

**CHEN** TIANQIAO  
& CHRISSY  
**INSTITUTE**

**2024 Annual Report**





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# Welcome

Thank you for your interest in the Chen Institute. In the following pages, we're delighted to present some highlights from 2024 and as always, we encourage you to look at our website for more of details.

In 2024, the Tianqiao and Chrissy Chen Institute advanced both fundamental research and translational science, while continuing to build a pioneering global research ecosystem that connects leading minds across disciplines and geographies. We launched the first "[Chen Institute and Science Award for AI Accelerated Research](#)", which aims to identify and reward innovative applications of artificial intelligence in scientific research. We also co-hosted two impactful meetings in Shanghai: "[The Chen Institute and Science Forum on AI and Mental Health](#)" in November, which convened scientists, clinicians, and industry leaders to explore the emerging paradigm of AI-driven mental health; and "[The Chen Institute | BCI Society Joint BCI Meeting](#)" in December, —marking the first time in the conference's 25-year history that it was held in Asia. Together, these events drew more than 1,000 interdisciplinary researchers and fostered vibrant exchanges on the latest developments in their respective fields.

We were excited to expand our [Chen Scholars Program](#) to include the Mayo Clinic, UCSF, and Mass General Hospital in 2024. We also brought scholars together for the inaugural [Chen Scholars Retreat](#) in Boston where there was a healthy exchange of ideas.

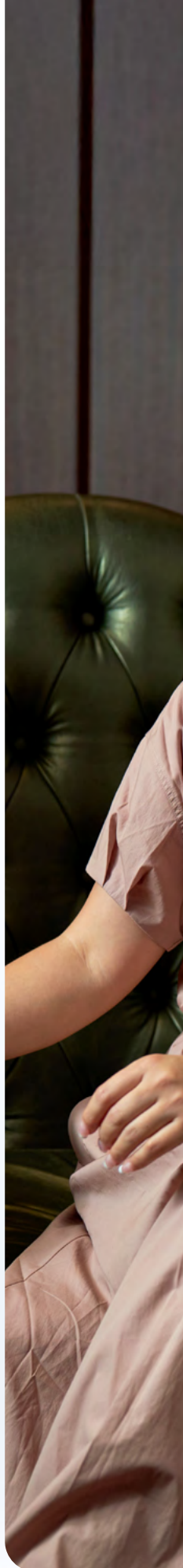
Meanwhile, we continued to expand our presence in both academic communication and public science education through a growing, multidimensional media platform. Our science communication brand, Next Question, launched several flagship series including Next Question Insight and Next Question 20w+, which have outperformed many leading brain science media outlets and helped bring specialized content to broader audiences. Our popular science video channel, The Grand Mirror Studio, reached more than 10 million views across 35 multilingual AIGC-produced videos. Highlights include The New Era of Consciousness, a standout production that introduced cutting-edge brain science to global audiences in an engaging and accessible way.

The AI-themed awards, meetings, and research you will see in this report reflect our continuing belief that we can draw from what we have learned about human intelligence to enhance artificial intelligence, which will then accelerate and expand our journey to unlock the secrets of the human brain.

Thank you for your ongoing support and interest.



Tianqiao Chen and Chrissy Luo









# Our Vision

The Chen Institute's vision is to improve the human experience by understanding the ways in which our brains perceive, learn, and interact with the world. We hope that by doing so, we will have the ability to alleviate human suffering such as chronic pain or mental disorders, which are fundamentally perceptions caused by neural processes.

We bring the world's most talented researchers in biology, chemistry, engineering, mathematics, physics, the humanities, and social sciences together as a means of investigating the complex interactions that govern sensation, perception, and cognition. We also support leading AI scientists globally so their technology can fuel and accelerate scientific research.





## Our Three Core Areas of Interest

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### Brain Discovery

Our primary focus is interdisciplinary research in basic sciences to help us understand the brain at the level of the individual neurons and synapses. We support research which has the potential to improve our understanding of how the brain gathers, organizes, and retains information, and translates perceptions into thoughts, emotions, decisions, actions, and memories.

### Brain Treatment

We hope to translate improved understanding of brain mechanisms and processes into breakthroughs for treating physical and psychological suffering. Together with our partner Shanghai Mental Health Center, our Chen Frontier Lab for AI & Mental Health focuses on mental disorders and neurodegenerative diseases.

### Brain Augmentation

An acute understanding of fundamental brain processes combined with cutting-edge AI provides multiple windows of opportunity to leverage and enhance brain capacity, with the following three areas of focus:

- Perfecting two-way neural communications between the brain and computers via seamless, real-time brain-machine interfaces.
- Advancing neural interfaces with the ability to augment human capabilities, enhancing neurorehabilitation, creating virtual sensation, and pushing the boundaries of brain performance in learning, memory, and concentration.
- Leveraging our understanding of the brain to help design novel learning models that mimic the layers of neuronal activity in our brains and training machines and robots to be more intelligent.



# Programs & Initiatives

## The Chen Institute Ecosystem

Working toward our vision, we have constructed an ecosystem that is comprised of strategic partnerships, people-focused programs, and initiatives that support the use of AI to accelerate the pace of research.



### Cornerstone Partnerships

- *Tianqiao & Chrissy Chen Institute for Neuroscience.* This Institute at Caltech has assembled a cross-disciplinary team of scientists and engineers to investigate and understand the brain at a fundamental level.
- *Tianqiao & Chrissy Chen Institute for Translational Research.* Created in Shanghai to focus on brain disease and strengthen translational research between clinical and fundamental science.



### Chen Institute Global Conference Program

The Chen Institute supports and organizes scientific meetings all over the world. Since 2017, we have supported more than 500 global meetings and have reached millions of people. The Institute will launch a signature meeting series in October 2025.



Spotlight

### 2024 Chen Institute and Science Joint Conference on AI & Mental Health

Shanghai, November 7-8, 2024



An annual conference presented by the Tianqiao and Chrissy Chen Institute and Science magazine focused on AI and mental health, 2024's two-day conference highlighted ways that AI can be used to provide benefits for both individuals and society. Speakers discussed the current state of AI and recent progress in the field. They also discussed promising AI applications for mental health diagnosis and treatment.

### BCI Society | Chen Institute, Joint BCI Meeting

Shanghai, December 6-7, 2024



A collaborative effort between two leading organizations, this Shanghai meeting fostered interaction between BCI communities in Asia and the rest of the world, sharing the latest in BCI science and creating an environment that was conducive to exchange and collaboration.

