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Artificial Intelligence Research in Neurology and Neurodegenerative Diseases

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Abstract

Artificial intelligence (AI) research in neurology and neurodegenerative diseases is fast moving on several fronts, involving areas as diverse as brain-computer interfaces, diagnosis from radiological imaging, personalized neurological treatment, and use of neuroscience to improve AI and conversely. After reviewing these several developmental areas, AI research in neurodegenerative diseases will be discussed.

The biggest focus areas will be early diagnosis, biomarker discovery, disease progression prediction, drug discovery, and personalized treatment especially for Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis, and Huntington's disease. A brief synopsis of the neurotechnology leading companies will also be presented in a sidebar.

Abbreviations

AD: Alzheimer's disease; AI: Artificial intelligence; ALS: Amyotrophic lateral sclerosis; BCI: Brain-computer interface; DLM: Deep learning model; ECoG: Electrocorticography; EEG: Electroencephalography; ERP: Event-related potential; fMRI: functional MRI; GAI: Generative AI; GAN: Generative adversarial networks; GPT: Generative pretrained transformer; HD: Huntington's disease; ICU: Intensive care unit; LLM: Large language model; MIT: Massachusetts Institute of Technology; MRI: Magnetic resonance imaging; PD: Parkinson's disease; SSVEP: Steady-state visual evoked potential; VAE: Variational encoder.

Drugs: Alzheimer's disease; dementia; epilepsy; amyotrophic lateral sclerosis; Huntington's disease; Parkinson's disease.

Keywords

Artificial intelligence research; neurodegenerative diseases; neurotechnology companies.

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Artificial intelligence (AI) research in neurology and neurodegenerative diseases is fast moving on several fronts. Generally, in neurology, it involves areas as diverse as brain-computer interfaces (BCIs), diagnosis from radiological imaging, personalized neurological treatment, and the use of neuroscience to improve AI and conversely. After reviewing these several developmental areas, AI research in neurodegenerative diseases - one of the fastest-growing intersections of AI, neuroscience, computational biology, and precision medicine will be discussed. The biggest focus areas will be early diagnosis, biomarker discovery, disease progression prediction, drug discovery, and personalized treatment especially for Alzheimer's disease (AD), Parkinson's disease (PD), amyotrophic lateral sclerosis (ALS), and Huntington's disease (HD). A brief synopsis of the neurotechnology leading companies will also be presented in a sidebar.

AI research in neurology

AI research in neurology is moving extremely fast in 2025–2026, especially in the following areas:

1. Brain-computer interfaces (BCIs);
2. Foundation models for brain signals;
3. AI-assisted diagnosis from electroencephalography (EEG)/ magnetic resonance imaging (MRI);
4. Neuroprosthetics and speech decoding;
5. Personalized neurological treatment; and
6. NeuroAI (using neuroscience to improve AI and vice versa).

The most important recent developments in these areas are set forth below;

AI + BCIs

BCIs are one of the hottest areas in neurology. Modern systems use AI to decode: Speech, movement intentions, emotions, attention, and memory-related signals. Recent work focuses on real-time adaptation, transfer learning, and generative AI (GAI) or neural signals.

A 2026 review highlighted how transformers, generative adversarial networks (GANs), diffusion models, and variational encoders (VAEs) are now being integrated into BCI pipelines. To be clear, in AI, a transformer is a type of neural network architecture designed to process sequences of data—such as text, audio, or even images—by using a mechanism called attention. Transformers are the foundation of many modern AI systems, including models like OpenAI's generative pretrained transformer (GPT) series, as well as models from Google, Anthropic, and others. The key idea here is "attention", meaning that instead of reading text one word at a time and trying to remember everything, a transformer can look at all relevant parts of the input simultaneously. Also, a generative adversarial network (GAN) is a type of AI model made up of two neural networks trained together: (1) a generator which creates fake data (e.g., images) and a discriminator which tries to distinguish real data from fake data. The generator's goal is to fool the discriminator, while the discriminator's goal is to catch the generator's fakes. This adversarial process drives both networks to improve. While GANs remain important, many modern image-generation systems now rely on diffusion models because they are often easier to train and can achieve very high-quality results. On the other hand, the VAE has also two main parts different from those of a GAN: (1) an encoder that compresses input data (such as an image) into a compact numerical representation called a latent space; and (2) a decoder that reconstructs the original data from that latent representation. The "variational" part means that the model learns a probability distribution in the latent space rather than a single fixed encoding. This allows it to generate new, similar data by sampling from that distribution. The key idea is that a VAE learns a compressed "map" of the data and can generate new examples by exploring that map. VAEs are commonly used for image generation, data compression, anomaly detection, representation learning, and molecular and drug design research. While GANs became famous for highly realistic images, VAEs are often preferred when one wants a meaningful latent space that can be analyzed, manipulated, or interpolated between samples. Key improvements include better decoding accuracy, less training data required, and more personalized interfaces.

