

Autism:

From Synapses to Circuits

Neuroscience News

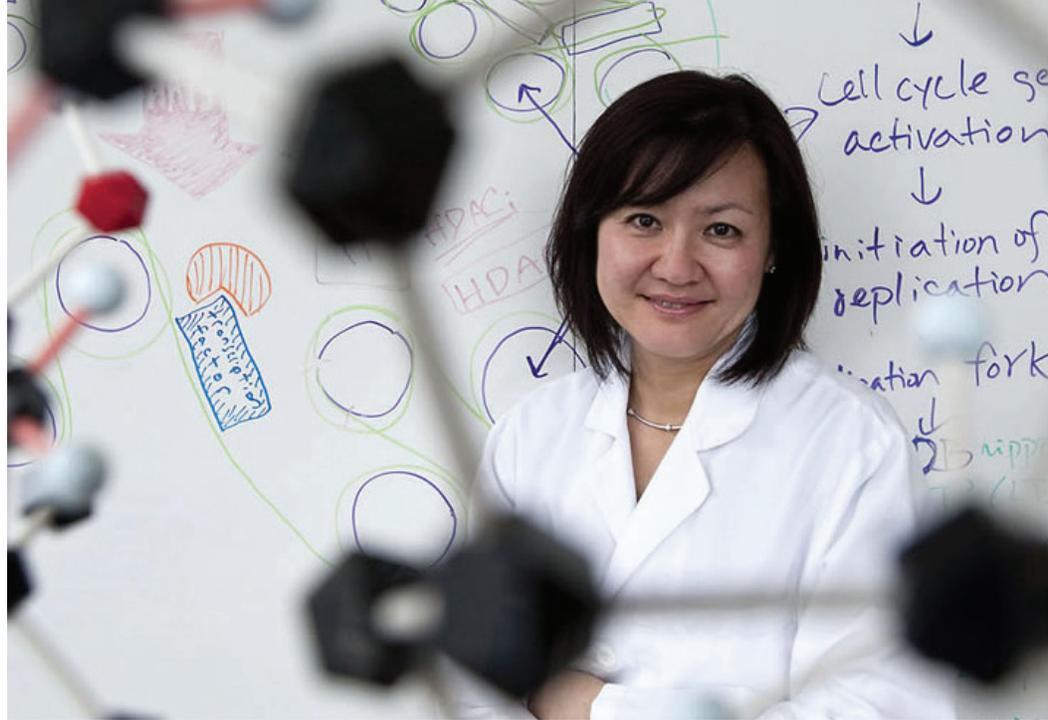


SUMMER 2017



THE PICOWER
INSTITUTE
FOR LEARNING AND MEMORY

Front Cover - A closeup look at a group of synapses as they release neurotransmitters across the synaptic cleft.



Director's Message

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Dear Friend,

Autism Spectrum Disorder, or ASD, is not easy to understand. Children, young people, and adults who have ASD interact with the world in ways that look, feel, and sound markedly different than those of us who don't,

But at the Picower Institute for Learning and Memory, we are working hard to try to understand the world and mind of those affected by ASD. In this issue of Neuroscience News, we explore a few different areas of research happening here that aim to unravel the mysteries of ASD.

Much of this research is focused on what happens at the synapse—the communications system that lets neurons talk to each other. Several Picower faculty are looking at the synapse from various angles and asking questions about whether there are occurrences here that are unique and common in those with ASD. Among the questions being explored are:

- Are there clues in this region that would help us understand the repetitive movements or the intellectual disabilities that can occur in some with ASD?
- Likewise, is there a link between the hyperactivity found in some with ASD and excessive—or hyper—levels of synaptic activity?
- And finally, if we can identify proteins that play a role in these behaviors, can we then target those proteins with pharmaceuticals in such a way that they can have an impact?

The future of research into ASD can be seen in another area that we are exploring at Picower – to look at the neural circuitry, or connections between brain regions. One focus is to look at the interactions between two emotion centers of the brain, the amygdala and the hippocampus.

I invite you to read more about what Picower faculty are doing to expand our understanding of ASD, and to narrow in on possible therapeutic targets or ways to alter the neural circuitry in ASD to make a positive difference in the lives of those affected.

In every issue, we include notes about new research published and awards received by Picower faculty. It's such a regular feature for us that I sometimes don't pause to call attention to how much these recognitions are testimony to the truly extraordinary brain trust we have here at Picower. I hope you'll agree after reading through this section.