## **Chen Institute Training Program (2022)**

Our international training programs furnish young scientists with the necessary tools to conduct innovative AI-driven scientific research. Our two main workshops in 2024 included:

### **FENS – Chen Institute – NeuroLéman Summer School on Monitoring and Manipulating the Affective State: New Perspectives on Neurotechnologies and AI Tools**

University of Lausanne, August 25-31, 2024

The 2024 FENS – Chen Institute – NeuroLéman Summer School aimed to integrate fundamental and clinical neuroscience with technology (especially AI tools) and harmonized these three types of investigations around novel approaches that were applied to animals and humans to decrypt affective states.

### **IRCN and Chen Institute Joint Course on Neuro-Inspired Computation**

University of Tokyo, July 16-19, 2024

In a collaborative effort, the World Premier International Research Center for Neurointelligence (WPI-IRCN) at the University of Tokyo and the Chen Institute presented an innovative course that was designed to explore the frontier at which natural and artificial intelligence converge. It examined critical areas such as intrinsic dynamics, network architectures, prediction, plasticity, and criticality, in addition to multi-agent learning and neuromodulation. This highlighted the potential for cross-disciplinary innovation in understanding cognitive processes.



## **Chen Institute Science Writers Program**

Enabling early-career scientists to attend important scientific meetings by covering the costs of entry and travel, their meeting reports extend the value of the meeting. Click above to apply.



## **Chen Frontier Labs**

Chen Frontier Labs are unique interdisciplinary R&D laboratories. Each of them operates with a distinct focus, but are united by a common vision to improve humanity by solving important problems of the brain and mind.

- *Chen Frontier Laboratory for Applied Neurotechnology.* Led by Professor Mao Ying, MD, Director of TCCI for Translational Research and President at Huashan Hospital, and focused on brain-computer interface research and technology research and development, and sleep.
- *Chen Frontier Laboratory of AI and Mental Health.* Led by Min Zhao, MD, PhD, President, Shanghai Mental Health Center, Consultant Psychiatrist, Professor, President of Shanghai Mental Health Center at Shanghai Jiao Tong University School of Medicine. Located at the Shanghai Mental Health Center, this lab is focused on the use of next-generation AI technology for mental illness diagnosis and treatment.





## Chen Scholars Program: AI Advancing Medicine (2023)

Founded in 2023, the Chen Scholars program serves to bridge the worlds of clinical study and AI by supporting

physician-scientists who are at the forefront of their fields. Current partners include:



### Massachusetts General Hospital

Founding Member, Mass General Brigham



**Jacqueline Clauss**  
MD, PhD



**Brian L. Edlow**  
MD



**Long Nguyen,**  
MD, MS



**Elaine Yu**  
MD, MSc



**Raghu Chivukula**  
MD, PhD



**Neguine Rezaii**  
MD



**Marc Wein**  
MD, PhD



University of California San Francisco



**Rima Arnaout**  
MD



**Joline Fan**  
MD, MS



**Andreas Rauschecker**  
MD, PhD



**Jing (Meghan) Shan**  
MD, PhD



**Doris Wang**  
MD, PhD



**Farwa Ali**  
MBBS



**Collin M. Costello**  
MD



**Robert T. Fazzio**  
MD, PhD



**Nathan P. Staff**  
MD, PhD



**Tatsunori Hashimoto**  
PhD



# Our Commitment to AI

We have created a number of AI-focused initiatives because we believe in the potential of artificial intelligence to accelerate our journey to unlock the secrets of the human brain.

## A Three-part AI Talent Initiative to Find Global Leaders in “AI for Science”

In 2024, the Chen Institute unveiled a three-point AI Talent Initiative, an ambitious program that aims to find and foster future leaders in AI-driven scientific research. This initiative creates a unique platform for aspiring talent so they can push the boundaries of research by collaborating with some of the top scientists in the world. This gives participants a unique opportunity to become pioneers in the emerging “AI for Science” field.



### 1. Unlocking the Secrets of AI Memory: A Collaborative Internship Program with Professor Mengdi Wang at Princeton University

Professor Mengdi Wang is Associate Professor of Electrical and Computer Engineering and the Center for Statistics and Machine Learning and Associated Faculty in Computer Science. She is also Affiliated Faculty to the Omenn-Darling Institute of Bioengineering at Princeton University and a recipient of the Donald Eckman Award, which recognizes the outstanding achievements of young researchers in the field of control theory. She is spearheading a collaborative global internship program with the Chen Institute that is looking for exceptional students who are keen to contribute to cutting-edge research in AI and cognitive science.

The program is open to algorithm-focused interns who specialize in large language models (LLM) and AIGC. Applicants can apply at [aitalents@cheninstitute.org](mailto:aitalents@cheninstitute.org)



### 2. Annual Chen Institute and Science Prize for AI Accelerated Research: Seeking Global AI Leaders

In partnership with Science magazine, we presented the first annual “Chen Institute and Science Prize for AI Accelerated Research Prize” in 2024 to honor young scientists who utilize AI techniques, including machine learning and deep learning, to address critical issues in natural and physical sciences.

Applicants submit a 1,000-word essay which details how they are using (or intend to use) AI to accelerate scientific research. Winners will be announced in July 2025 and they will have their essays published in Science magazine, in addition to receiving a cash prize and a five-year subscription to the magazine. More information at [www.cheninstitute.org/prize](http://www.cheninstitute.org/prize)

### 3. Ongoing AI Talent Recruitment



The Chen Institute also continues to recruit passionate AI interns and full-time employees in Beijing, Shanghai, Silicon Valley, Singapore, and Tokyo. We are always looking for individuals who will bring enthusiasm, technical innovation, and strong teamwork to tackle real-world challenges with AI. Visit the careers page on our website for more information.