An important BCI model is Neuralink, which is briefly presented in the Sidebar.

Foundation models for brain signals

Researchers are now building "GPT-like" models for brain activity. A major trend is training huge models on:

• Electroencephalography (EEG);
• Functional MRI (fMRI;)
• Electrocorticography (ECoG); and
• Neural spike recordings.

Neurons generate electrical activity. ECoG electrodes detect the combined activity of large groups of neurons from the cortical surface. It records electrical activity directly from the surface of the brain using electrodes placed on the cortex. It differs from EEG in that the electrodes are placed directly on the brain surface. It requires surgery, has higher signal intensity, better spatial resolution, and is used in clinical and research settings.

These models learn general representations of brain activity that can transfer across tasks. Important recent projects include:

TRIBE v2

TRIBE v2 is a neuroscience AI model that predicts how the human brain responds to video, audio, and language stimuli. Researchers at Meta AI introduced a multimodal foundation model trained on more than 1,000 hours of fMRI data from 720 subjects. The model can estimate whole-brain activity for new subjects and new types of content and can predict brain responses to visual, auditory, and language stimuli and enables "in silico neuroscience" experiments. It can predict high-resolution fMRI responses across roughly 70,000 brain voxels, a major increase over the original TRIBE model. This is important because it: (a) may reduce the need for expensive experiments; (b) helps map functional organization of the brain; and (c) connects neuroscience with large-scale AI modeling.

Unified EEG foundation models

Several major benchmark efforts appeared in 2026, including NeuroAtlas and NeuralBench, as summarized below:

NeuroAtlas

The NeuroAtlas benchmark is a major 2026 effort to address a simple but important question: "Do EEG foundation models actually generalize across real-world neuroscience and clinical tasks?" For this purpose, researchers assembled what they describe as the largest EEG benchmark to date: 42 datasets totaling roughly 260,000 hours of EEG recordings spanning epilepsy, sleep medicine, brain-age estimation, and BCIs. They found that current EEG foundation models still do not fully generalize across tasks, emphasizing that brain data is much harder to generalize than language data.

NeuroAtlas matters because, before it, EEG foundation models were often evaluated on different datasets, preprocessing pipelines and metrics, making comparisons difficult. NeuroAtlas standardizes evaluation across many tasks and datasets to provide a more realistic assessment of model performance. The benchmark covers four major domains (Table 1):

Domain	Example tasks
Epilepsy	Seizure detection
Sleep medicine	Sleep staging, sleep-event detection, sleep disorder assessment
Brain age	Age prediction and brain-age gap estimation
BCI	Motor imagery, ERP, SSVEP, and related BCI tasks

Abbreviations: BCI: Brain-computer interface; ERP: Event-related potential; SSVEP: Steady-state visual evoked potential

Table 1: Major domains covered by NeuroAtlas

NeuroAtlas has several implications for BCI and neurotechnology startups, especially those building products around EEG foundation models. One of the strongest takeaways is that EEG-specific foundation models did not consistently dominate either general time-series models or task-specific approaches, suggesting that simply training a large EEG transformer is unlikely to create a durable competitive advantage. Further, it highlighted the difficulty of generalizing across datasets collected with different electrode montages, recording hardware, patient populations, protocols, or noise characteristics. This suggests that specialized datasets for epilepsy, sleep disorders, depression, stroke recovery, or intensive care unit (ICU) monitoring could outperform broad collections; in other words, "better data" often beats "more data". Still further, the benchmark emphasizes clinically meaningful outcomes rather than only machine-learning metrics and multimodal approaches may become the next frontier combining EEG, eye tracking, wearable sensors, motion data, speech, medical records, and imaging data. The biggest gains may come from integrating multiple signals rather than scaling EEG models alone.

NeuroAtlas has indirectly reinforced a long-standing challenge that EEG signals vary dramatically across individuals, generalization remains difficult, and robust real-world performance is hard to achieve. This does not mean that consumer BCI is impossible, but it suggests claims of universal cognitive decoding should be viewed cautiously.

