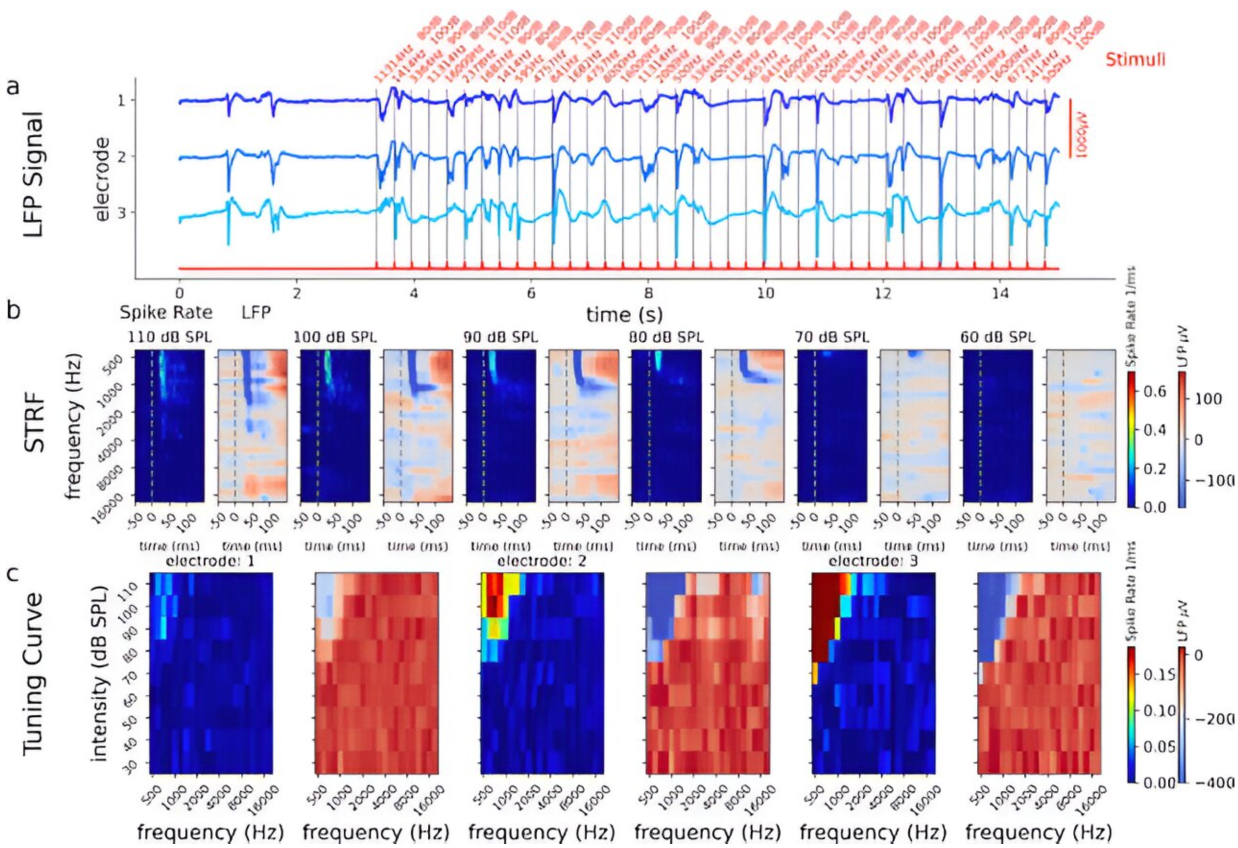
Medical Xpress

AI reveals new insights into human brain activity

September 10 2024



Tuning curve: a: LFP stream of 3 electrodes (shades of blue) during 50 ms pure tone stimuli (pure tone intensity: 110 dB SPL–70 dB SPL, frequencies: 500 Hz–19 027 Hz in half octave steps). The red curve shows the trigger channel (trigger: black vertical lines). b: Spectro-Temporal-Receptive-Fields (STRFs) of position/electrode 3 in terms of spiking activity and field potentials (sound intensities 110 dB SPL–60 dB SPL). c: Tuning-curves calculated from STRFs in b. Credit: *NeuroImage* (2024). DOI: 10.1016/j.neuroimage.2024.120696

In a pioneering study, Dr. Patrick Krauss and Dr. Achim Schilling from the Cognitive Computational Neuroscience Group at Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) have used artificial intelligence to gain major insights into how our brains work, which may substantially change our understanding of human thought processes and emotions.

