



CHEN TIANQIAO
& CHRISSY
INSTITUTE

2021

ANNUAL REPORT

Founders Letter

Dear Friends,

While 2021 proved to be another challenging year around the world, we're thankful for so many things. Beyond the introduction of vaccines and the protection they offer, we were happy to continue growing our circle of friends, partners, and advisors in the scientific community and to observe just how resilient the world can be when faced with such challenges.

Last year marked exciting progress for us on multiple fronts. In May, for example, we launched a cognition training game with Tencent Games. In July we opened the Chen Frontier Lab for AI and Mental Health at Shanghai Mental Health Center and in December, we celebrated the fifth anniversary of the Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech.

We invite you to read all about these developments and more in this year's annual report.

Thank you for your continuing support.

Warmly,



Tianqiao Chen



Chrissy Luo





Our Vision

Improving the human experience by understanding how our brains perceive, learn and interact with the world.

Supporting brain research focused on:

- Understanding the sensation-perception mechanisms and related systems of memory, attention, learning and expectations.
- Advancing discoveries and applications that minimize the negative and enhance the positive impact of perceptions.

The ability to shape and refine perception will help us better understand our world, be it through more targeted therapies to alleviate negative psychological states such as depression or seamless brain-machine interfaces to enhance the utilization of mental capacity and capabilities.





Tianqiao and Chrissy Chen Institute for Neuroscience @ Caltech

Over the past five years, the Chen Institute for Neuroscience at Caltech has emerged as a focal point for interdisciplinary and collaborative research. With a mission to bring people from diverse backgrounds together, the Institute has fostered innovative, interdisciplinary approaches to studying the brain on a fundamental level.



David Anderson: Leading Seven Interdisciplinary Centers

David Anderson is the Director of the Tianqiao and Chrissy Chen Institute for Neuroscience and interim Director, T&C Chen Center for Systems Neuroscience. He is also Caltech's Seymour Benzer Professor of Biology and an investigator of the Howard Hughes Medical Institute. He received his AB from Harvard University (biochemical sciences, summa cum laude) and his PhD in cell biology from the Rockefeller University, where he trained with Nobel Laureate Günter Blobel, and did his postdoctoral training at Columbia University with Nobel Laureate Richard Axel.

Anderson has made it a priority to build an interdisciplinary community at Caltech so that the Institute can, in his words, “do science that matters”. Biologists, computer scientists, and psychologists are all very welcome, Anderson says — but so too are philosophers, astronomers, applied physicists, and even geologists.

Anderson's own research focuses on the study of neural circuits that control emotional behaviors in animal models. He has been at the forefront of developing and applying new technologies for neural-circuit manipulation, such as optogenetics and pharmacogenetics, to the study of emotional behaviors such as fear, anxiety, and aggression in both mice and the fruit fly *Drosophila melanogaster*. His work in mice is currently focused on limbic circuits, including the amygdala and hypothalamus, and their role in aggression.

A New Center Focused on Data Sciences and AI

Celebrating its five-year anniversary, the Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech released a special anniversary publication and announced in December the creation of the Center for Data Science and Artificial Intelligence (AI). The new Center, which will be co-directed by renowned Professors Lior Pachter and Pietro Perona, was made possible with the support of Tianqiao Chen and Chrissy Luo. Its mission is to help young neuroscientists acquire and improve the skills needed to analyze and interpret the vast amounts of data generated by their lab experiments.

“We have seen the Institute achieve tremendous momentum since it was created,” said Chrissy Luo, co-founder of the Tianqiao and Chrissy Chen Institute (TCCI®). “Caltech continues to push the envelope and now this program, which will help young neuroscientists work better with the data they’re generating in the lab, will help to accelerate their work over the next five years.”

“Emerging neurotechnologies are generating enormous datasets,” explains David J. Anderson. “The analysis and interpretation of such ‘big data’ is a real and present challenge to the researchers who generate it, many of whom are not formally trained in data science or machine learning.”