We close this issue with a very special story about a really special friend to us and MIT: Eduardo Elejalde-Arena. Eduardo tragically and unexpectedly lost his daughter, Natalia, this past winter. His Myrtlewood Foundation, which is supporting our work here, is helping to advance our research into schizophrenia and bi-polar disorder. In this issue, we are honored and moved by Natalia's story that he shares with us, and the renaming of his foundation in her memory to raise awareness about the need to support research into mental disorders.

LI-HUEI TSAI, DIRECTOR



The Future of Autism Spectrum Disorder Research

An artist rendition of the connectivity and complexity of the human brain.

AUTISM SPECTRUM DISORDER, OR ASD, IS a neurodevelopmental disorder characterized by two types of symptoms -- social impairment and repetitive behavior.

As a spectrum disorder, ASD is graded from low to high severity. Someone with low severity ASD can lead a perfectly healthy life, while those with a high severity form of the disorder may experience crippling symptoms such as anxiety, sleeping deficit, gastro-intestinal problems, intellectual disabilities, and self-injurious behavior.

Although research has greatly helped to improve the diagnosis of ASD, there are a lack of therapeutics to treat the severe symptoms of ASD. Researchers at the Picower Institute for Learning and Memory are attempting to better understand the complex disorder.

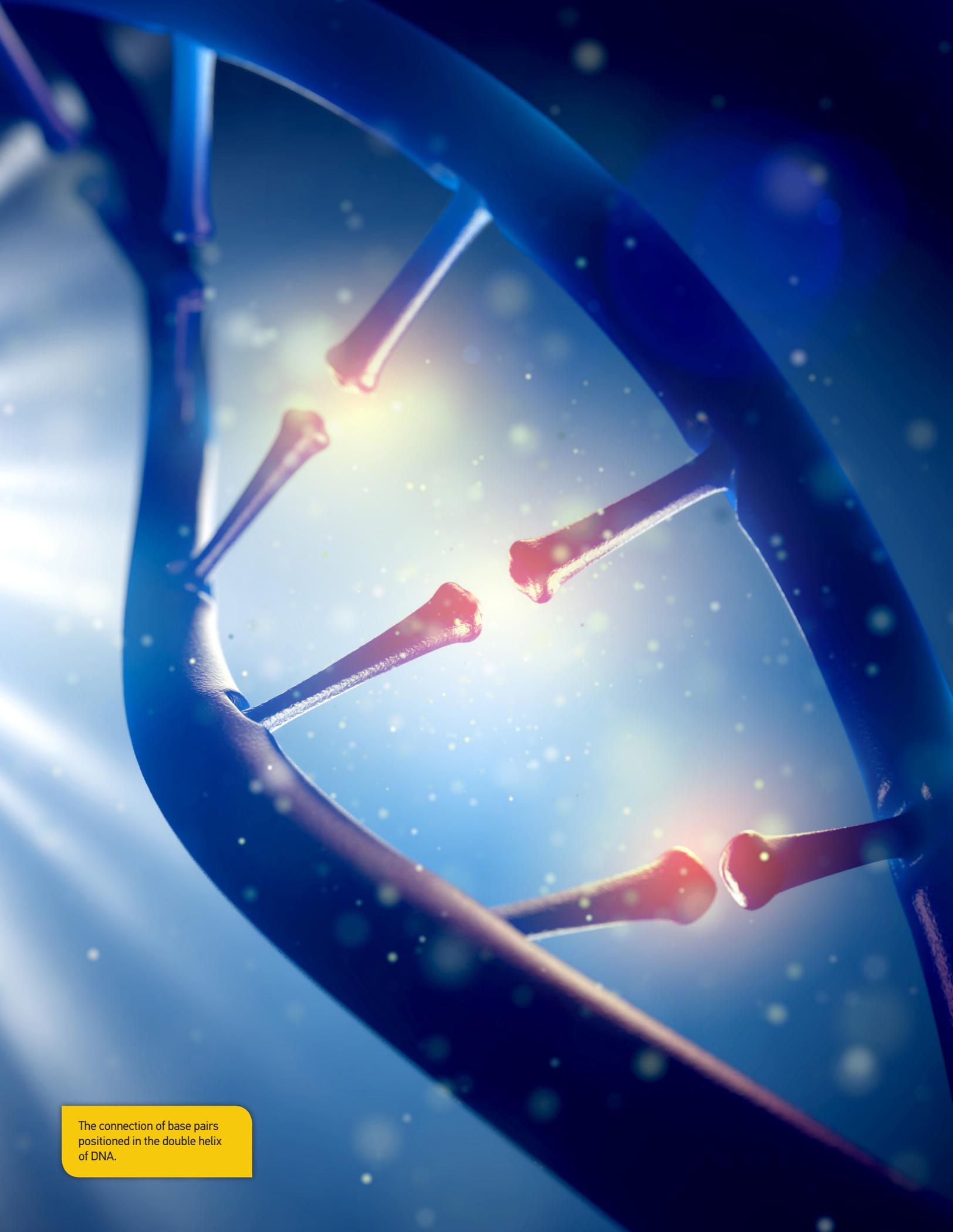
They have been studying animal models of ASD to identify genetic changes that affect the structure of synaptic connections between neurons, and network changes within and between brain regions. They are also investigating altered social cognition and behavior.