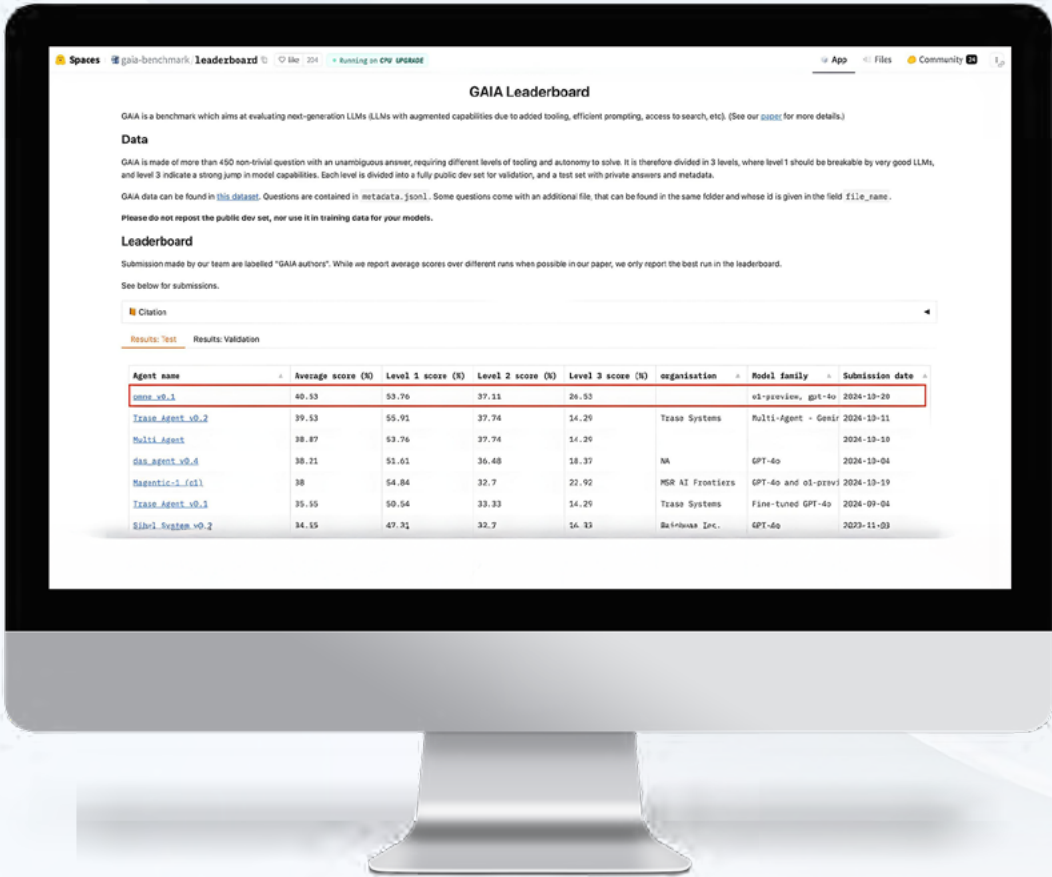
**The Tianqiao & Chrissy Chen Institute's  
OMNE Framework for Long-Term AI Memory  
Claims Top Spot on the GAIA Leaderboard**

Drawing from their deep knowledge of the brain and memory, the Chen Institute's internal AI team achieved a major breakthrough in artificial intelligence in October, 2024. Their self-developed OMNE Multiagent Framework earned the top position on the GAIA (General AI Assistants) benchmark leaderboard, which is published by Hugging Face. OMNE outperformed frameworks from some of the leading institutions in the world, including Microsoft Research. This achievement builds on years of brain research at the Chen Institute, equipping agents with Long-Term Memory (LTM) capabilities, which enables the framework to engage in deeper, slower thinking while also enhancing the decision-making capabilities of Large Language Models (LLMs) in complex problem-solving.

OMNE currently boasts an overall success rate of 40.53%, which has surpassed submissions from well-known institutions including Meta, Microsoft, Hugging Face, Princeton University, the University of Hong Kong, the British AI Safety Research Institute, and Baichuan. In comparison, GPT-4 equipped with plugins achieved a success rate of just 15%.

The breakthrough with OMNE involves the integration of a long-term memory mechanism, which significantly reduces the search space of MCTS and improves the decision-making ability for complex problems. Through the introduction of more efficient logical reasoning, OMNE improves the intelligence level of a single agent and significantly enhances the overall capabilities of the multi-agent system by optimizing the collaboration mechanism. This enhancement mechanism was inspired by the study of the columnar structure of the human cerebral cortex. As the basic unit of the brain's cognitive and behavioral functions, the cortical column realizes information processing through a complex collaboration mechanism. By strengthening the collaboration between single intelligence and agents, the AI model could gradually produce the emergence of cognitive abilities, build an internal representation model, and promote a leap in the overall intelligence of the system.

TCCI's paper on AI long-term memory, "Long Term Memory: The Foundation of AI Self-Evolution", has been published on arXiv: <https://arxiv.org/abs/2410.15665>



# Recognition

Many of the scientists and researchers who are affiliated with the Chen Institute were recognized in a variety of ways in 2024.

## Joe Parker Named MacArthur Fellow



The John D. and Catherine T. MacArthur Foundation chose Joe Parker, assistant professor of biology and biological engineering, Chen Scholar, and director of Caltech's Center for Evolutionary Science, as a 2024 MacArthur Fellow. The MacArthur Fellowship is an \$800,000 "no strings attached" grant that is awarded to individuals in a variety of fields who have demonstrated "exceptional originality in and dedication to their creative pursuits."

## SfN Tianqiao and Chrissy Chen Young Investigator Award: Nicholas Bellono and Catherine Jensen Peña



The SfN Tianqiao and Chrissy Chen Young Investigator Award recognizes outstanding achievements and contributions that are made by young neuroscientists who lead independent research groups. The award is supported by the Tianqiao and Chrissy Chen Institute and includes a \$25,000 prize that is shared by the recipients. This year's recipients were Nicholas Bellono, PhD, and Catherine Jensen Peña, PhD. Both researchers applied interdisciplinary approaches to basic science investigations of how neural pathways in the brain are affected by factors in the environment of an organism.

## Caltech Grad Student Named as Quad Fellow



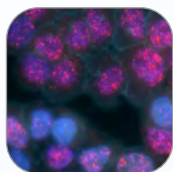
Caltech graduate student Honami Tanaka was named the 2024 cohort of the Quad Fellowship, an initiative of the Australian, Indian, Japanese, and U.S. governments that is designed to promote social good and foster intercultural ties through scientific and technological innovation. This year, the cohort included students from Southeast Asian countries, in addition to the original quad countries.

## Andersen Receives Prize for Outstanding Achievements in Neurological Research



Richard Andersen, the James G. Boswell Professor of Neuroscience and director and Leadership Chair of the Tianqiao and Chrissy Chen Brain-Machine Interface Center at Caltech, was awarded the 2024 International Prize for Translational Neuroscience by the Gertrud Reemtsma Foundation.

## BBE Researchers Receive NIH Award for Transformative Research



Three TCCI-affiliated faculty members were among a group at Caltech who received an NIH Director's Transformative Research Award from the National Institutes of Health's High-Risk, High-Reward Research Program. They were Michael Elowitz, the Roscoe Gilkey Dickinson Professor of Biology and Bioengineering and HHMI Investigator; Lior Pachter, Bren Professor of Computational Biology and Computing and Mathematical Sciences; and Carlos Lois, research professor of biology.