The new Center will run a number of programs including an annual four-week immersive workshop, a Chen visiting Scholar program to bring experts from other institutions in to inject a breadth of perspective and expertise, paid summer internships at academic or non-profit research centers specializing in data science and A.I. and a graduate student stipend support for second-year students whose projects are dependent on data science and AI.



Lior S. Pachter

Lior Pachter is a computational biologist and the Bren Professor of Computational Biology at Caltech. He has widely varied research interests including genomics, combinatorics, computational geometry, machine learning, scientific computing, and statistics. In 2017, Pachter was elected a Fellow of the International Society for Computational Biology (ISCB). Prior to Caltech, he was on the faculty of University of California where he was given the Sackler Chair in 2012.



Pietro Perona

Pietro Perona is the Allan E. Puckett Professor of Electrical Engineering and Computation and Neural Systems at Caltech and director of the National Science Foundation Engineering Research Center in Neuromorphic Systems Engineering. He is known for his research in computer vision and is the director of the Caltech Computational Vision Group. Perona was a postdoc fellow at University of California, Berkeley in 1990 and from 1990 to 1991, he was a postdoc fellow at MIT.

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Recognizing Excellence

As in year's past, Caltech researchers were recognized for their innovative work.



David Van Valen Named a Moore Inventor Fellow

David Van Valen, assistant professor of biology and biological engineering and affiliated faculty member of the Chen Institute for Neuroscience at Caltech, was named a 2021 Moore Inventor Fellow in October. One of five fellows named this year by the Gordon and Betty Moore Foundation, Van Valen received \$825,000 to “further the development of new tools and technologies that promise to accelerate progress in the foundation’s areas of interest: scientific discovery, environmental conservation, and patient care,” according to a release from the foundation.

Van Valen’s research aims to understand how living systems store, process, and transfer information, and how problems with this biological information processing are related to human diseases.



Mikhail Shapiro Named HHMI Investigator

Mikhail Shapiro, professor of chemical engineering and affiliated faculty member of the Chen Institute for Neuroscience at Caltech, was named a Howard Hughes Medical Institute (HHMI) investigator in October. He is one of 33 scientists named as investigators this year by HHMI, chosen for his work using sound waves to image and control the behavior of cells within living tissues.

Shapiro’s research has taken a well-established imaging method and reimaged it. The work makes use of so-called reporter genes—specialized sections of DNA inserted into the genome of a cell as a marker.

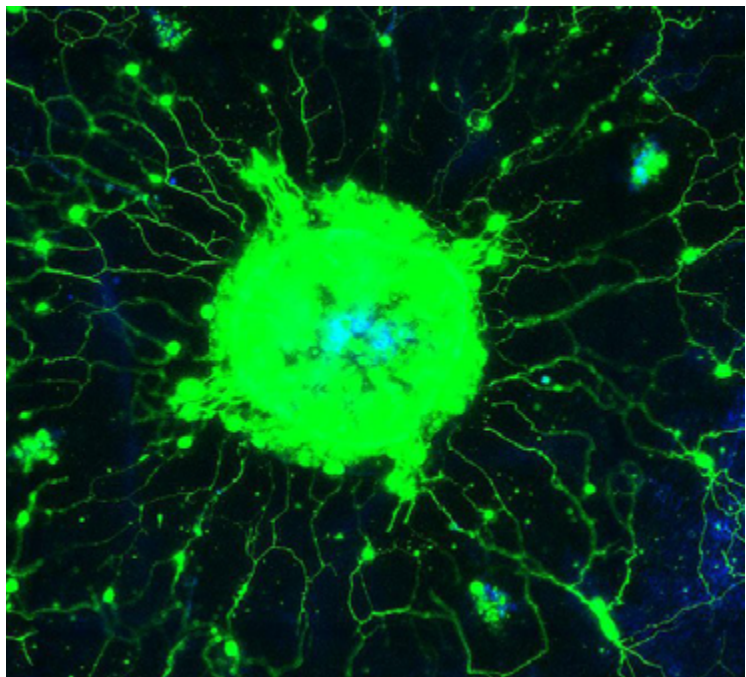


But wait, there’s more: Chen Neuroscience Research Building Awarded Leed Gold Certification

In August 2021, the Chen Neuroscience Research Building at Caltech also received an award, LEED Gold certification for its numerous sustainable features. This hub for studying the brain consumes nearly 30 percent less energy than a typical lab building. It also features native and drought-resistant vegetation and serves as a model for resiliency with a one-megawatt fuel cell able to power the entire building independently from the electric grid.

