INCUBATOR

UCSD

http://inc.uscd.edu/

Spring 2014

In this Issue:

Bioengineer Studies How the Brain Controls Movement

A University of California, San Diego research team led by bioengineer Gert Cauwenberghs is working to understand how the brain circuitry controls how we move. The goal is to develop new technologies to help patients with Parkinson's disease and other debilitating medical conditions navigate the world on their own. Their research is funded by the National Science Foundation's Emerging Frontiers of Research and Innovation program.

"Parkinson's disease is not just about one location in the brain that's impaired. It's the whole body. We look at the problems in a very holistic way, combine science and clinical aspects with engineering approaches for technology," explains Cauwenberghs, a professor at the Jacobs School of Engineering and co-director of the Institute for Neural Computation at UC San Diego. "We're using advanced technology, but in a means that is more proactive in helping the brain to get around some of its problems--in this case, Parkinson's disease--by working with the brain's natural plasticity, in wiring connections between neurons in different ways."

(cont on page 2)

Jim Bell is a Parkinson's patient who is working with researchers to better understand the brain dynamics of motor control in Parkinson's disease. The team is working to develop non-invasive therapies. Photo by National Science Foundation.

Brain Control, cont from page 1

Outcomes of this research are contributing to the system-level understanding of human-machine interactions, and motor learning and control in real world environments for humans, and are leading to the development of a new generation of wireless brain and body activity sensors and adaptive prosthetics devices. Besides advancing our knowledge of human-machine interactions and stimulating the engineering of new brain/body sensors and actuators, the work is directly influencing diverse areas in which humans are coupled with machines. These include brain-machine interfaces and telemanipulation.

The research in this episode was supported by NSF award #1137279, EFRI-M3C: Distributed Brain Dynamics in Human Motor Control. Besides Cauwenberghs, the following researchers are contributing to this research: Howard Poizner, Kenneth Kreutz-Delgado, Tzyy-Ping Jung, Scott Makeig, Terrence Sejnowski, Akinori Ueno, Mike Arnold, Frederic Broccard, Yu Mike Chi, John Iversen, Christoph Maier, Emre Neftci, David Peterson, Abraham Akinin, Srinjoy Das, Ariana Dokhanchy, Nikhil Govil, Sheng-Hsiou Hsu, Tim Mullen, Alejandro Ojeda, Bruno Pedroni, and Cory Stevenson.

In addition, Jim Campbell dedicated time and effort as subject in helping the researchers better understand the brain dynamics of motor control in Parkinson's disease and non-invasive avenues for its remediation.

The wireless dry-contact 64-electrode electroencephalogram (EEG) headset was contributed by Cognionics. Other highlighted resources include: Source Information Flow Toolbox and BCILAB for real-time predictive modeling and visualization of brain activity from the EEG data; and the NSF Temporal Dynamics of Learning Center Motion Capture Laboratory for brain-machine-body activity mapping in immersive virtual-reality.

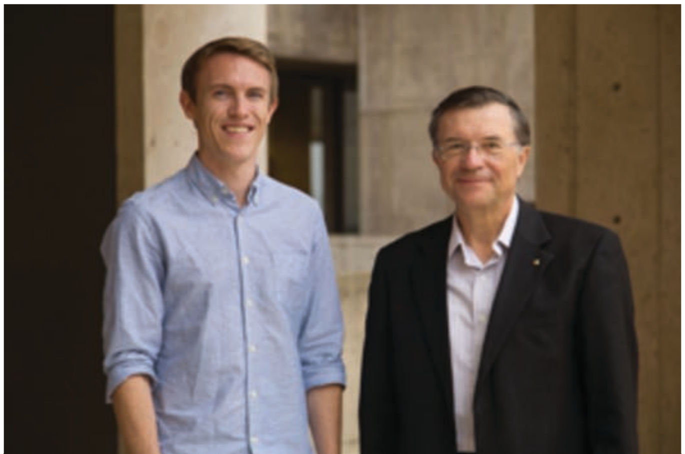
The above story is reprinted from materials provided by UCSD News Center.