This has resulted in the development of novel therapeutics that are now being tested on inherited forms of ASD.

ASD Converging at the Synapse

Synaptopathy refers to diseases of the nervous system that result in dysfunctional synapses -- the structures through which neurons communicate with each other. Evidence suggests that ASD is a disorder of altered synaptic connections, resulting from genetic mutations. However, several hundred genes are associated with neurodevelopmental disorders such as ASD. To reduce the number of genes to be studied, Picower researchers are examining related genetic disorders with known mutations, which offer an insight into the synaptopathology of ASD.

Around 10 percent of children with autism have other developmental disorders, such as fragile X syndrome, Rett syndrome, and chromosomal alterations. Children with fragile X syndrome exhibit repetitive movement and intellectual disabilities, while those with Rett syndrome also display repetitive actions such as hand wringing and body rocking. Chromosomal micro-deletion, or duplication of a genetic region called 16p11.2, is found in those with ASD and results in anxiety, language impairment, and intellectual disability.



The connection of base pairs positioned in the double helix of DNA.

Picower Professor Mark Bear has studied fragile X syndrome for more than 15 years, and has co-founded a biotech company, Seaside Therapeutics, to develop therapies to treat the condition.

Bear's research suggests that synaptic proteins called metabotropic glutamate receptors (mGluR) become overactive in those with fragile X syndrome, leading to dysfunctional synaptic activity and aberrant structural changes at the synapse.

Bear has demonstrated that mice with fragile X syndrome have perturbed activation of a specific mGluR, called mGluR5. In addition, he has found that mice with a 16p11.2 micro-deletion, which results in ASD-like symptoms, also have altered mGluR5 activity.

His findings show that these two mouse models of ASD have excessive synaptic connections, altered synaptic communication, and heightened levels of synaptic proteins. When researchers in his lab normalized the activity of mGluR5, they found that the synaptic deficits were ameliorated. Bear is now creating therapeutic compounds that target mGluR5 in people with inherited forms of ASD.

But while mGluR5 has provided an excellent target for therapeutics, there are many genes linked to ASD, meaning other sites of intervention will be necessary to treat additional symptoms, such as hyperactivity and repetitive behavior.

Picower Professor Susumu Tonegawa has identified a novel target for fragile X syndrome that, like mGluR5 inhibition, reduces abnormal and excessive synaptic connections. By inhibiting a protein called PAK using a drug named FRAX48, Tonegawa was able to improve synaptic connections. In addition, FRAX48 also treats behavioral symptoms such as hyperactivity and repetitive behaviors.

Tonegawa's discovery has led to the creation of a startup called aFraxis, which recently licensed FRAX48 to the pharmaceutical company, Roche.

A catalyst for the success of Picower faculty, and others, in investigating ASD, has been the Simons Center for the Social

Brain. The center, which was launched in 2012, aims to study social cognition and its disorders, including ASD. It is led by **Newton Professor Mriganka Sur**, who investigates Rett syndrome. Sur has discovered that mice with Rett syndrome have immature synapses and persistent synaptic plasticity, a change in strength between synapses. Recently, his lab showed that organoids, or "minibrains", of human neurons with mutations in MECP2, the gene responsible for Rett syndrome, had immature structure and migration patterns. He has also identified a candidate treatment for Rett syndrome -- a molecule called IGF1 -- which recently underwent Phase 1 clinical trials at Boston Children's Hospital, and has shown promising results.

In addition to Bear, several other Picower faculty members have been recently supported by the Simons Center.

Menicon Professor Troy Littleton investigates how specific genes affect synaptic transmission. Recent findings from his lab show that deleting the gene *Shank* in fruit flies reduces the number of synapses and prevents them from maturing. One version of this gene, *SHANK3*, is associated with ASD. These findings suggest that immature, and fewer, synapses may be one reason for behavioral deficits in ASD.

Fairchild Professor Matthew Wilson has been studying the role of the thalamus and the thalamic reticular nucleus (TRN) in regulating brain functions during wakefulness and sleep that may be essential to normal memory processing and cognition. They are working to identify novel biomarkers and therapeutic targets that could improve cognitive deficits in those with ASD.