Caltech Research Highlights

The Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech is prolific, producing a large volume and variety of research throughout the year. A sampling is below but you can read more about Caltech's research on the Chen Institute website [here](#).



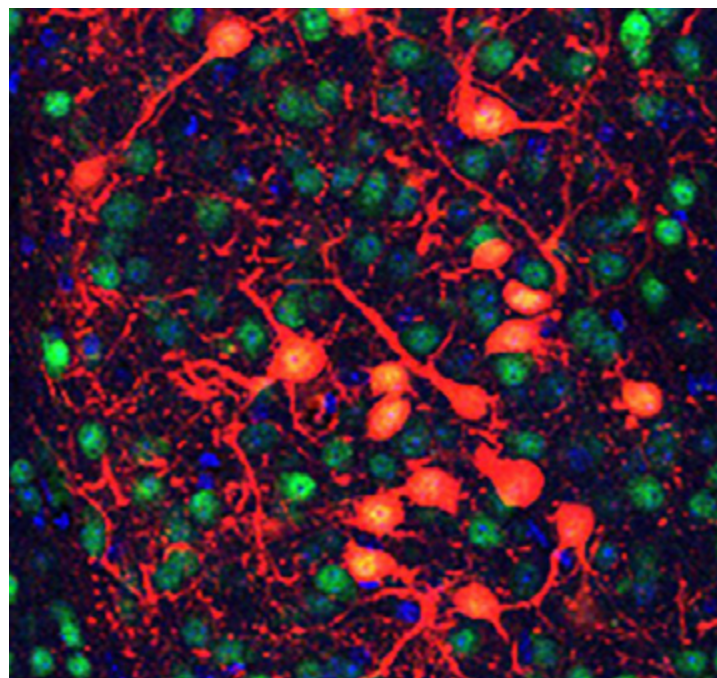
How to Read a Jellyfish's Mind

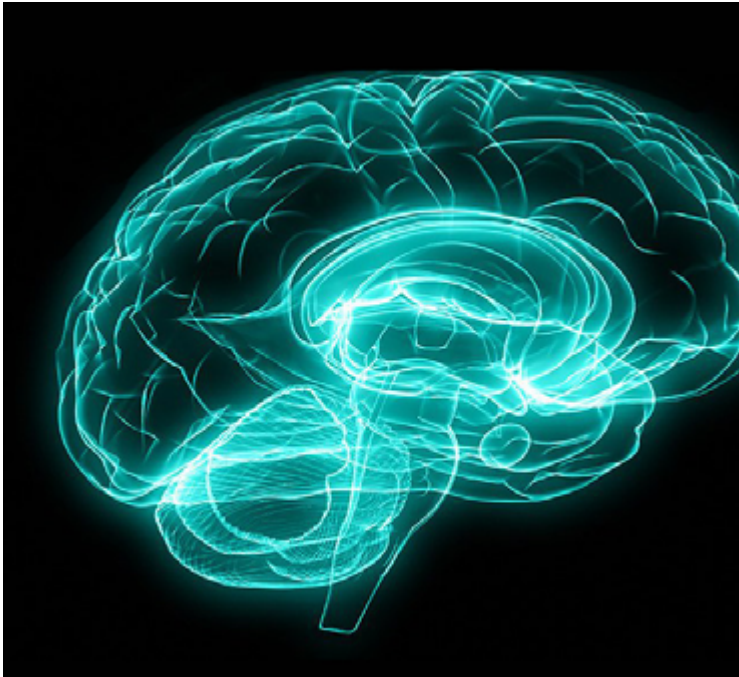
The human brain has 100 billion neurons, making 100 trillion connections. Understanding the precise circuits of brain cells that orchestrate all of our day-to-day behaviors—such as moving our limbs, responding to fear and other emotions, and so on—is an incredibly complex puzzle for neuroscientists. But now, fundamental questions about the neuroscience of behavior may be answered through a new and much simpler model organism: tiny jellyfish.