The work is published in the journal *NeuroImage*.

What comes next in a sentence? What will I see next? How does the environment change when I do this and what happens to my body when I do that? The human brain is continuously occupied at all levels of complexity and abstraction with predicting what will happen next.

Known as predictive coding, this is considered one of the main tasks of the human super-organ, making adaptive behavior possible and allowing us to find our bearings in our surroundings. Dr. Krauss and Dr. Schilling have succeeded in underlining this widely held hypothesis and contributing new findings in their recent study.

The two physicists and neuroscientists analyzed the spontaneous activity of the human brain using auto-encoders, an advanced form of artificial intelligence that allows patterns and connections to be perceived in the complex quantities of data provided by our brain that would have been unachievable using more traditional methods. This was made possible thanks to their collaboration with researchers from the Epilepsy Center at Uniklinikum Erlangen. Epilepsy patients in the Center received electrodes implanted into their brains before the surgical removal of epileptogenic foci.

Using the rare and valuable data received as a result, the researchers made a discovery that led to groundbreaking results: Certain spontaneous activities in our brain known as local field potential events (LFPs) were able to give decisive indicators regarding how our brains work. These spontaneous signals seem to play an important role in how our brains process information, even in the absence of external stimuli.

New avenues for research

"In our study, we realized that our brains are constantly progressing through active states defined by these LFPs. It is as if our brains are constantly playing through various options for what might happen next, even if we are not doing or perceiving anything in particular and not receiving any external stimuli at that moment in time," says Dr. Krauss.

"We have also discovered that the form of these LFPs can determine the direction of information flux within the brain. This could give us important insights into how thoughts and feelings are processed in our minds," adds Dr. Schilling.

Findings that not only open new avenues for research but may also lead to better methods for diagnosis and treatment for brain disease. These AI-based methods can also be used in conjunction with normal EEG or MEG measurements, where electrodes are attached to the surface of the skull to measure brain activity.

"Knowledge of what our brains usually do while we are at rest can be put to good use for diagnostic purposes. If we can gain an ever better understanding of how our brains work and process information, that will allow us to develop more specific methods of diagnosis and treatment for neurological diseases," emphasizes Dr. Schilling. "If, for example, the brain enters a state that does not correlate with the external stimuli, that may be an indication of pathological changes."

Increased reciprocity between technology and brain

research

While AI is being used as a tool, the results of the study from the two FAU researchers may also help to further develop AI. The long-term aim: AI inspired by neuroscience that is capable of continuously making predictions, even if it is not currently processing any input.

"This may be particularly useful in AI systems incorporated into vehicles, for example, especially when bearing safety in mind," explains Dr. Schilling.

Dr. Krauss continues, "Even if there is not much traffic and the car is only driving straight ahead on the highway, it would be beneficial for the AI to be considering in the background which traffic incidents could occur to which it may potentially have to react."

The study from Dr. Krauss and Dr. Schilling therefore shows that the synergetic connection between AI and brain research is capable of expanding the boundaries of what is known about cognitive processes and brain function, eventually leading to innovative new approaches in medical diagnosis and therapy.

The increasing fusion of technology and brain research also indicates how decisive interdisciplinary approaches are for decoding the complex systems found in nature. With their discoveries, the FAU researchers are approaching nothing less than a better understanding of the perhaps most complex of all systems: the human brain.

More information: Achim Schilling et al, Deep learning based decoding of single local field potential events, *NeuroImage* (2024). DOI: 10.1016/j.neuroimage.2024.120696

Provided by Friedrich–Alexander University Erlangen–Nurnberg