NeuralBench

NeuralBench is a newer benchmark than NeuroAtlas and has a slightly different goal. While NeuroAtlas asks "How well do foundation models perform across clinical EEG and BCI tasks?", NeuralBench asks "Can we create a standardized, extensible benchmark for all NeuroAI models and brain-recording modalities?" This other major benchmarking framework evaluates deep learning models (DLMs) across 94 EEG datasets. It showed that current models only slightly outperform specialized systems and clinical neuro-AI remains an open challenge.

The most important result is that current EEG foundation models only marginally outperform task-specific models. In some tasks, relatively small, specialized architectures remain competitive with models that have tens or hundreds of times more parameters.

Both NeuroAtlas and NeuralBench independently found that many cognitive decoding tasks remain extremely difficult, clinical prediction remains challenging, foundation-model gains are often modest, and benchmark standardization is badly needed. The emerging picture from both benchmarks is not that brain foundation models have failed. Rather, they appear to be in roughly the stage that language models were around 2018–2020: promising, useful, but still far from demonstrating a universal representation that reliably transfers across all downstream tasks.

UniBCI

UniBCI represents a different direction from benchmarks like NeuroAtlas and NeuralBench. It is a new pretrained model for invasive neural spike recordings with the goal to build a universal neural decoder. Key innovations include: 1/ Self-supervised learning; 2/ cross-subject generalization; and 3/ spatiotemporal neural tokenization.

A key lesson from NeuralBench and other EEG studies is that EEG signals often fail to generalize well across datasets and subjects. Researchers repeatedly observe substantial distribution shifts. Unlike most EEG foundation models, UniBCI focuses on invasive neural recordings (spike trains from implanted electrodes) rather than scalp EEG. It is designed for high-performance BCI applications such as motor decoding, prosthetic control, and potentially speech neuroprostheses. The most important implication is that the first successful "brain GPT" may emerge from invasive neural data rather than EEG.

The most important open question remains: "Will UniBCI still outperform specialist decoders when evaluated on entirely unseen labs, subjects, recording hardware, and future clinical deployments? If the answer turns out to be yes, UniBCI would be one of the strongest pieces of evidence so far that a general-purpose neural foundation model is achievable. If not, it may join the growing list of brain foundation models that show promising benchmark results but limited real-world transfer.

Viewed together, NeuroAtlas and NeuralBench are cautionary signals, while UniBCI is a more optimistic bet: the field may have been searching for universal neural representations in the wrong modality. EEG may be too noisy, whereas invasive neural recordings may contain enough information density for foundation-model scaling laws to emerge.

CORTEG

CORTEG is part of a trend toward foundation models for neural data, like how large pretrained models transformed language and vision. Rather than training a decoder from scratch for every subject, the model starts with broad neural representations and adapts them to a specific individual. It is a BCI decoding framework that transfers knowledge from large pretrained EEG foundation models (trained on scalp EEG recordings) to ECoG (electrocorticography, intracranial brain recordings). The goal is to improve decoding performance when intracranial data are scarce. It is important because intracranial data is scarce and expensive. The research has so far shown how pretrained EEG models may help decode finger movement, speech, and motor control with much less patient-specific training.

A major challenge in BCI research is that ECoG datasets are small and patient specific. CORTEG addresses this by leveraging representations learned from much larger EEG datasets and adapting them to intracranial recordings. This enables better cross-patient generalization, faster calibration for new users, and stronger performance in low-data settings.

The framework combines a pretrained EEG foundation model backbone, a spatial adapter that accounts for differing electrode placements, a dual-stream tokenizer for low-frequency and high-gamma neural signals, and fine-tuning strategies that adapt the model to a new patient.

Neuromorphic and artificial neurons

Researchers recently developed artificial neurons capable of communicating with biological neurons using flexible materials. This area combines neuromorphic engineering and biomedical engineering. Potential applications include smarter implants, low-power AI chips, neuroprosthetics, and adaptive neural interfaces.

Personalized neurology

A major shift is happening from generalized neurological treatment → to adaptive AI-driven personalized therapy. Emerging systems continuously learn patient-specific neural patterns and adapt stimulation in real time. Potential future applications are adaptive epilepsy treatment, personalized depression therapy, memory restoration, and stroke rehabilitation.