A paper describing this new research from David J. Anderson, Seymour Benzer Professor of Biology, Tianqiao and Chrissy Chen Institute for Neuroscience Leadership Chair, Howard Hughes Medical Institute Investigator, and director of the Tianqiao and Chrissy Chen Institute for Neuroscience appears in the journal *Cell* on November 24.

Identifying the Neural Link Between Gut Bacteria and Social Behavior in Mice

New research conducted primarily in the laboratory of Sarkis Mazmanian, Luis B. and Nelly Soux Professor of Microbiology, HRMI Investigator and affiliated faculty member of the Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech, shows that germs living inside our bodies could be affecting our ability to socialize and make friends...at least for mice. The new study, which appeared in the journal *Nature* on June 30, has identified a specific circuit of neurons that is directly influenced by the gut microbiome and is subsequently responsible for antisocial behaviors in mice that lack a gut microbiome.



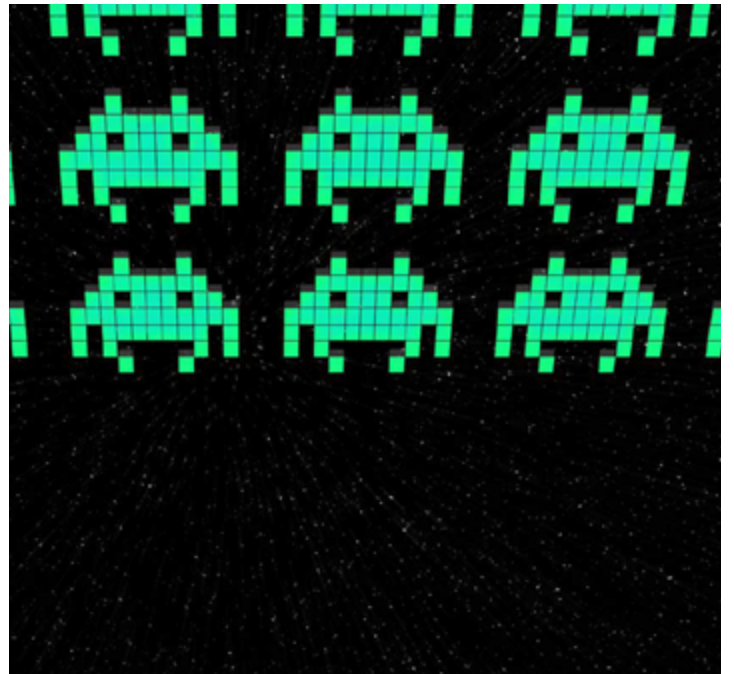


Recording Brain Activity with Laser Light

Lihong Wang, Bren Professor of Medical Engineering and Electrical Engineering at Caltech, in collaboration with researchers at the University of Southern California, has demonstrated for the first time a new technology for imaging the human brain using laser light and ultrasonic sound waves. The technology, known as photoacoustic computerized tomography, or PACT, has been developed as a method for imaging tissues and organs.

Neural Networks Playing Video Games Teach Us About Our Own Brains

A new study from Caltech compares brain scans of humans playing classic Atari video games to artificial intelligence (AI) networks that have been trained to play the same games. The research was led by graduate student Logan Cross, in the laboratory of TCCI®-affiliated Professor of Psychology John O'Doherty and found that the activity in the artificial "neurons" in the AI looked quite similar to activity in the human brain. A paper describing the research appeared in the journal *Neuron* on December 15.







Tianqiao and Chrissy Chen Institute @ Shanghai

The Tianqiao Chen Institute for Brain Health was established in April 2018 in partnership with the Shanghai Zhou Liangfu Medical Development Foundation and Fudan University-affiliated Huashan Hospital, focusing on the research and treatment of brain diseases such as neurodegenerative diseases. Shanghai Mental Health Center then joined the alliance which focuses on mental health and brain disease treatment.

