methods can therefore decode the latent patterns hidden in this 'idle-mode' signal, shedding light on questions as fundamental as how the brain builds self-representations, weaves internal narratives, and perhaps even follows universal principles of evolution.

For skeptical readers, a more rigorous explanation is warranted. In the next installments, I will delve further into the capabilities of modern AI and contrast them with the persistent barriers that have long hindered the integration of diverse findings in neuroscience. Seen through that lens, spontaneous activity emerges as a necessary bridge – one that links experimental paradigms, species, and even measurement scales, while furnishing the stable statistical footing that predictive models demand.

I do not use the term 'gluing' to equate spontaneous activities from different experiments. Rather, I propose a two-step approach: first, compare spontaneous activity through mutual generation, then compare evoked activity. This allows careful cross-comparison of time-series data recorded under differing lab conditions.

For spontaneous-activity data to become genuinely reusable, it is essential to follow common standards such as NWB and BIDS[8,9] and to annotate rich metadata, including arousal or attentional state and sensor modality, in detail. Dense human recordings with devices like Neuropixels also require thorough ethical review, including robust privacy safeguards. Ultimately, for spontaneous activity to function as the true adhesive dots — the essential points of connection — across datasets, collaboration with policymakers who can support scientists in advancing both technical and societal standardization is indispensable.

In each of the next two submissions, I plan to devote one mainly to AI-related topics and the other mainly to neuroscience-related topics. From this perspective, I would like to take this opportunity to share my thoughts with you, and I hope this article can also serve as a space where I can hear your thoughts in return.

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