Neural Circuits of Social Interaction: The Next Generation in Understanding ASD

Alongside studying related conditions, researchers are also mapping the neural circuits that underlie the two key characteristics of ASD -- social impairment

and repetitive behavior -- in order to better understand the disorder. **Assistant Professor Kay M. Tye** has discovered that dopamine neurons in the brainstem can represent the experience of social isolation. Activating these neurons can mimic a "loneliness-like" state, and inhibiting them can suppress loneliness following social isolation. This discovery represents the first foothold in an otherwise featureless landscape, providing an entry point for the study of subjective social experiences.

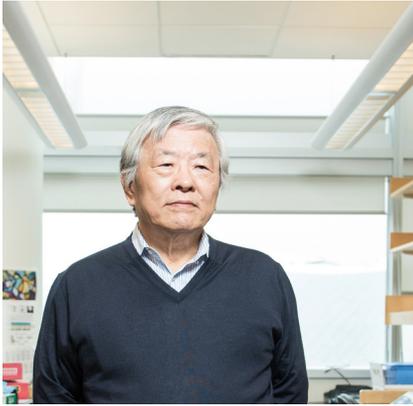
Similarly, Susumu Tonegawa's lab has identified a circuit necessary for social memory. Social memory -- the ability to form memories of familiar people -- is critical for maintaining lasting social interactions. Tonegawa's team discovered that by shutting down the connection between the hippocampus and the nucleus accumbens -- a brain structure important in motivation to find rewarding experiences -- mice did not recognize a familiar mouse and treated them as a stranger. Researchers in his lab now plan to see if they can improve social interaction in mouse models of ASD.

Picower faculty have been trailblazers in identifying the genetic, synaptic, and neural circuits of ASD, including generating significant theories of inherited forms of the disorder, and mapping key brain structures and their involvement in social interaction.

In just 15 years of studying ASD, Picower investigators have generated potential treatments such as mGluR inhibitors, FRAX48, and IGF, which show real promise in treating genetically inherited forms of ASD. This sense of urgency will continue to drive important gains in our knowledge, as we work to spearhead the next generation of ASD research.

JOSHUA SARIÑANA, PhD

A New Circuit for Old Memories



Picower Professor Susumu Tonegawa

WHEN WE VISIT A FRIEND OR GO TO the beach, our brain stores a short-term memory of the experience in a part of the brain called the hippocampus. Those memories are later *consolidated*, the term used when a memory strengthens and is transferred to another part of the brain for longer-term storage.

The standard model of memory consolidation proposes that short-term memories are initially formed and stored in the hippocampus only, before being gradually transferred to long-term storage in the neocortex. At this point, the model suggests, they disappear from the hippocampus.

However, a new study suggests the standard model is out of date. **Picower Professor Susumu Tonegawa's** lab has mapped the specific neural circuits that underlie

memory consolidation. His findings reveal that memories are actually formed simultaneously in both the hippocampus and the long-term storage location in the brain's prefrontal cortex. What's more, these long-term memories require help from the hippocampus for about two weeks before they reach a mature state.

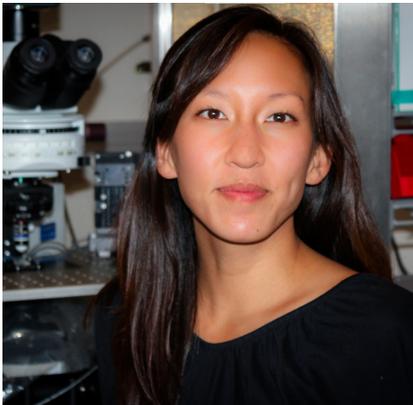
"The findings in this paper provide a comprehensive circuit mechanism for consolidation of memory," says Susumu Tonegawa.

Indeed, the study reveals a brain network that upends the standard model of memory consolidation.

■ Published in **Science**

Engrams and circuits crucial for systems consolidation of a memory. Kitamura, Ogawa, Roy, et al. *Science* April 7, 2017

Dealing with Conflicting Choices



Assistant Professor Kay Tye

WHEN ANIMALS HUNT OR FORAGE FOR food, they must constantly weigh whether the chance of a meal is worth the risk of being spotted by a predator. The same conflict between cost and benefit is at the heart of many of the decisions humans make on a daily basis.

The ability to instantly consider contradictory information from the environment and decide how to act is essential for survival. It is also a key feature of mental health. Yet despite its importance, very little is known about the connections in the brain that give us the ability to make these split-second decisions.