Professor Mao Ying, MD: a much respected Hospital President and neurosurgical expert

Professor Mao Ying is the Director of the Tianqiao and Chrissy Chen Institute for Translational Research and President of Huashan Hospital. Concurrently, he is Designate President of the Chinese Neurosurgical Society and President of the Congress of Neurological Surgeons of Shanghai Medical Doctor Association. "When I discovered that we as neurosurgeons had the privilege of touching the brain, I realized that it is our responsibility to engage in brain science research and to study the benefits of treating, restoring and reshaping the brain."

Professor Mao received his Medical Doctor's Degree at Shanghai Medical University and was a postdoctoral researcher at the Crosby Neurosurgical Laboratories, University of Michigan. In 2017, he was conferred the "Shanghai Medical Excellence Contribution Award." His areas of research include cerebrovascular disease, minimally invasive brain tumor microsurgery for brain tumors and functional neurosurgery.



Unbound from Traditional Constraints: Chen Frontier Labs

The first Chen Frontier Lab for Applied Neurotechnology, located on the Huashan Hospital Hongqiao Campus near Shanghai, was announced in October 2020. A second Chen Frontier Lab for AI and Mental Health, at Shanghai Mental Health Center, was announced in July 2021.

The well-resourced labs are free from the conventional constraints of academic labs. Their mission is to use technology to improve and enrich people's lives and they uniquely focus on the end-to-end process of identifying, validating, and then incubating neuroscience research. The Chen Frontier Lab for Applied Neurotechnology will do this by supporting the development of new technologies and protocols. Focused on improving evaluation and interventions for mental diseases of large populations using big data and AI-powered analysis of individual behaviors and symptoms, the ultimate goal of the Chen Frontier Lab for AI and Mental Health is to develop novel ways to improve mental health for the general public.

"Tianqiao and I care very much about using new technologies to improve mental health for the public and we hope to find more effective treatments through continuous investment," TCCI cofounder Chrissy Luo said.



Passion & Power: Tianqiao and Chrissy Chen Investigators

Chen Investigators are accomplished academic experts who help to advance the Chen Frontier Labs' exciting mission by contributing their leadership and expertise during a one-year sabbatical from their home institution. These experts, chosen by an international selection committee, are successful mid-career engineers or scientists (typically at the Associate Professor level) who have substantial technical expertise related to the Chen Frontier Lab's core areas of focus. Once appointed, they can hit the ground running with projects that have been set up and are ready-to-go or those that may already be underway. Chen Investigators will oversee and participate in technology validation efforts that can lead to commercial incubation. Thus, while the Chen Investigator may write academic papers about these validation efforts, their explicit goal is technical and clinical validation of their ideas prior to potential commercialization.

Recognizing Meaningful Contribution

TCCI® Investigator Wins Sail Award at World Artificial Intelligence Conference 2021

On July 8th, Professor Tao Hu, Deputy Director and Researcher at the Shanghai Institute of Microsystems and Information Technology under the Chinese Academy of Sciences and Investigator at the Tianqiao Chen Institute for Brain Health, won a SAIL (Super AI Leader) Award at the World Artificial Intelligence Conference 2021 for his achievements with a brain-computer interface which is non-invasive, implanted and high-throughput. The system is composed of four parts, namely, a front-end, flexible deep electrode, a middle-end transmitter, back-end EEG collection and a transmission module and biocompatible encapsulation material.

In October last year, Tao Hu and his team demonstrated the system, Which was supported by TCCI® in China at the inauguration ceremony for the TCCI® Frontier Lab for AI and Mental Health.

An Outstanding Contribution Award

Earlier last year, Professor Tao Hu also won an Outstanding Contribution Award for Young Scientists in Shanghai. Hu has been long been devoted to researching on new micro nano sensor technology and he has made innovative accomplishments in interdisciplinary fields including brain-machine interface (BCI), AI sensor chip, and bioelectronics. He has published more than 70 articles in SCI journals including Science and Nature and has over 20 patent applications.