## Henry Lester Receives Langley Award for Basic Research on Nicotine and Tobacco



Professor of Biology Henry Lester was named the 2024 recipient of the Langley Award for Basic Research on Nicotine and Tobacco from the Society for Research on Nicotine & Tobacco (SRNT). The Langley Award Honors scientists who have made groundbreaking advances in basic nicotine research in the areas of pharmacology, neuroscience, and/or genetics.





## Research

### When Does the Brain Process Reward and Risk?



Many decisions are like this. The can of tomato paste that is reduced in price at the grocery store is a fantastic bargain if it hasn't gone bad, but if it has, you have thrown away your money. Decisions like this are a classic situation that is often considered by economists. New research from the lab of John O'Doherty, Caltech's Fletcher Jones Professor of Decision Neuroscience, and an affiliated faculty member of the TCCI for Neuroscience, aimed to understand how the brain implements such decisions by testing a computational model that proposes how representations of reward and risk are built from experience.

### Mutant Newts Can Regenerate Previously Defective Limbs



Many salamanders have the remarkable ability to regrow their own limbs and tails following an injury. How can they do this while more complex mammals such as humans cannot? Marianne Bronner, the Edward B. Lewis Professor of Biology and director of the Beckman Institute at Caltech, collaborated with Ken-ichi T. Suzuki of the National Institute for Basic Biology in Japan to show that a particular molecule that is necessary for proper development is not required for regeneration.

### Large Language Models in the Classroom



In fall 2023, Professor Frederick Eberhardt allowed Ethics & AI students to use large language models (LLMs) such as ChatGPT for their assignments, which sparked debate. Eberhardt required 'Generative AI Memos' that detailed tool use. He embraced LLMs despite some initial challenges, noting the evolution of students in their integration of human and AI-generated content. While some students produced impressive work, others struggled with machine dominance.

### Ying Mao Presents the Results of the Chinese MAGIC-MT Study at the 2024 International Stroke Conference



Ying Mao, President of Huashan Hospital and Director of the Translational Center of Tianqiao and Chrissy Chen Institute, released the results of the MAGIC-MT study on the management of non-acute subdural hematoma using liquid materials on behalf of all investigators during the closing ceremony of the 2024 International Stroke Conference in the United States.

## **Large-Scale Exome-Wide Association Analysis Identifies New Genes Associated with Sleep**



A joint team led by Jintai Yu, a researcher at the Chen Institute, identified new genes that are associated with sleep phenotypes based on exome-wide sequencing data and association analysis algorithms of almost 450,000 people. The team further analyzed the genetic contribution of rare mutations to sleep phenotypes and explained the genetic mechanisms that underlie the association of sleep with health outcomes such as cognition, neuropsychiatric disorders, and inflammation.

## **How Different Learning Modes May Explain Problem Gambling**



Caltech's John O'Doherty is on a quest to understand how human brains make decisions, how they gather evidence about their environments and their own impacts on these environments, and how they apply this information to their decision-making. Researchers in his lab examined subjects in order to determine how brains learn from positive and negative feedback, and why some brains can learn more easily and effectively than others.

## **Thinking Slowly: The Paradoxical Slowness of Human Behavior**



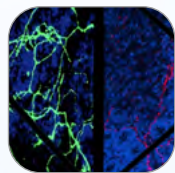
Caltech researchers have quantified the speed of human thought: a rate of 10 bits per second. However, the sensory systems in our bodies gather data about our environments at a rate of a trillion bits per second, which is 100 million times faster than our thought processes. This new study raises major new avenues of exploration for neuroscientists, in particular why we can only think one thing at a time while our sensory systems process thousands of inputs at once.

## **Improving Brain-Machine Interfaces with Machine Learning**



Researchers in Richard Andersen's lab found that BMIs can be trained to interpret data from neural activity even after the signal from an implant has become less clear by applying machine learning. The algorithm the team created to do this is called FENet (Feature Extraction Network). It can be trained using data from one patient and then used successfully on another. FENet can also generalize across different brain regions and types of electrodes and be easily incorporated into existing BMIs.

## **New Study Demonstrates How Autonomic Neurons Control Digestive Functions**



The autonomic nervous system serves as a connection between the brain and the rest of the body and is classified into two divisions: the sympathetic and parasympathetic systems. A new study from Caltech uncovers diverse neuron populations in the sympathetic nervous system and reveals how they control visceral functions in an organ-specific manner.

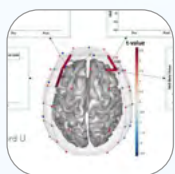
## **Transforming Neurological Care in 30 Seconds with QDG Health**



QDG Health, which was developed by Dr. Helen Bronte-Stewart at Stanford, introduces Quantitative Digitography (QDG), a 30-second finger-tapping test that uses the KeyDuo device to remotely monitor Parkinson's disease (PD) symptoms. Its AI-driven algorithm translates movement data into validated motor biomarkers and can track tremors, rigidity, and bradykinesia with a high rate of accuracy. Recently designated as an FDA Breakthrough Device, QDG Health is a game-changing innovation in precision neurology.



### **Revolutionizing ADHD Treatment Through Neuromonitoring-Guided Working Memory Interventions**



A recent Stanford University study that was published in iScience explores a neuromonitoring-guided working memory intervention for children with ADHD. Traditional treatments often fail to address the neural mechanisms of ADHD, but this research integrates real-time functional near-infrared spectroscopy (fNIRS) with cognitive training and neurofeedback as a means of enhancing working memory (WM) networks.

### **Decoding the Hidden Signals of Aggression and Arousal in the Brain**



A series of three papers from neuroscientist David J. Anderson's laboratory, two published in the Nature journal and one published in the journal Cell, reveal new insights into the neural signals that underlie internal emotional states, including aggression and sexual arousal. The studies show that the state of aggression in male mice and the state of arousal in female mice are both encoded by a common type of signal in the brain.

### **Thalamic Transcranial Ultrasound Stimulation in the Treatment of Resistant Depression**



Transcranial ultrasound stimulation (TUS) or low-intensity focused ultrasound is an emerging, non-invasive method that has millimeter spatial specificity and the ability to achieve deep subcortical neuromodulation. TUS can reversibly modulate brain networks and confer durable behavioral effects. Preliminary studies have suggested that when it is applied to classical TMS and DBS targets, TUS can improve anxiety, worry, avoidance, and mood. UCSF Chen scholar, Joline M. Fan, used dual-phased array crossbeam focusing to stimulate subcortical mood-related circuitry.

### **Understanding Online Toxicity**



In 2022, Professor of Cognitive Neuroscience Dean Mobbs started investigating the relationship between social media use and mental health and well-being. As his research program ramped up to test brain activity and physiological markers of stress during social media use, Mobbs and his colleagues, postdocs Swati Pandita, Ketika Garg, and Jiajin Zhang, constructed a theoretical model with the ability to highlight key differences between online and face-to-face communications.