Remaining major challenges

Despite huge progress, several problems remain (Table 2):

Challenge	Why it matters
Limited brain data	Brain data sets are small and noisy
Interpretability	Clinicians need explainable AI
Generalization	Models often fail across patients
Privacy concerns	Neural data is highly sensitive
Ethics	BCIs interact with cognition and identity

Table 2: Remaining challenges in AI neuro data

The field is converging toward:

"AI"+"Neuroscience" → "Adaptive Intelligent Neurotechnology"

The long-term vision includes thought-controlled devices, AI-assisted neurological treatment, adaptive prosthetics, brain-inspired AI systems, and digital biomarkers for disease prediction.

Researchers increasingly believe neuroscience and AI will co-evolve such that AI will help understand the brain and brain principles will help build better AI systems.

AI research in neurodegenerative diseases

AI research in neurodegenerative diseases is now one of the fastest-growing intersections of AI, neuroscience, computational biology, and precision medicine. The biggest focus areas are early diagnosis, biomarker discovery, disease progression prediction, drug discovery, and personalized treatment especially for:

- Alzheimer's disease;
- Parkinson's disease;
- Amyotrophic lateral sclerosis; and
- Huntington's disease.

Foundation models for neurodegeneration

Researchers are beginning to build "foundation models" specifically for neurodegenerative disease research. One emerging direction is training large multimodal models on clinical, genomic, imaging, and proteomic data.

The broader trend is moving toward:

"Multiomic AI Models"→"Predictive Neurology"

Alzheimer's

Early detection

This is one of the most important advances in detecting disease years before symptoms appear. Researchers are now combining MRI/fMRI, EEG, speech, genomics, blood biomarkers and wearable sensor data using deep learning and foundation models.

A notable 2026 initiative is FINGERS-7B, an Alzheimer's foundation model developed through collaborations involving the Massachusetts Institute of

Technology (MIT) and global Alzheimer's datasets. The model integrates lifestyle data, genomics, proteomics, biomarkers, and longitudinal cognitive data to predict Alzheimer's risk and progression.

A major 2026 review showed AI systems increasingly outperform traditional statistical methods for identifying early-stage Alzheimer's (and Parkinson's) disease from multimodal data.

AI-assisted protein-structure analysis

AI-assisted protein-structure analysis recently helped researchers identify a previously unknown disease mechanism involving the PHGDH gene and a potential therapeutic molecule. The AI systems were used to model protein structure, identify hidden functional domains, and simulate molecular binding interactions.

This reflects a broader trend as AI is becoming central to molecular neuroscience.

Parkinson's disease

Researchers at the Cleveland Clinic used AI-based biology systems models to identify potential Parkinson's risk genes, progression pathways, and FDA-approved drugs that could be repurposed.

The models integrate genomics, proteomics, pharmaceutical databases, and patient datasets to uncover hidden biological relationships.

Dementia

Speech analysis has become a major non-invasive biomarker. Researchers found that foundation speech and language models can detect cognitive decline, mild cognitive impairment, and Alzheimer's-related dementia from spontaneous speech patterns.

The systems analyze pauses, fluency, syntax, acoustic patterns, and semantic drift. This is important because speech-based screening could eventually become cheap, scalable, and smartphone-based without requiring expensive imaging.

Generative AI in clinical neurology

Large language models (LLMs) are increasingly being tested as "clinical copilots" for dementia care. Recent frameworks propose using generative AI to summarize neurological records, assist diagnosis, analyze patient histories, monitor progression, and recommend evidence-based care plans while keeping physicians in the loop. Researchers emphasize human oversight, explainability, bias reduction, and clinical governance because neurodegenerative diagnosis is high stakes.

AI-driven drug discovery

AI is dramatically accelerating target discovery and drug repurposing (see Fymat, 2026c).

Radiomics and neuroimaging AI

Radiomics refers to extracting quantitative information from medical images using AI. Researchers are applying deep learning to MRI, PET, CT, and diffusion imaging to identify subtle neurodegenerative signatures invisible to humans.

Current goals include predicting disease progression, distinguishing dementia subtypes, identifying treatment responders, and tracking brain aging.

AI-neuropathology foundation models

Another major frontier is digital neuropathology. A 2025 study introduced NeuroFM, a domain-specific foundation model trained directly on brain tissue pathology slides. The model improves Alzheimer's pathology classification, Lewy body detection, cerebellar degeneration analysis, and hippocampal segmentation compared with general pathology AI systems. This is important because brain pathology differs greatly from ordinary tissue pathology.