Shanghai Research Highlights

Researchers affiliated with the Tianqiao Chen Institute for Brain Health in Shanghai made significant contributions to the body of brain and mind research throughout 2021. A handful of articles is featured below. Read more on the Chen Institute website [here](#).

Identifying the association between physical activity and depression among community-dwelling older adults

Tianqiao and Chrissy Chen Institute (TCCI®) investigator Professor Huang Yanyan recently co-authored an article published in BMC Geriatrics. The study supported by TCCI®, revealed a correlation between the amount and patterns of physical activity and depression among the elderly community in Shanghai. The research suggests that both quantity and patterns of physical activity are associated with depressive symptoms among older, community-dwelling adults and that this population should be encouraged to increase their quantity of physical activity to reduce the risk of depression.



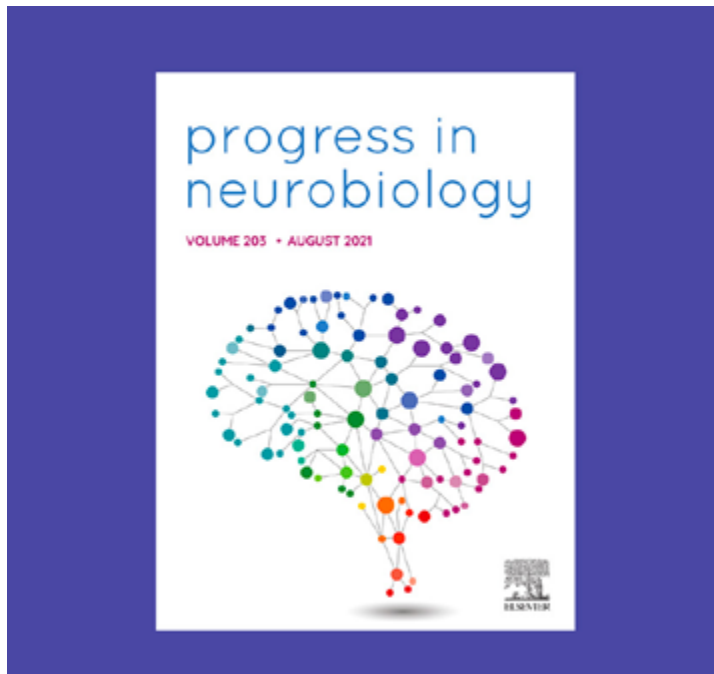
TCCI® Investigator Professor Yu Jintai's Team Discovers Correlations between Environmental Factors and Longevity

Professor Yu Jintai, a researcher from the Neurology Department of Fudan University-affiliated Huashan Hospital and a TCCI® Investigator, and his team revealed for the first time a correlation between longevity and controllable environmental factors. Their findings, published in BMC Medicine, cited many “firsts”. For example, that venous thromboembolic diseases are crucial factors influencing longevity, that high body fat mass and body fat percentage are bad for longevity, that not eating sugary foods or drinking sugary beverages is not beneficial for longevity and that being taller than average during adolescence is adverse to longevity.



Why is it so hard to quit drugs? Revealing the neurological mechanisms behind drug cravings

TCCI® investigator, Professor Yuan Tifei from Shanghai Mental Health Center recently worked with Professor Luo Wenbo from Liaoning Normal University on research published in Molecular Psychiatry that revealed key findings related to the neurological mechanisms behind drug cravings. Previous studies both in laboratory animals and humans have reported that abstinence induces incubation of cue-induced drug craving. However, current experimental procedures do not incorporate the temporal dynamics of neuropsychological measures and associated electrophysiological activities. To address this, Yuan and Luo used high-density EEG signals as a rapid, inexpensive, and noninvasive measure of cue-induced craving potential. Their findings will help to identify those with high risks of relapse and carry out preliminary interventions and treatments.