### **Birds Overcome Brain Damage to Sing Again**



Every year, over 795,000 people experience a stroke. With practice, our brains have the remarkable ability to rewire and repair themselves after damage. Researchers at the laboratory of Carlos Lois, Research Professor of Biology at Caltech, and affiliated faculty member with TCCI for Neuroscience, use zebra finches to study how brains rewire themselves to regain essential functionality following damage. In a new paper, they discover that zebra finches can reacquire the ability to sing after brain damage similar to stroke victims, but without practice.

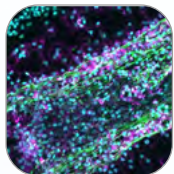
### **Autism Research Via Smartphone**



One of the most effective ways to investigate autism is the use of eye tracking. Participants were shown photos or videos and computer software records where their gaze rested. Ralph Adolphs, the Bren Professor of Psychology, Neuroscience, and Biology and an affiliated faculty member of the TCCI for Neuroscience at Caltech, has researched autism for several decades as part of a larger project that aims to understand the neuroscience of human social behavior. "Smartphone-based gaze estimation for in-home autism research" was recently published in the journal Autism Research.



## **Genetic Foundations of Regeneration Remain Elusive**



A paper titled “A Novel Approach to Comparative RNA-Seq Does Not Support a Conserved Set of Orthologs Underlying Animal Regeneration” appears in the journal *Genome Biology and Evolution*.

The research was conducted in the Caltech Labs of Lior Pachter, Bren Professor of Computational Biology and Computing and Mathematical Sciences and an affiliated faculty member with the TCCI for Neuroscience at Caltech, with Professor of Biology Lea Goentoro, and David Gold, an associate professor at UC Davis.

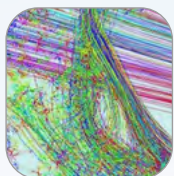
## **‘Magic Mushrooms’ Work by Scrambling Key Brain Network**



In a new study supported by the Chen Institute, researchers report that psilocybin, the active compound that is found in magic mushrooms, temporarily scrambles a critical network of brain

areas that are involved in introspective thinking such as daydreaming and remembering. People who consume this typically undergo a surreal experience where their sense of space, time, and self becomes distorted. Advocates have long argued that psychedelics can alleviate mental distress under the right conditions and a smattering of scientific studies have suggested that they may be right.

## **Neural Network Learns to Build Maps Using Minecraft**



A new paper from the Thomson lab found that neural networks can be designed to build spatial maps using a type of algorithm that is called predictive coding. The paper will appear in the journal

*Nature Machine Intelligence* on July 18.

## **Intestinal Blastocystis Linked to Healthier Diets and More Favorable Cardiometabolic Outcomes**



A team co-led by Long Nguyen, Chen Institute Department of Medicine Transformative Scholar, analyzed data from 56,989 gut microbiome samples from all over the world and found

Blastocystis to be more common in certain regions and among people with specific lifestyles and diets. Blastocystis in the gut was found to be linked to a unique bacterial profile and associated with better heart and metabolic health, in addition to lower rates of obesity and gut-related disorders.

## **Beetles Conquered Earth by Evolving Their Own Biochemical Laboratory**



Beetles are the poster child of evolutionary success: approximately 400,000 species are known, which is around 25% of all described lifeforms, and there are potentially hundreds

of thousands more awaiting discovery. What drove this remarkable success is the focus of a new study by researchers in the laboratory of Joe Parker, Assistant Professor of Biology and Biological Engineering, Chen Scholar, and director of Caltech’s Center for Evolutionary Science.

## **TCCI Lead Author on Nature Reviews Bioengineering Paper: Translation of Neurotechnologies**



Dr. Gerwin Schalk, former director of the Chen Frontier Lab, is the lead author of a paper that was published this in *Nature Reviews Bioengineering*. Schalk and his co-authors examined the strengths and

weaknesses of neurotechnologies, with a focus on scientific and engineering aspects. They discuss what is required to overcome challenges to bringing these technologies from the lab to real-world use and provide a detailed plan to help with the success of these technologies in clinical and commercial scenarios.

## **Breakthroughs in Targeted Therapies for Gliomas**



A team led by Professor Ying Mao, President of Huashan Hospital and Director of the Chen Institute in Shanghai, recently achieved major breakthroughs, developing targeted therapeutic strategies for brain tumors. Their glioma research, published in the Proceedings of the National Academy of Sciences (PNAS), introduced a novel intraoperative mass spectrometry technique that reduces the detection time for IDH mutations to just 1.5 minutes. This provides a rapid, reliable method for identifying tumor types and determining surgical boundaries in real time. In a separate study on medulloblastomas, published in Advanced Science, the team conducted single-cell analysis of 59,015 cells from 11 patient samples which led to the first chromatin accessibility map of human medulloblastoma subtypes and uncovered distinct neurotransmitter receptor expression patterns among different molecular subtypes. This offering new options for precise, personalized treatment.

## **Brain-Machine Interface Device Predicts Internal Speech in Second Patient**



Caltech neuroscientists have made promising progress toward demonstrating that a device known as a brain-machine interface (BMI), which they developed to implant into the brains of patients who have lost the ability to speak, could help such patients communicate by simply thinking rather than speaking or miming.

## **How Insects Control Their Wings: The Mysterious Mechanics of Insect Flight**



A tiny, intricate structure in the fruit fly *Drosophila melanogaster* that it uses to control its wing hinge is the subject of a new study by Michael Dickinson. His Caltech lab collected data from tens of thousands of fly wingbeats using high-speed cameras and machine learning and created a map of how fly muscles puppeteer the motion of the wing hinge as a means of creating agile aerodynamic flight maneuvers. The study is published in the journal Nature.

## **Debunking a Decades-Long Misconception About the Origin of the Vertebrate Sympathetic Nervous System**



Researchers in the laboratory of Marianne Bronner, Edward B. Lewis Professor of Biology, director of the Beckman Institute, and an affiliated faculty member with the TCCI for Neuroscience at Caltech, used lamprey to study how developmental changes may promote the progressive evolution of vertebrate traits. New research from Bronner's lab has found sympathetic neurons in lamprey, which has facilitated the need to revise the timeline of sympathetic nervous system evolution.

## **New Biomarkers for Early Diagnosis of Alzheimer's Disease**

In 2024, a research team led by Professor Jintai Yu, a Chen Institute researcher and professor of neurology at Huashan Hospital, achieved three major breakthroughs at the intersection of proteomics and AI. Their study, published in Nature Aging, showed that plasma proteomics can predict the risk of dementia up to 15 years in advance. The research was selected as a Nature "Highlight" for its scientific significance. In a separate study published in Nature Human Behavior, the team identified a novel biomarker, YWHAG, with a standalone diagnostic accuracy of 96.9%, which increased to 98.7% when combined with additional markers.