Precision and personalized neurology

Researchers increasingly view neurodegenerative diseases as highly heterogeneous, multi-factorial and patient specific. AI is helping move neurology toward personalized prediction and treatment.

Using patient-specific multimodal data, emerging systems attempt to estimate:

"Risk"+"ProgressionRate"→"Treatment Response"

Key technical trends and overall direction of the field

The hottest AI methods in this field include (Table 3):

Method	Main use
Transformers	Longitudinal patient modeling
Graph neural networks	Brain connectivity analysis
Diffusion models	Synthetic neuroimaging
Foundation models	Generalizable biomarkers
Multimodal learning	Combining imaging + genomics
Sel-supervised learning	Learning from unlabeled brain data

Table 3: Key technical trends in precision and personalized neurology

Overall, the field is moving toward:

"AI"+"Neurobiology"+"Precision medicine"→"Predictive neurodegenerative care"

with long-term goals including detecting disease before symptoms, slowing progression earlier, personalized neurological therapy, AI-guided drug development, and continuous home monitoring via wearables and speech.

Recent bibliometric analyses also show explosive growth in publications connecting AI with neurodegenerative disease research since 2020.

Conclusions and take-aways

- AI research in neurology is moving extremely fast in 2025–2026, especially in the following areas: brain-computer interfaces, foundation models for brain signals, AI-assisted diagnosis from EEG/MRI, neuroprosthetics and speech decoding, personalized neurological treatment, and NeuroAI (using neuroscience to improve AI and vice versa).
- Brain-computer interfaces are modern systems use AI to decode speech, movement intentions, emotions, attention, and memory-related signals. Key improvements include better decoding accuracy, less training data required, more personalized interfaces, and synthetic EEG generation. An important such model is Neuralink.
- Foundation models are now building "GPT-like" models for brain activity. A major trend is training huge models on electroencephalography, functional MRI, electrocorticography, and neural spike recordings. These models learn general representations of brain activity that can transfer across tasks. They predict how the human brain responds to video, audio, and language stimuli. They may reduce the need for expensive experiments, help map functional organization of the brain, and connect neuroscience with large-scale AI modeling.

- Unified EEG foundation models include NeuroAtlas, NeuralBench, and NeuroBCI. While NeuroAtlas asks "How well do foundation models perform across clinical EEG and BCI tasks?", NeuralBench asks "Can we create a standardized, extensible benchmark for all NeuroAI models and brain-recording modalities?" Both models found that many cognitive decoding tasks remain extremely difficult, clinical prediction remains challenging, foundation-model gains are often modest, and benchmark standardization is badly needed. On the other hand, NeeuroBCI is a new pretrained model for invasive neural spike recordings with goal to build a universal neural decoder. The most important open question remains: “Will UniBCI still outperform specialist decoders when evaluated on entirely unseen labs, subjects, recording hardware, and future clinical deployments?”

- CORTEG is part of a trend toward foundation models for neural data, like how large pretrained models transformed language and vision. It is a brain computer interface decoding framework that transfers knowledge from large pretrained EEG foundation models (trained on scalp EEG recordings) to ECoG (electrocorticography, intracranial brain recordings). The goal is to improve decoding performance when intracranial data are scarce. A major challenge is that ECoG datasets are small and patient specific. CORTEG addresses this by leveraging representations learned from much larger EEG datasets and adapting them to intracranial recordings.

- Researchers recently developed artificial neurons capable of communicating with biological neurons using flexible materials. This area combines neuromorphic engineering and biomedical engineering. Potential applications include smarter implants, low-power AI chips, neuroprosthetics, and adaptive neural interfaces.

- A major shift is happening from generalized neurological treatment → to adaptive AI-driven personalized therapy. Potential future applications are adaptive epilepsy treatment, personalized depression therapy, memory restoration, and stroke rehabilitation.

- AI research in neurodegenerative diseases is now one of the fastest-growing intersections of AI, neuroscience, computational biology, and precision medicine. The biggest focus areas are early diagnosis, biomarker discovery, disease progression prediction, drug discovery, and personalized treatment especially for Alzheimer’s disease, Parkinson’s disease, amyotrophic lateral sclerosis, and Huntington’s disease.

- Researchers are beginning to build ″foundation models″ specifically for neurodegenerative disease research. One emerging direction is training large multimodal models on clinical, genomic, imaging, and proteomic data.