Neural Circuitry Underlying REM Sleep

Professor Zhili Huang, a researcher from Fudan University, president of the Chinese Sleep Research Society and a Tianqiao and Chrissy Chen Institute (TCCI®) Investigator, recently published a paper titled “Neural Circuitry Underlying REM Sleep: A review of the literature and current concepts” in the journal Progress in Neurobiology. The paper discusses several types of rapid eye movement (REM) sleep including a reciprocal interaction model, limit-cycle model, flip-flop model, and a model involving γ -amino butyric acid, glutamate, and aminergic/orexin/melanin-concentrating hormone neurons. He also summarizes two common disorders related to REM sleep, REM sleep behavior disorder and narcolepsy.



Supporting the Community

The Tianqiao and Chrissy Chen Institute has long believed that bringing diverse minds together, whether for in-person or online meetings, is one of the most effective ways to advance brain and mind science. We are therefore very happy to support a wide array of meetings, from national conferences to more intimate meetings.

2021 saw a couple of firsts for us in the meeting space. In October, we partnered with SCIENCE magazine to host the inaugural, annual conference series described below and in China, we started the ZNext Webinar Series.



SCIENCE | TCCI Conference: Cutting Edge Research in Cognitive Science

Last year, we launched what will be an annual event focused on different aspects of cognition. Cognitive science has made enormous progress in the last decade. What was considered science fiction only a few years ago has rapidly been turned into standard methods and daily routine in the leading laboratories around the world. This reflects the modern interdisciplinary scientific approach to tackle some of the most profound questions concerning the human mind and human cognition. It is also thanks to a number of revolutionary technologies that have recently become available. The October conference highlighted two areas that have seen major advances in the last years: the first day was focused on Affective Computing/ Emotion/Facial Expression and the second was Machine Learning/ Speech/ Language.





ZNext Webinars: Facilitating important and timely discussions

In July last year, the Chen Institute held its first ZNext Webinar. Named on the theme of “after A to Z, what comes next?” the series brings a mix of experienced experts and young scientists together to discuss the latest science across a variety of topics.

- The inaugural webinar examined how we understand cognition and behaviors in a real-world context and was hosted by Doctor Luo Yi, Research Associate at Virginia Polytechnic Institute and State University.
- In September, Li Yuanning, a post-doc at the Edward Chang Lab of the University of California, San Francisco, facilitated a roundtable discussion on “how to achieve two-way communications via brain computer interfaces.”
- In early October, Geng Haiyang, a postdoctoral fellow in the Department of Psychology, University of Hong Kong, hosted a ZNext Webinar which explored how computational psychiatry helps with the diagnosis and treatment of mental illness.
- The last webinar in 2021, was hosted by Doctor Cui Wenwen of Basic Medicine from Shanghai Jiaotong University’s School of Medicine and examined the work of 2021 Nobel Prize winners, Professors David Julius and Ardem Patapoutian.



9th International
Conference on Affective
Computing & Intelligent
Interaction (ACII 2021)

The 14th Annual Meeting
of Chinese Neuroscience
Society (CNS 2021)



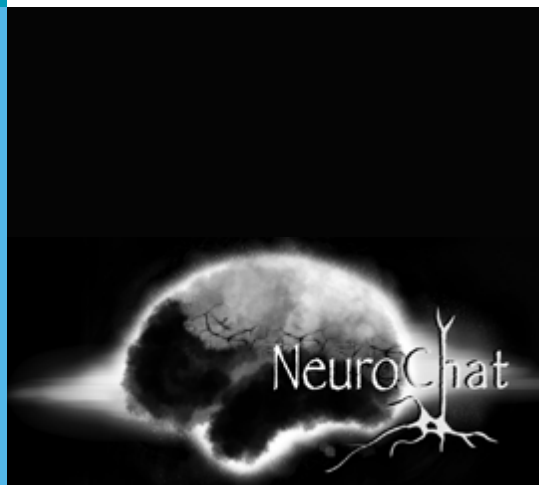
These are just some of the
scientific meetings around the
world that TCCI® sponsored in
2021.

To learn more, visit
[cheninstitute.org/newsroom/
meetings/](https://cheninstitute.org/newsroom/meetings/)

**20TH WORLD CONGRESS
OF PSYCHOPHYSIOLOGY**



44th Annual Meeting of
the Japan Neuroscience
Society (JNS)



Cogsci 2021



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