## **Development of a High-Precision Flexible BCI System**

In a significant advancement for BCI technology, the team at NeuroXess, led by Chen Institute researcher Hu Tao, developed a high-throughput, ultra-flexible gustatory neural interface for the restoration of taste. This system enables taste-like sensations through a BCI and offers a promising new approach for postoperative sensory rehabilitation in patients with tongue cancer. This research was published in Nature Communications. The team also made strides in the field of motor intention decoding. By implanting a flexible BCI with 256 conductive channels, they achieved real-time motor control with a latency of less than 60 ms. Patients could perform brain-controlled gameplay within two days post-operation, with full functional use extended to daily tasks within two weeks, showing the system's potential for aiding rapid recovery.



The Chen Institute sponsors hundreds of scientific meetings and conferences globally. In 2024, we independently organized two meetings and partnered with global leaders to organize another two strategic meetings.

## **Inaugural Chen Scholars Retreat Held October 2024:** **A New Era for AI in Medicine**



On October 17, during fall on the East Coast, The Tianqiao and Chrissy Chen Institute (TCCI) held its inaugural Chen Scholars Retreat at the Boston Public

Library. There, Chen Scholars from the Mayo Clinic, Mass General Hospital, UCSF, and Stanford who were studying the use of AI in medicine to improve patient care and outcomes gathered to explore the future of brain science and artificial intelligence.

## **2024 Chen Institute and Science Joint Conference on AI & Mental Health**



Held on November 7–8, 2024, the annual Artificial Intelligence and Mental Health conference—co-organized by the Chen Institute, Science magazine, and the

Shanghai Mental Health Center—brought together global leading scientists to explore how AI can be harnessed for the benefit of individuals and society. Speakers shared insights from diverse perspectives, engaging in in-depth discussions on critical issues such as data quality, methodological alignment, and the importance of open data sharing. The conference also looked ahead, outlining future directions for advancing the field of AI-driven mental health.

## **BCI Society –Chen Institute Joint BCI Meeting**



On December 6–7, 2024, a collaborative effort between two leading organizations, this joint BCI meeting, organized by Chen Institute and the BCI Society with

special support from Huashan Hospital of Fudan University, was successfully held in Shanghai, China. This international conference served as a platform to foster dialogue between BCI communities in Asia and around the world, while showcasing the latest scientific advancements in brain–computer interface research. Keynote presentations and expert-led discussions highlighted the progress of BCI applications both within China and globally, offering valuable insights into the emerging frontiers and future trajectory of the field.

## **Brain Health Database Construction and Ethics of Science and Technology: How to Balance Scientific and Technological Advancement with Ethics?**



On May 30, 2024, the Tianqiao and Chrissy Chen Institute (China), the Shanghai Mental Health Center, and the Brain Health Research Institute of the National Medical

Center for Mental Disease co-hosted the Seminar on Brain Health Database Construction and the Ethics of Science and Technology. The event brought together more than 30 leading experts across fields including mental health, artificial intelligence, psychology, neuroscience, data science, science and technology ethics, data security, and academic publishing. Through interdisciplinary dialogue, participants explored pressing challenges at the intersection of innovation, privacy, and ethical responsibility.

## TCCI-Neurochat 2024: Advancing Neuroscience, AI, and HCI



On June 15, 2024, the TCCI-Neurochat 2024 Academic Conference, co-organized by the Chen Institute (China) and Neurochat, was held in Shanghai.

The event spotlighted the latest advancements at the intersection of neuroscience, artificial intelligence (AI), and human-computer interaction (HCI), with a particular focus on fostering dialogue among emerging Chinese cognitive neuroscientists. The conference featured a keynote address by Professor Yanchao Bi of Beijing Normal University, along with presentations by ten early-career researchers from around the world.

## Interdisciplinary Public Community Talk: Decoding the Neurological Dialogue Between Food and the Brain



On September 6, 2024, the Chen Institute (China) and the Chinese Neuroscience Society launched a new forum series titled Brain and Food, designed to explore the

intricate relationship between taste, smell, and brain function through a cross-disciplinary lens. Experts from neuroscience, psychology, and the culinary arts came together to examine how food influences cognition and emotion at the neural level. The event featured an innovative blend of scientific talks and sensory-based demonstrations, including real-time EEG monitoring that visualized brain responses to smell and taste—offering the public a deeper, more immersive understanding of the food-brain connection.

## Data Synthesis and Next-Generation AI Models in Mental Health Conference: Unlocking New Paths in Research and Ethics



On September 10, 2024, the Chen Institute (China) and the Shanghai Mental Health Center co-hosted the conference on Data Synthesis and AI Models in Mental

Health, addressing long-standing challenges in mental health research—particularly data scarcity and privacy concerns—in the era of large-scale AI models. The event brought together over 30 leading AI researchers and clinical experts to foster interdisciplinary collaboration. With a focus on both ethical considerations and practical applications, participants advocated for the development of a cross-disciplinary evaluation framework and the refinement of data quality standards tailored to clinical needs.

## Brain-Computer Interfaces and Philosophy: An Interdisciplinary Dialogue — Building Ethical Foundations for Future BCI Technology



On September 21–22, 2024, the Chen Institute (China), in partnership with the Shanghai Academy of Social Sciences (SASS) and other institutions,

hosted the Brain-Computer Interfaces and Philosophy conference—an interdisciplinary forum examining the complex ethical and societal questions raised by BCI technologies. The event convened over 60 experts from diverse disciplines to explore the evolving intersection of technology and ethics, including the governance of emerging BCI systems, the digitization of social relationships, and new interpretations of collective consciousness.



## CNS AI+BCI Special Forum: Advancing Toward a Universal Brain Model



On September 27, 2024, during the annual meeting of the Chinese Neuroscience Society (CNS), the Chen Institute (China) hosted the AI+BCI Forum, spotlighting the evolution of brain-computer interface (BCI) technology and the pursuit of a universal brain model powered by artificial intelligence. Addressing the fragmentation of research efforts and the challenges of technological integration, the forum brought together leading experts in neuroscience and computational engineering to explore collaborative solutions. Key discussions centered on the development of large-scale EEG models, multimodal digital twin brain systems, neuromuscular dynamics modeling, and the optimization of BCI engineering through neuroscience-informed frameworks.