- Foundation models for neurodegeneration train large multimodal models on clinical, genomic, imaging, and proteomic data. One of the most important advances was in detecting disease (for example Alzheimer′s) years before symptoms appear. Researchers are now combining MRI/fMRI, EEG, speech, genomics, blood biomarkers and wearable sensor data using deep learning and foundation models.

- AI-assisted protein-structure analysis recently helped identify a previously unknown disease mechanism involving the PHGDH gene and a potential therapeutic molecule. The AI systems were used to model protein structure, identify hidden functional domains, and simulate molecular binding interactions. This reflects a broader trend as AI is becoming central to molecular neuroscience.

- AI-based biology systems identify potential Parkinson's risk genes, progression pathways, and FDA-approved drugs that could be repurposed. The models integrate genomics, proteomics, pharmaceutical databases, and patient datasets to uncover hidden biological relationships.

- Foundation speech and language models can detect cognitive decline, mild cognitive impairment, and Alzheimer's-related dementia from spontaneous speech patterns.by analyzing pauses, fluency, syntax, acoustic patterns, and semantic drift.

- Large language models are increasingly being tested as "clinical copilots" for dementia care. Recent frameworks propose using generative AI to summarize neurological records, assist diagnosis, analyze patient histories, monitor progression, and recommend evidence-based care plans while keeping physicians in the loop.

- AI is dramatically accelerating target discovery and drug repurposing.

- Radiomics refers to extracting quantitative information from medical images using AI. Researchers are applying deep learning to MRI, PET, CT, and diffusion imaging to identify subtle neurodegenerative signatures invisible to humans. Current goals include predicting disease progression, distinguishing dementia subtypes, identifying treatment responders, and tracking brain aging.

- Another major frontier is digital neuropathology - a domain-specific foundation model trained directly on brain tissue pathology slides. The model improves Alzheimer's pathology classification, Lewy body detection, cerebellar degeneration analysis, and hippocampal segmentation compared with general pathology AI systems. This is important because brain pathology differs greatly from ordinary tissue pathology.

- Neurodegenerative diseases are highly heterogeneous, multi-factorial and patient specific. AI is helping move neurology toward personalized prediction and treatment.

- Key technical trends and overall direction of the field have been identified.

- The Sidebar briefly presents current brain-computer interface & neurotechnology leading companies.

Sidebar 18.1 - Brain-computer interface & neurotechnology leading companies

As of 2026, BCI & neurotechnology leaders are: Neuralink, Syncron, Paradromics, and Presision Neuroscience. These are briefly presented below.

Neuralink

Neuralink is a U.S. neurotechnology company founded by Elon Musk that develops implantable BCIs to help people with paralysis and neurological disorders communicate and control devices using neural signals. Their core device, the N1 Implant (or "the Link"), is a coin-sized chip that connects to the brain via thousands of microscopic threads, allowing people with paralysis to control computers and phones using only their thoughts.

How the technology works

Neuralink is developing:

• A small implantable device placed in the skull;
• Very thin electrode threads that connect to neurons in the brain; and
• Software that interprets neural signals and converts them into computer commands.

The electrodes are placed near neurons to detect action potentials. Recording from many neurons allows to decode the information represented by those cells. In the movement-related areas of the brain, for example, neurons represent intended movements. There are neurons in the brain that carry information about everything we see, feel, touch, or think.

The idea is that a person could control a computer, smartphone, or other device using their thoughts. In simple terms, Neuralink is working on technology that allows direct communication between the brain and computers through implanted devices. It consists of:

• **The threads:** A custom surgical robot implants ultra-fine, flexible electrodes into the cerebral cortex (the region of the brain responsible for motor control and higher-level processing). These threads detect neuron spikes, or electrical signals, generated when a user simply thinks about moving a part of their body.

• **Decoding signals:** Advanced on-board chips process these signals and transmit them wirelessly over Bluetooth to a paired device. Machine learning algorithms then translate this brain activity into digital actions, like moving a mouse cursor or typing.

• **Power:** The device is powered by a small battery that is recharged wirelessly from the outside using a compact inductive charger.

Medical applications

The company's initial focus is to help people with severe paralysis regain abilities such as: controlling a computer cursor, typing and communication, and operating assistive technologies thereby restoring autonomy to individuals with unmet medical needs such as those suffering from quadriplegia, spinal cord injuries, or amyotrophic lateral sclerosis (ALS). In clinical trials, paralyzed patients have successfully used the implant to play video games, browse the internet, and control digital keyboards simply by imagining the movement of their limbs.