The original article was written by Catherine Hockmuth.

Terrence Sejnowski to Give the 2014 Joseph Leiter NLM/MLA Lecture

Terrence Sejnowski, PhD, will give the 2014 Joseph Leiter NLM/Medical Library Association (MLA) Lecture on Thursday, June 12, 2014, at 1:00 pm (ET) in the Lister Hill Center Auditorium at the National Library of Medicine (Building 38A, first floor), on the campus of the National Institutes of Health, Bethesda, Maryland. The lecture will also be recorded and broadcast live on the Web at: http://videocast.nih.gov.

Salk Researchers' Work Explains How Brain Selects Memories



Cian O'Donnell and Terrence Sejnowski.
Image courtesy of the Salk Institute for Biological

Scientists at the Salk Institute in La Jolla have created a new model of memory that explains how neurons retain select memories a few hours after an event.

This new framework provides a more complete picture of how memory works, which can inform research into disorders liked Parkinson's, Alzheimer's, post-traumatic stress and learning disabilities.

The work is detailed in the latest issue of the scholarly journal Neuron. "Previous models of memory were based on fast activity patterns," said Terrence Sejnowski, holder of Salk's Francis Crick Chair and a Howard Hughes Medical Institute Investigator. "Our new model of memory makes it possible to integrate experiences over hours rather than moments."

Over the past few decades, neuroscientists have revealed much about how long-term memories are stored. For significant events — for example, being bitten by a dog — a number of proteins are quickly made in activated brain cells to create the new memories. Some of these proteins linger for a few hours at specific places on specific neurons before breaking down.

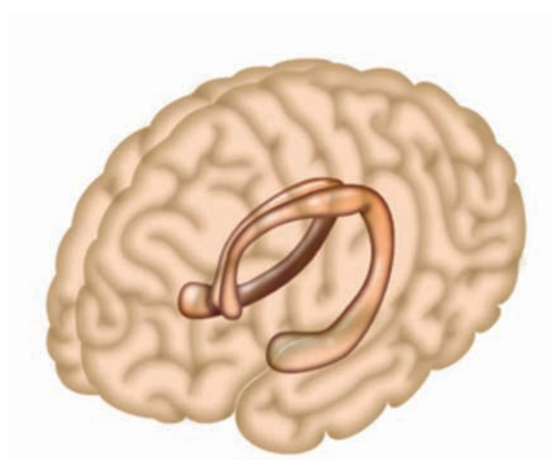
This series of biochemical events allow us to remember important details about that event — such as, in the case of the dog bite, which dog, where it was located and so on.
One problem scientists have had with modeling memory storage is explaining why only selective details and not everything in that 1-2 hour window is strongly remembered. Sejnowski and first author Cian O'Donnell, a Salk postdoctoral researcher, developed a model that bridges findings from both molecular and systems observations of memory to explain how this 1-2 hour memory window works.

The new model also provides a potential framework for understanding how generalizations from memories are processed during dreams.

"During sleep there's a reorganizing of memory — you strengthen some memories and lose ones you don't need anymore," says O'Donnell. "In addition, people learn abstractions as they sleep, but there was no idea how generalization processes happen at a neural level."

By applying their theoretical findings on overlap activity within the 1-2 hour window, they came up with a theoretical model for how the memory abstraction process might work during sleep.

The original article was published by the Salk Institute.



The hippocampus is a region of the brain largely responsible for memory formation.

Students Face Education Improvements

As final exams and school projects begin to consume students' lives, researchers are developing new software that can discern how engaged they are in the classroom.

A study published April 10 in the journal IEEE Xplore introduced a new facial detection software that can measure students' engagement levels. Researchers from Emotient, a facial recognition technology development company, collaborated with researchers from Virginia State University and the University of California, San Diego to create the software. "[The inspiration] was a combination of the opportunity to pursue automatic facial expression recognition research and applying it to education," said Jacob Whitehill, co-founder and research scientist at Emotient.