## Rethinking Memory: Bridging AI and the Human Brain



On November 28, 2024, the Chen Institute (China) hosted the Big Model and Human Brain Memory forum during the 3rd National Conference on Intelligent Generation of Large Models. The event focused on the limitations of long-term memory in artificial intelligence and explored brain-inspired pathways for overcoming these challenges. Experts reached a consensus that addressing AI's bottlenecks in continuous learning and reasoning requires deeper insights into the mechanisms of human memory—particularly internalization and dynamic updating. The Chen Institute emphasized the urgent need for cross-disciplinary dialogue between neuroscience and AI, calling for the development of next-generation memory models that reflect the adaptability and flexibility inherent to biological intelligence.

## Meetings we supported in 2024



### AI User Conference

📅 1/29/24  
📍 San Francisco, CA



### 3rd Neurogenesis Conference

📅 2/8/24  
📍 Cancun, Mexico



### Chen Institute Brain & Mind Lecture – Our Minds on VR

📅 2/13/24  
📍 San Francisco, CA



### The 38th Annual AAAI Conference on Artificial Intelligence

📅 2/20/24  
📍 Vancouver, Canada

**MPA** Molecular Psychiatry Association

### 9th Biennial Molecular Psychiatry Meeting

3/6/2024  
Oahu, HI

**SANS**  
Social & Affective Neuroscience Society

### Social & Affective Neuroscience Society Conference

4/10/2024  
Toronto, Canada

**USC** University of  
Southern California

### USC-Chen Institute Frontiers Forum

4/24/2024  
Pasadena, CA

**NEURO TECHNOLOGY CENTER**  
COLUMBIA UNIVERSITY

### Neuronal Ensembles 2024

5/2/2024  
Virtual

**ICLR**

### Twelfth International Conference on Learning Representations - (ICLR)

5/7/2024  
Vienna, Austria

**CHI 2024**  
Surfing the World  
11-16 May 2024

### CHI Human Computation Interaction

5/11/2024  
Oahu, HI

**NeuroPSI**  
PARIS-SACLAY INSTITUTE OF NEUROSCIENCE

### The NeuroPSI- Chen Institute Joint Conference On Brain, Behavior & Beyond

5/16/2024  
Saclay, France

**Société  
des  
Neurosciences**

### Societe des Neurosciences - Neuroscience and Artificial Intelligence

5/23/2024  
Bordeaux, France

**CVPR**  
SEATTLE, WA JUNE 17-21, 2024

### The IEEE/CVPR Conference on Computer Vision and Pattern Recognition 2024

6/17/2024  
Seattle, WA

**CAI** 2025 IEEE Conference  
on Artificial Intelligence

### The IEEE/ Conference on Artificial Intelligences

6/25/2024  
Singapore

**FENS** Federation of  
European  
Neuroscience  
Societies

### FENS Forum 2024

6/25/2024  
Vienna, Austria

**SIGIR**  
2024  
Washington, D.C.

### SIGIR 2024

7/14/2024  
Washington, DC



#cpconf2025

Computational  
Psychiatry  
Conference

7/16/2024  
Minneapolis, MN

第46回日本神経科学大会  
The 46th Annual Meeting of the Japan Neuroscience Society

The 47th Annual  
Meeting Of  
The Japanese  
Neuroscience  
Society

7/24/2024  
Fukuoka City, Japan

ACL 2024  
Bangkok, Thailand

The 62nd Annual  
Meeting of the  
Association for  
Computational  
Linguistics

8/11/2024  
Bangkok, Thailand

Ai4

Ai4

8/12/2024  
Las Vegas, NV

BOSTON  
UNIVERSITY

Neuroscience  
of the Everyday  
World

8/26/2024  
Boston, MA



ARDD 2024.  
The Tenth Aging  
Research And  
Drug Discovery  
Meeting

8/26/2024  
Copenhagen, Denmark



European  
Conference  
on Computer  
Vision

9/29/2024  
Milan, Italy

SfN SOCIETY for  
NEUROSCIENCE

Neuroscience  
2024

10/5/2024  
Chicago, IL

Massachusetts General Hospital  
Founding Member, Mass General Brigham

MGH and Chen  
Institute Joint  
Symposium for  
AI

10/16/2024  
Boston, MA

上海市精神卫生中心  
SHANGHAI MENTAL HEALTH CENTER

Science

AI & Mental  
Health Meeting  
with SCIENCE  
Magazine

11/7/2024  
Shanghai, China



BCI Society and  
Chen Institute  
Joint BCI  
Meeting

12/6/2024  
Shanghai, China





NeurIPS



12/8/2024  
Vancouver, Canada

## 2024 Chen Institute (China) Conference List



### Jaspers Mental Health Book Club No.11

 1/14/24  
12/22/24  
 Online

### TCCI Researcher Annual Meeting

 3/23/24  
 Shanghai



### Unicase Meeting (Dr. Xu's conference/ special casecommunity presentations/closed forums)

 5/23/24  
5/25/24  
 Online



### Brain Health Database Construction and Ethics of Science and Technology

 5/30/24  
 Shanghai

### Neurochat #4

 6/15/24  
 Shanghai



### Puci Forum - New advances in computer psychiatry: data, AI and mental health

 7/12/24  
7/14/24  
 Shanghai



### Brain and Food Community Talk

 9/6/24  
 Shanghai



### Data Synthesis and Next- Generation AI Models in Mental Health Conference

 9/10/24  
 Shanghai



### Brain-Computer Interfaces and Philosophy: An Interdisciplinary Dialogue — Seminar

 9/21/24  
 Shanghai

### Chinese Neuroscience Society 17th National Conference Special Forum: BCI+AI

 9/27/24  
 Suzhou

### Chinese Information Processing Society of China 2024 Annual Academic Conference 3rd National Conference on Intelligent Generation of Large Models - Rethinking Memory: Bridging AI and the Human Brain

 11/28/24  
 Jiaxing





## Unique Case

### UniCaseHub: Advancing Rare Case Research Through an Innovative Ecosystem

In May 2024, the Chen Institute launched UniCaseHub—an online platform dedicated to collecting and sharing unique clinical cases in brain disease. Designed to crowdsource rare and exceptional cases from physicians worldwide, the initiative aims to uncover diagnostic blind spots and offer fresh perspectives on brain function and disorders. To guide the selection process, the community assembled a panel of 11 leading experts from top neurological and psychiatric institutions in China and abroad. During the platform's first two rounds of submissions, 29 cases were received, with 5 high-value cases selected for the initial round of funding. In parallel, UniCaseHub also introduced the Patient Care Program to extend support for individuals affected by rare brain conditions.