Looking ahead, Neuralink aims to expand its technology beyond basic digital control. Future developments may include:

• Restoring motor and sensory functions (e.g., helping people with paraplegia walk or restoring sight to the blind).
• Treating degenerative neurological conditions.
• Building a higher-bandwidth bridge between the human brain and AI or advanced prosthetics.

Some of these longer-term ambitions remain speculative and are subjects of ongoing research.

Human trials

Neuralink has received regulatory approval in the U.S. to conduct human clinical studies. Early participants have demonstrated thought-controlled cursor movement and other computer interactions using the implanted device. Research is still ongoing to evaluate safety, reliability, and long-term effectiveness.

These trials are summarized in Table 4:

Technology	Purpose	Eligibility	Status
Neuralink for device control	To investigate the control of a computer and robotic arm through thought	People with quadriplegia, spinal cord injury, or ALS	Actively recruiting
Prime *(ID: NCT06429735)*	To investigate the N1 implant to help control external devices using only thoughts	People with paralysis	o Actively recruiting o Multiple ALS and SCI participants have received the implant
CONVOY *(ID: NCT06710626)*	To investigate the use of the N1 implant to control an assistive robotic arm	People with paralysis and others	Study sites: Barrow Neurological Institute; University of Miami
VOICE *(ID:NCT07224256)*		People with severe speech impairment	Multiple ALS and SCI participants have received the implant or other conditions

Abbreviations: ALS: Amyotrophic lateral sclerosis; SCI: Spinal cord injury;

Table 4: Current Neuralink clinical trials

An upcoming trial will investigate restoring visual perception. Neuralink has received FDA Breakthrough Device Designation for blindsight. This will accelerate the path towards helping restore visual perception to those who have lost the ability to see.

Synchron

Synchron, a U.S. company, is one of the leading BCI companies; it is often viewed as the main competitor to Neuralink. It was founded by Tom Oxley and is focused on helping people with paralysis, ALS, spinal cord injuries, and other severe motor impairments communicate and control devices. In 2026, the company was recognized in the *TIME 100 Most Influential Companies* list and is preparing larger pivotal clinical trials aimed at eventual regulatory approval.

How the technology works

Its flagship device, the Stentrode, is implanted through a blood vessel in the neck (via the jugular vein) rather than requiring open-brain surgery. The electrodes are positioned near the motor cortex from inside a blood vessel, making the procedure significantly less invasive than traditional brain implants. It remains, however, an investigational device and is currently undergoing clinical trials rather than commercial deployment.

Recent progress

Synchron has demonstrated patients controlling computers, smartphones, and even Apple devices using thought alone. The company has also integrated AI technologies from NVIDIA to improve decoding of neural signals.

Many neuroscientists consider Synchron's approach more scalable for hospitals because it leverages procedures like those already used for cardiovascular stents. Neuralink, however, may ultimately achieve higher bandwidth because its electrodes are implanted directly into brain tissue.

Clinical trials

Synchron has conducted several important clinical trials primarily focused on people with severe paralysis (Table 5):

Technology	Purpose	Eligibility	Status
SWITCH (Australia, 2019-2022)	To evaluate the safety and feasibility of Stentrode	Participants with paralysis caused by conditions such as ALS, SCI, stroke, muscular dystrophy, or limb loss.	o First-in humans study o Enrolled 5 participants o Achieved primary safety objectives: implanted device remained stable and allowed participants with severe paralysis to perform digital tasks using neural signals
COMMAND (U.S.A.)	o Feasibility study of Synchron's motor neuroprosthesis o Evaluate safety and ability of participants to control digital devices using thought-driven neural signals	o People with severe upper-limb paralysis	o First FDA-authorized IDE trial for a permanently implanted BCI o For 6 implanted participants (in 2024): No device-related serious adverse events reported; brain signals successfully recorder and translated into digital actions; participants able to perform activities such as communication and computer interaction
INTENT (U.S.A.)	o To further evaluate implanted BCI for restoring meaningful control of digital devices	o Individuals with bilateral upper-limb impairment, including people with ALS	o Actively recruiting

Abbreviations: ALS: Amyotrophic lateral sclerosis; IDE: Investigational Device Exemption; SCI: Spinal cord injury

Table 5: Synchron clinical trials

Overall progress

Across SWITCH and COMMAND, approximately 10 implanted participants have been reported in the scientific literature and trial documentation. The accumulated data suggest that:

• The endovascular implantation approach can be performed without open-brain surgery.
• Long-term implantation appears feasible;
• Neural signals can be decoded sufficiently for communication and computer control; and
• Safety outcomes have so far been encouraging, though larger pivotal studies will be needed before regulatory approval and broad clinical use.