The software can predict a student's attention levels with 70 percent accuracy, Whitehill said, adding that the software can also predict students' test scores more accurately than their previous grades suggest. The software is modeled after machine learning technology, which uses statistics-based algorithms to compare images and videos to find distinctions —in this case, images of the students' facial expressions, Whitehill said.
To test the software, students were recorded while using online learning software on their iPads and laptops, Whitehill said. The team then selected moments in which participants looked engaged and or distracted and added the facial responses to a catalogue that processed the images to determine a student's engagement level, Whitehill said.

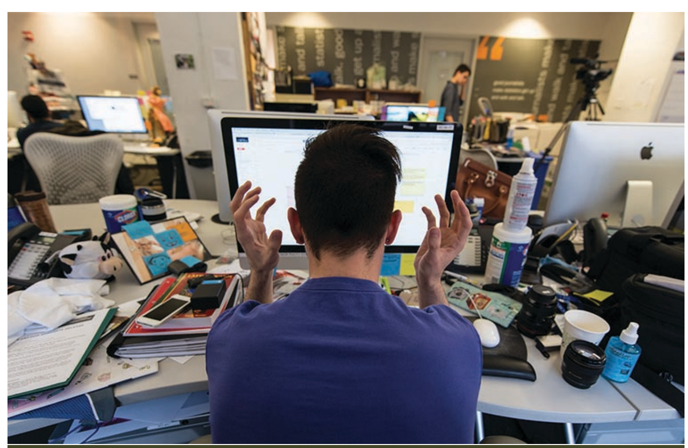
Jeff Cohn, professor of psychology at the University of Pittsburgh, said he thinks educators need to be able to accurately measure their students' engagement levels to address any learning concerns students may have, such as grades and understanding of the material.

"While we're teaching, we're [constantly] trying to evaluate our students' responses to what we're saying," Cohn said.

Whitehill said educators have shown increased interest in this technology in the last five years as universities have begun implementing more online resources. He said facial recognition software research can improve online lecture content and offer students a way to provide more honest feedback.

"What we can do instead [of regular evaluations] is get an automatic and massively wide-scale sense of how our students respond to what they're learning from," Whitehill said. "By using this technology, you can identify parts that need to be improved."

According to Javier Movellan, a researcher at the Machine Perception Laboratory at UC San Diego and lead researcher at Emotient, the company has developed several cameras that detect facial expressions associated with primary emotions, which can be universally understood by any culture, and cognitive states, such as feelings of confusion or frustration.



New facial detection software can measure students' engagement levels. *Photo Illustration by Angela Conners, Photo Editor*

"The technology is ready to be used in real-life environments. We are very close."

— Javier Movellan

The cameras used in the engagement study record muscle movements, Movellan said. When the camera detects which facial muscles moved in a particular area, it can then determine the subject's emotion.

In addition to use for student feedback, Movellan said the software could be implemented into a retail setting to analyze customer experiences. He said the technology could also be applied in the medical field, as doctors could monitor the effects of a new drug by tracking their patients' facial expressions daily to monitor their emotional reactions to the medicine.

"Basically the technology is ready to be used in real-life environments," Movellan said. "[We are] very close."

Whitehill said the facial detection software is similar to human observation because neither is entirely accurate. However, the software is consistent, he said, whereas two human observers judging a subject's engagement level are likely to disagree about the subject's specific emotion. People are generally better able to determine a person's emotions because they can account for the context of the situation, Cohn said.

For example, smiles of embarrassment and enjoyment both use the Duchenne marker, the contraction of the sphincter muscle that surrounds the eyes and controls their movement, Cohn said, adding that the person's behaviors within a given context are important when inferring emotion.

"Software does not recognize emotion," Cohn said. "It may be recognizing expressions due to emotion labels, but to know what someone is feeling, that requires inference."

The above story is reprinted from The Columbia Chronicle, and the original article was written by Sarah Schlieder.