# Media

## NextQuestion

To explore new dimensions of intelligence and promote dialogue between brain science and artificial intelligence, NextQuestion—a Chinese science media platform affiliated with the Tianqiao and Chrissy Chen Institute—continued to grow its influence in 2024. Over the course of the year, the platform published 566 articles and engaged with 2,188 pieces of cutting-edge scientific literature, contributing to a total output of more than 3.2 million words.

Among its key initiatives, NextQuestion launched two flagship publications: NextQuestion Insight, an exclusive internal briefing focused on notable discoveries in neuroscience and AI; and Next Question 20w+, a curated print journal featuring some of the platform’s highest-quality articles.

On WeChat, the platform received over 730,000 reads, 83,000 shares, 35,000 saves, 10,000 audio plays, and 784 reader comments. Its content was reprinted more than 200 times by prominent outlets including Mr. Science and Tencent Research Institute, and select articles were featured in academic journals such as Internet Frontiers.

In 2024, NextQuestion achieved its highest-ever ranking—No. 109—on China’s Academic Personal Media Index, surpassing several established brain science media accounts. It was also named “Popular Creator of the Year” by NetEase, recognizing its impact on science communication and public engagement.





## The Grand Mirror Studio

In 2024, the Chen Institute (China) launched Grand Mirror, a science communication video platform focused on using AIGC (AI-generated content) technology to produce engaging and accessible content on brain science. Over the year, the team released 35 videos across eight major platforms, reaching audiences in three languages—Chinese, English, and Spanish—and generating more than 12 million total views and 1.6 million user interactions.

Among the standout productions were Lingxi and The New Era of Consciousness, both written and narrated by Institute founder Mr. Tianqiao Chen. These videos alone attracted millions of views and resonated widely with audiences. Several Grand Mirror videos ranked among the top 30 on WeChat's "Technology and Internet" influencer list, with the highest ranking at No. 5—outperforming numerous accounts with followers of over 10 million.



# Original Content

## Will AI Help Solve the Global Mental Health Crisis?

The global mental health crisis has left over two-thirds of affected individuals untreated. AI technologies are emerging as transformative tools for addressing this issue. At Cincinnati Children's Hospital, AI is used to analyze linguistic patterns as a means of identifying suicidality with 90% accuracy and detecting anxiety months earlier than traditional methods. Dr. Frederike Petzschner of Brown University highlights the potential of AI to provide personalized care and enhance treatment predictions. Advanced platforms such as Woebot and Happify deliver AI-driven cognitive therapy and mindfulness exercises. However, challenges remain in building robust datasets, as there is a lack of clear diagnostic biomarkers in psychiatry, which limits the ability of AI to fully integrate into mental health care solutions.



[Read the full article](#)



## Researchers Are Turning to AI to Turbo-Charge Scientific Discovery

AI is revolutionizing scientific discovery and has enabled breakthroughs that would have taken many decades to achieve otherwise. Researchers are now using AI to tackle complex problems such as protein engineering, material synthesis, and understanding brain function. For example, AI-powered tools have been pivotal in the development of next-generation vaccines and the exploration of neural mechanisms in both artificial and biological systems. The Chen Institute & Science Prize for AI-Accelerated Research recognizes early-career scientists who have pushed the boundaries of knowledge with AI. Supported by TCCI, this award aims to accelerate the transformative potential of AI across various scientific fields and offers \$50,000 in prizes to encourage young researchers to explore new frontiers in life and physical sciences.



[Read the full article](#)





## Is Background Noise the Key to Beating Alzheimer's?

This article discusses the innovative SoundMind project, which is led by Dr. Alexander Khalil and Dr. Gráinne McLoughlin and explores the use of Augmented Audio Reality (AAR) for the treatment of neurodegenerative diseases such as Alzheimer's. The project was inspired by Khalil's experience with his father, who had dementia. He developed an AAR algorithm that can subtly alter background noise to induce neuromodulation – a process that helps rewire the brain's electrical rhythms. Supported by the Tianqiao and Chrissy Chen Institute, SoundMind aims to create wearable technologies that can slow or even reverse the progression of Alzheimer's through the continuous delivery of therapeutic audio stimuli. Initial findings are promising and future plans include clinical trials and potential applications for broader conditions and devices.



[Read the full article](#)



Chen Institute & Science  
Prize for  
**AI Accelerated Research**

## AI Prize

Fostering innovation and celebrating advancements in AI that help to transform research and ultimately improve lives, we are inviting young scientists from across the globe to showcase their AI-driven projects, solutions, and ideas with a 1,000 word essay.

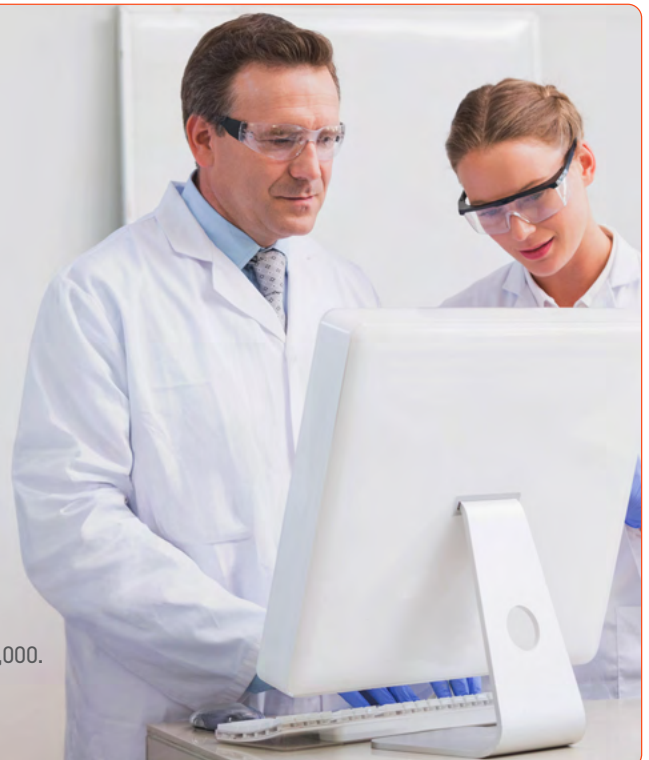
### The Grand Prize Winner

The winner will have their winning essay published in Science, both in print and online, in July 2025. They will receive a 5-year digital subscription to Science and they will also be awarded a cash prize of US \$30,000 plus travel and accommodation expenses for the awards ceremony later in 2025.

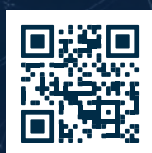
### Runner(s)-Up

Up to two runner(s)-up will have their essay published in Science online. They will also receive a 5-year digital subscription to Science and US \$10,000.



More information at [www.cheninstitute.org/prize](http://www.cheninstitute.org/prize)



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