A paper from **Assistant Professor Kay Tye's** lab reveals a circuit in the brain that is critical for governing how we respond to conflicting environmental cues.

Two regions of the brain -- the basolateral nucleus of the amygdala and the medial prefrontal cortex -- have for some time been implicated in reward-seeking and fear-related responses. The amygdala is thought to

be crucial for processing emotions, and the prefrontal cortex in evaluating whether the emotional response is accurate.

Researchers in Tye's lab found that "the routing of information from the basolateral nucleus of the amygdala to the prefrontal cortex is critical for decision-making during conflict," she says.

This is important, because the ability to make good decisions when there is conflict is a fundamental one, she says: "We are constantly being presented with positive and negative cues, and a lot of the time it is up to us to determine what we respond to."

The findings could also have implications for our understanding of mental illness, since people with a psychiatric disorder may not always be capable of making good judgments.

■ Published in **Nature Neuroscience**

Amygdala inputs to prefrontal cortex guide behavior amid conflicting cues of reward and punishment. Burgos-Robles, Kimchi, et al. *Nature Neuroscience* April 24, 2017

Mixing Good with Bad

SCIENTISTS HAVE LONG BELIEVED THAT the central amygdala, a structure located deep within the brain, is linked with fear and responses to unpleasant events.

However, researchers from **Picower Professor Susumu Tonegawa's** lab have discovered a circuit in the amygdala that responds to rewarding experiences. The researchers activated the circuit using optogenetics, a technique in which light sensitive channels that can be turned on or off with lasers are inserted into neurons. Activating the circuit caused animals to seek further rewarding stimuli.

Although Tonegawa's team also found a circuit that controls responses to fearful events, they discovered that most of the neurons

within the central amygdala are involved in the reward circuit.

"It's surprising that positive-behavior-promoting subsets are so abundant, which is contrary to what many people in the field have been thinking," said Tonegawa.

The study challenges the central tenant of 20 years of amygdala research, which had suggested that the structure is critical for aversive responses, and is likely to change neuroscientists' understanding of the central amygdala.

■ Published in **Neuron**

Basolateral to Central Amygdala Neural Circuits for Appetitive Behaviors. Kim, Zhang, et al. *Neuron* March 22, 2017

“It's surprising that positive-behavior-promoting subsets are so abundant, which is contrary to what many people in the field have been thinking.”

— PICOWER PROFESSOR
SUSUMU TONEGAWA

Piecing Together the Molecular Puzzle of Autism Spectrum Disorder

MOST CASES OF AUTISM SPECTRUM disorder (ASD) are not caused by a single genetic mutation. However, several disorders with autism-like symptoms, including the rare fragile X syndrome, can be traced to a specific mutation.

By better understanding the genetic causes of these related disorders, it is hoped that researchers can develop therapies to treat the symptoms of ASD.

Several years ago, **Picower Professor Mark Bear** discovered that the fragile X syndrome mutation leads to overproduction of proteins found in brain synapses — the connections between neurons that allow them to communicate with each other.

Bear's previous work has shown that mice with fragile X syndrome have perturbed activation of a protein called mGluR5. This causes an overproduction of dendritic spines, or the contact points between neurons known as synapses, a proliferation of synaptic connections, deficits in synaptic communication, and heightened levels of

synaptic proteins. However, how mGluR5 activation signals alter synaptic communication remains poorly understood.

In a new paper from the Bear lab, researchers indicate that a protein called β -Arrestin2 is necessary for protein synthesis downstream of mGluR5, and that decreasing β -arrestin2 in mice with fragile X syndrome reduces synaptic deficits and normalized protein production. In addition to synaptic changes, fragile X mice also exhibit memory deficits. Reduction of β -arrestin2 greatly improved memory in mice with fragile X syndrome.

The research adds a new piece to the complex puzzle of autism. In understanding the molecular mechanism of ASD it is possible to create therapeutics that can treat the diverse array of symptoms.

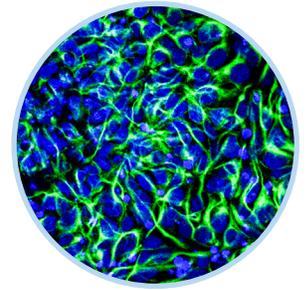
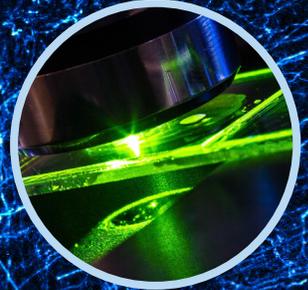
■ Published in **Cell Reports**

β -Arrestin2 Couples Metabotropic Glutamate Receptor 5 to Neuronal Protein Synthesis and Is a Potential Target to Treat Fragile X. Stoppel, Auerbach, et al. *Cell Reports*, March 21, 2017



Picower Professor Mark Bear

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Family Foundation
raising **AWARENESS** about

Schizophrenia

An old family photo of Eduardo Elejalde and his wife, Vanessa, with their two young daughters Natalia (left) and Alexia.