Reference

Whitehill, J.; Serpell, Z.; Yi-Ching Lin; Foster, A.; Movellan, J.R. (2014) **The Faces of Engagement: Automatic Recognition of Student Engagement from Facial Expressions.** *IEEE Transactions on Affective Computing*, vol.5, no.1, pp.86,98, Jan.-March 1 2014.

doi: 10.1109/TAFFC.2014.2316163

INCEVENTS

2014 COGNITIVE NEUROSCIENCE SPRING RETREAT AND KAVLI INSTITUTE FOR BRAIN AND MIND SYMPOSIUM

05/10/14 San Diego Supercomputer Center (Auditorium- Room B211, Floor B-2)

8:00 AM	Welcome Continental Breakfast
8:30 AM	**Symposium: Human Neuroscience** Chair: Steve Hillyard
10:30 AM	**Keynote Speaker: Ralph Greenspan** *"Seymour Benzer, Drosophila, and the Improbable Origins of the BRAIN Initiative"*
11:00 AM	**INC Cognitive Neuroscience Fellows Blitz Talks (5-minute talks)** Chair: Terrence Sejnowski
12:00 PM	Lunch
1:30 PM	**Ninth Annual KIBM Symposium on Innovative Research** Chair: Nick Spitzer

More information: http://inc.ucsd.edu/spring_retreat_main.html

INC CHALK TALKS

04/17/14	**Thorsten O. Zander**	Passive Brain-Computer Interfaces for Automated Adaptation and Implicit Control in Human-Computer Interactions
05/01/14	**Stuart Anstis**	I Thought I Saw it Move: Illusions of Movement
05/15/14	**Sadique Sheik**	Role of Mismatch in Neuromorphic Engineering
05/22/14	**Stephen E. Robinson**	MEG Comparisons of Shared Information Among Schizophrenic Patients, Their Unaffected Siblings and Normal Controls
05/29/14	**Manuel Hernandez**	Towards an Understanding of the Neural Mechanisms Underlying Human Postural Control
06/05/14	**Osonde Osoba**	Noise-benefits in Backpropagation Training
06/19/14	**Mark McDonnell**	Impact of Stochastic Vesicle Variability on Spiking in the Peripheral Auditory System

More information: http://inc.uscd.edu/events.html

For more information on current events,
please contact **Kristen Michener** kmichener@ucsd.edu

inc at a glance

INC Research Groups and staff

Institute for Neural Computation (INC)
http://www.inc.ucsd.edu
Terrence Sejnowski and Gert Cauwenberghs, Co-Directors
Carol Hudson, Management Service Officer

Swartz Center for Computational Neuroscience at INC
http://www.sccn.ucsd.edu
Scott Makeig and Tzyy-Ping Jung, Co-Directors

Machine Perception Laboratory at INC
http://mplab.ucsd.edu/
Javier Movellan, Marian Stewart Bartlett, and Glen Littlewort, Principal Investigators

Temporal Dynamics of Learning Center (TDLC) Motion Capture/Brain Dynamics Facility at INC
http://inc.ucsd.edu/~poizner/motioncapture.html
Howard Poizner and Scott Makeig, Co-Directors

Office of Naval Research (ONR) Multidisciplinary University Initiative (MURI) Center
http://inc.ucsd.edu/~poizner/onr_muri/
Howard Poizner, UCSD (PI); Gary Lynch, UCI (Co-PI); Terrence Sejnowski, Salk Institute/UCSD (Co-PI)

Mobile Brain Imaging Laboratory (MoBI) at INC
Scott Makeig, Principal Investigator

Poizner Laboratry at INC
http://inc2.ucsd.edu/poizner/
Howard Poizner, Principal Investigator

Dynamics of Motor Behavior Laboratory at INC
http://pelican.ucsd.edu/~peter/
Peter Rowat, Principal Investigator

Data-Intensive Cyber Environments (DICE) Group at INC
Wayne Schroeder, Principal Investigator
http://diceresearch.org/DICE_Site/Home/Home.html

International Exchange Scholar Program:
Tzyy-Ping Jung <jung@sccn.ucsd.edu>

Newsletter Editor:
Tomoki Tsuchida<ttsuchida@ucsd.edu>

Webmaster and Information Technology:
Luis Palacios <lpalacio@crl.ucsd.edu>

For general inquiries, contact:
Luisa Flores <m2flores@ucsd.edu>