Paradromics

Paradromics is a U.S. neurotechnology company was founded by Matt Angle and headquartered in Austin, Texas. It is one of the most technically ambitious BCI companies today. It is often mentioned alongside Neuralink because both are developing implantable BCIs. Its strategy differs from many competitors by prioritizing very high-resolution neural recording—capturing signals from individual neurons rather than broader brain activity patterns. It is developing high-bandwidth BCI designed to help people with severe paralysis communicate and interact with computers using neural signals. Paradromics argues that recording individual neurons is necessary for natural-speed communication and precise control because more information can be extracted from the brain. It differs from Neuralink in device architecture and implantation strategy.

How the technology works

The company’s flagship device, the Connexus BCI, uses hundreds of microscopic electrodes implanted in the brain’s cortex and designed to record activity from individual neurons with emphasis on high data rates (exceeding 200 bits per second) and speech restoration. These electrodes detect activity from individual neurons and send the data to an implanted receiver, which wirelessly transmits it to an external computer. AI models then decode the neural activity into intended speech, text, cursor movements, or other computer commands.

Medical applications

Paradromics is initially focused on restoring communication for people who have lost the ability to speak or move due to conditions such as:

• ALS (amyotrophic lateral sclerosis);
• Brainstem stroke;
• Spinal cord injury; and
• Other severe motor impairments.

The next few years of clinical trial results will be crucial in determining whether high-resolution implants can reliably restore natural communication in everyday life. Longer term, the same technology could enable advanced prosthetic control, computer interaction, and potentially more direct interaction with AI systems, although those applications remain experimental.

Recent milestones

• In May 2025, Paradromics completed its first human recording during a temporary implantation procedure performed alongside epilepsy surgery, demonstrating that Connexus could be implanted, record brain signals, and be removed safely.
• In November 2025, the U.S. FDA approved its first long-term clinical study (Connect-One) to evaluate whether the system can restore communication through text or synthesized speech for people with paralysis.
• Human feasibility trials began in 2026 to evaluate long-term safety and communication restoration in people with severe motor impairments.

In simple terms:

• Synchron prioritizes safety and easier implantation.
• Neuralink emphasizes scaling and robotic surgery.
• Paradromics emphasizes maximizing neural data rate and speech decoding performance.

Precision Neuroscience

Precision Neuroscience is a private U.S. neurotechnology company founded in 2021 by former Neuralink team members, including Benjamin Rapoport and Michael Mager. The company is based in New York City and develops less invasive neural interfaces combined with AI-based neural decoding. Unlike some BCI approaches that insert electrodes deep into brain tissue, The company's goal is to achieve high-resolution neural recordings while reducing tissue damage and making implantation more reversible.

How the technology works

Precision's flagship technology, the Layer 7 Cortical Interface, is an ultra-thin electrode array that sits on the brain's surface. Key features include:

• A flexible film roughly thinner than a human hair.
• Up to 1,024 electrodes for high-density neural recording.
• A minimally invasive implantation technique using a tiny skull opening ("cranial microslit") rather than traditional open-brain approaches.

The main differentiator is the emphasis on high-bandwidth neural recording with less invasive implantation compared with fully penetrating brain implants.

Medical applications

The company's primary target is helping people with severe paralysis interact with computers, smartphones, and other digital devices using neural signals. Potential future applications include:

• Spinal cord injury.
• Stroke rehabilitation.
• ALS and other neurodegenerative disorders.
• Neurosurgical guidance.
• Neuroprosthetics and communication restoration.

Recent developments

A major milestone came when the U.S. FDA granted 510(k) clearance for the Layer 7 Cortical Interface, allowing commercial use for recording, monitoring, and stimulation on the brain surface for implantation periods of up to 30 days. This clearance does not yet represent approval of a fully implantable long-term BCI system, but it is an important step toward broader clinical adoption. The company partnered with Medtronics to integrate its neural interface with neurosurgical navigation systems. It also expanded clinical research collaborations, including work with University of Chicago Medicine on neural cursor control and neuroprosthetics.

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