“Eduardo hopes that over the long term, this research will help foster the development of next generation psychiatric drugs that have increased efficacy and reduced side-effects.”



A more recent photo of Alexia (left) and Natalia and their father, Eduardo.

AT THE AGE OF TEN, NATALIA ELEJALDE-Ruiz began showing symptoms of a serious mental health disorder, including auditory and visual hallucinations, irritability and withdrawal. Her father, Eduardo Elejalde, as well as her mother, Vanessa Ruiz, and step-father, David Birenbaum, for years, didn't know what was going on or how to help her. There was very little known about the underlying condition in children. There were no readily available experts or facilities to help cope with its effects that interfered with a young child's schooling, emotional development, friendships, and caused serious disruption to family life. Their search for information resulted initially in a diagnosis of childhood psychosis by a childhood psychiatry specialist at Cornell University and, subsequently, led them to an NIH study on early childhood schizophrenia. After participating in this study, Natalia was diagnosed with schizophrenia.

Notwithstanding these severe challenges, Natalia's spirit and strength of character shone through. She was a very lively and social person. Her younger sister, Alexia, remembers her unapologetically bold

fashion choices and fearlessness on the karaoke stage singing to her favorite artist, Madonna. She was also smart, determined, and wanted to grow as a person. At the age of 19, when Alexia left home to attend Brown University, Natalia also left home to become a resident of Merry Meadow Farm, a therapeutic residential program for people living with serious mental illness. Their approach combines psychiatric medication, therapy and a supportive living community. Natalia lived there for nearly 20 years, where with the constant support and love of her family, her condition improved greatly and she became a leader in her community.

Eduardo recalls how Natalia's experience at Merry Meadow transformed her life. She took the initiative to find a job in a local Walmart store where she worked for many years. This boosted her self-esteem, and she gradually became more and more independent. Given the combination of family support, community, employment and therapy, Natalia's medications were gradually reduced, and she was living a fulfilling life. In the last year of her life, she was self-reliant enough to live in her own apartment.

Following a part-time sabbatical year in 2015 from his career in investment management, Eduardo launched a new social enterprise with the goal of helping others affected by schizophrenia and bipolar disorder. As a fellow of Harvard University's Advanced Leadership Initiative, among other courses at Harvard, he enrolled in Course 9.01 at MIT with Picower Professor Mark Bear to improve his understanding of neuroscience and mental health (Eduardo is an MIT graduate and during the 1960's, also took Course 9.00 taught by Doctor Hans-Lukas Tauber, a pioneer in neuro-psychology and the founder of MIT's Brain and Cognitive Sciences Department). Armed with purpose, personal insight and new knowledge, the Myrtlewood Foundation was born.

And then, tragically and unexpectedly, in late January of this year, Natalia died at the age of 39 from a pulmonary embolism following surgery to mend a broken ankle. The family is renaming their foundation The Natalia Mental Health Foundation and publicizing its efforts in her memory.

Towards Better Solutions for Schizophrenia and Serious Mental Illnesses

The Myrtlewood Foundation (soon to be The Natalia Mental Health Foundation) supports a consortium of mental health experts from MIT, Harvard and Dartmouth who meet regularly and share knowledge. At MIT, the foundation helps to fund Picower Investigator Myriam Heiman's research on the long-term effects of currently prescribed antipsychotic drugs like haloperidol and clozapine. Heiman's work is helping to pave the way for a better understanding of the molecular pathways targeted by these drugs, knowledge which will allow for better future therapeutic

drug design. Eduardo hopes that over the long term, this research will help foster the development of next generation psychiatric drugs that have increased efficacy and reduced side-effects. Professor Heiman feels very lucky to be associated with Eduardo, and for his energy, purpose, and clear vision.

Ultimately, Eduardo hopes to gather financial support to have a larger impact on society. He believes that the public sector is not equipped to alleviate the burden of disorders like schizophrenia, which affects over 21 million people worldwide and over 3 million people in the United States. In the U.S. alone, the economic burden of schizophrenia is over \$155 billion per year due to unemployment, productivity loss and health care costs. The foundation is exploring social impact bonds as a way to address these burdens to society via partnerships between public and private sectors.

Having witnessed Natalia's success and personal development at Merry Meadow Farm, Eduardo believes that creating employment programs for people with schizophrenia and bipolar disorder would have the biggest benefit to society, as well as programs for early intervention in psychosis. He thinks that with the right training, treatment and support, others living with schizophrenia and bipolar disorder may be able to stay in school, keep their jobs, and live happy and productive lives.

Natalia's family hopes that the story of her journey from childhood psychosis to growing independence will serve as an example of the capability and fortitude of people living with serious mental illness, and a reminder of the importance of integrated support, employment, and community for people living with these conditions. Their goal is to help bring this approach to the millions of people living with schizophrenia and bipolar disorder worldwide, and to help reverse the stigma of mental illness in our society.

To learn more, please visit:

www.myrtlewoodfoundation.org

PICOWER

Accomplishments



EARL MILLER ELECTED TO AMERICAN ACADEMY OF ARTS AND SCIENCES FOR 2017

Founded in 1780, the American Academy of Arts and Sciences is one of the country's oldest learned societies and independent policy research centers, convening leaders from the academic, business, and government sectors to respond to the challenges facing—and opportunities available to—the nation and the world. Members contribute to Academy publications and studies in science, engineering, and technology policy; global security and international affairs; the humanities, arts, and education; and American institutions and the public good.



DHEERAJ ROY RECEIVES HAROLD M. WEINTRAUB AWARD

PhD candidate Dheeraj Roy received the 2017 Harold M. Weintraub Graduate Student Award, which recognizes outstanding achievement during graduate studies in the biological sciences.

Fall Symposium

10.16.17

Catherine Dulac, PhD is the Higgins Professor of Molecular and Cellular Biology and chair of the Department of Molecular and Cellular Biology at Harvard University. Her lab investigates the architecture and functional logic of neuronal circuits underlying pheromone signaling and the phenomenon of genomic imprinting in the brain, and the role of this mode of epigenetic modification in brain development and adult brain function.

Barry Everitt, ScD is a Professor and Director of Research, and Provost of the Gates Cambridge Trust, at the University of Cambridge. His research is concerned with the neural and psychological mechanisms underlying learning, memory, motivation and reward especially related to drug addiction.

Steven Flavell, PhD is an Assistant Professor in the Brain and Cognitive Sciences Department and the Picower Institute for Learning and Memory at MIT. His lab's goal is to understand how neural circuits generate sustained behavioral states, and how physiological and environmental information is integrated into these circuits.

Hailan Hu, PhD is a Professor and Senior Principal Investigator at the Zhejiang University Interdisciplinary Institute of Neuroscience and Technology (ZIINT) and School of Medicine at Zhejiang University. Her lab aims to understand how emotional and social behaviors are encoded in the brain, with a main focus on the neural circuitry underlying depression and dominance hierarchy.

Zachary Knight, PhD is an Assistant Professor in the Department of Physiology at the University of California, San Francisco and a Robertson Neuroscience Investigator of the New York Stem Cell Foundation. His lab studies neural circuits in the mouse that control

feeding and other motivated behaviors central to survival. Their goal is to understand how these circuits are able to sense the needs of the body and then generate specific behavioral responses that restore homeostasis.

Eve Marder, PhD is the Victor and Gwendolyn Beinfeld Professor of Neuroscience in the Biology Department of Brandeis University. She studies the dynamics of small neuronal networks, and her work was instrumental in demonstrating that neuronal circuits are not "hard-wired" but can be reconfigured by neuromodulatory neurons and substances to produce a variety of outputs.

Hee-Sup Shin, MD, PhD is the Director of the Center for Cognition and Sociality Institute for Basic Science and a Principal Research Scientist at the Korea Institute of Science and Technology. His work is aimed at understanding how changes in calcium dynamics in nerve cells regulate brain functions.

Garret Stuber, PhD is an Assistant Professor in the Department of Cell Biology and Physiology at the University of North Carolina at Chapel Hill. His primary research goal is to further delineate the synaptic mechanisms and functional neural circuitry that underlie motivated behavioral processes that are perturbed in neuropsychiatric disorders such as addiction, depression, and eating disorders.

Kay Tye, PhD is an Assistant Professor in the Brain and Cognitive Sciences Department and the Picower Institute for Learning and Memory at MIT. Her lab employs an interdisciplinary approach including optogenetics, electrophysiology, pharmacology and imaging techniques to find a mechanistic explanation for how emotional and motivational states can influence learning and behavior, in both health and disease.

Agging Brain Seminar Series

09.06.17 **Patrick Purdon, PhD** is an Associate Professor of Anesthesia at Massachusetts General Hospital. He develops and applies novel methods in neuroimaging and biomedical signal processing to study the systems neuroscience of general anesthesia and other altered states of consciousness.

10.17.17 **Scott A. Small, MD** is the Director of the Alzheimer's Disease Research Center at Columbia University, where he is the Boris and Rose Katz Professor of Neurology. With an expertise in Alzheimer's disease and cognitive aging, Dr. Small's research focuses on the hippocampus, a circuit in the brain targeted by these and other disorders, notably schizophrenia. He has pioneered the development and application of high-resolution functional MRI techniques that can pinpoint parts of the hippocampus most affected by aging and disease. His lab then uses this information to try to identify causes of these disorders.

11.01.17 **Richard Ransohoff, MD** is Vice President and Senior Research Fellow in Neuroimmunology at Biogen. He is a leading neuroimmunologist whose research has focused on the functions of chemokines and chemokine receptors in the development and pathology of the central nervous system.

12.06.17 **Bruce Yankner, MD, PhD** is Professor of Genetics and Neurology at Harvard Medical School, Director of the Harvard Neurodegeneration Training Program, and Co-Director of the Paul F. Glenn Center for the Biology of Aging. His work has contributed to understanding pathogenic mechanisms in Alzheimer's disease, Down's syndrome and Parkinson's disease, beginning with the initial observation that amyloid beta protein is a toxic molecule, and later with investigations into the roles of presenilin proteins, Notch and Wnt in neuronal signaling and pathology.

MIT Colloquium on Brain and Cognition

09.28.17 **Joshua P. Johanse, PhD** Team Leader of the Laboratory for Neural Circuitry of Memory at the RIKEN Brain Science Institute. His lab studies how teaching signals regulate memory formation and guide adaptive behavior.

10.05.17 **Tony Wyss-Coray, PhD** is a Professor of Neurology & Neurological Sciences at the Stanford University School of Medicine. His lab studies the role of immune and injury responses in neurodegeneration and Alzheimer's disease. They seek to understand how immune responses and injury pathways may modulate neurodegeneration and age-related changes in the brain.

11.30.17 **Cyril Herry, PhD** Researcher and Team Leader, Neuronal circuits of associative learning, at the University of Bordeaux. His lab aims at understanding the functional, anatomical and physiological properties of specific prefrontal and amygdala excitatory/inhibitory neuronal circuits involved in the acquisition and expression of Pavlovian associative learning.

Picower Lecture

10.16.17 **Fred "Rusty" Gage, PhD** is a Professor at the Salk Institute for Biological Studies, Vi and John Adler Chair for Research on Age-Related Neurodegenerative Disease. His lab concentrates on the adult central nervous system, and unexpected plasticity and adaptability to environmental stimulation that remains throughout the life of all mammals. Our lab has demonstrated that human beings are capable of growing new nerve cells throughout life in a process called Neurogenesis.

Neuroscience News // Summer 2017



OUR VISION

The Picower Institute is a community of scientists focused on a common question: How is the brain modified by experience?

To answer this question we use multiple levels of analysis, ranging from molecular to behavioral, and exploit the tools of modern molecular biology and genetics to dissect the contributions of specific molecules, synapses, cells and circuits to behavior.

We work to understand the pathophysiological mechanisms underlying complex disorders of the brain that affect emotion and cognition.

SUPPORT THE PICOWER INSTITUTE

For more information on our research or how to make a gift to the Picower Institute for Learning and Memory, please contact:
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BOTTOM ROW: **Elly Nedivi**, Professor, Departments of Brain and Cognitive Sciences and Biology; **Mriganka Sur**, Paul E. Newton Professor of Neuroscience, Director of The Simons Center for the Social Brain; **Susumu Tonegawa**, Picower Professor of Biology and Neuroscience, Departments of Brain and Cognitive Sciences and Biology, Investigator, Howard Hughes Medical Institute, Investigator and Director of the RIKEN-MIT Center for Neural Circuit Genetics; **Li-Huei Tsai**, Picower Professor of Neuroscience, Department of Brain and Cognitive Sciences, Director, The Picower Institute for Learning and Memory; **Kay Tye**, Assistant Professor of Neuroscience, Department of Brain and Cognitive Sciences; **Matthew Wilson**, Sherman Fairchild Professor in Neurobiology, Departments of Brain and Cognitive Sciences and Biology, Associate Director, The Picower Institute for Learning and Memory; **Weifeng Xu**, Assistant Professor of Neuroscience, Department of Brain and Cognitive Sciences.