ISSUE
04
Summer
2009

The Temporal Dynamics of Learning Center's
ON Time
tdlc.ucsd.edu

This Issue

Upcoming Events

1st Annual TDLC Trainee Bootcamp
August 10-22, 2009
UC San Diego

Questions, Comments or Suggestions?

Is there something that you would like to see in an upcoming issue of ON Time? Or information that you would like to see on the website? Do you have any burning questions about the brain, learning, or anything else that you would like our scientists to answer for you? If so, please visit us at tdlc.ucsd.edu and use the 'Contact Us' form to submit your questions, comments and suggestions. We look forward to hearing from you.

Just Who/What is TDLC?

By Carolan Gladden

The Temporal Dynamics of Learning Center (TDLC) is an amalgamation of principal investigators, researchers, faculty, post-doctoral fellows, graduate students, undergrads and pre-undergraduates – all dedicated to the goal of understanding how the element of time is critical for learning and using this understanding to improve learning and education. These scientists, plus staff, an external advisory board and educational/corporate partners presently number nearly 200. And everyone, in countless offices, classrooms and labs across the US, in Canada and even Australia are dedicated to the same mission:

To develop a science of learning that treats the element of time as a crucial component in the learning process, on time scales ranging from milliseconds to years.

Underpinned by National Science Foundation funding (as one of six Science of Learning Centers in the U.S.) and under the scientific leadership of Director Gary Cottrell, Science Director Andrea Chiba and Education/Outreach Director Terry Sejnowski, plus the administrative leadership of Shelley Marquez, TDLC's laboratories and partnerships generate an impressive amount of relevant research.

As a multi-institute Center, logistics for TDLC are complex. With UC San Diego the lead university and operating within its Institute for Neural Computation, the Center consists of a host of other institutions as research partners: Arizona State, UC Berkeley, Brown, Carnegie-Mellon, Children's Hospital of Philadelphia, Rutgers, Salk Institute, San Diego State, University of Buffalo, University of Colorado, University of North Carolina, University of Pittsburg, University of Queensland (Australia), University of Victoria (Canada) and Vanderbilt. Currently some 60 research projects are in progress under four distinct initiatives within four networks: Interacting Memory Systems Network (IMSN), Perceptual Expertise Network (PEN), Sensory Motor Network (SMN) and Social Interaction Network (SIN).

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Trainee Committee Gets New Leader

By Carolan Gladden

Taking the reins for a yearlong stint as Chair of the TDLC Trainee Committee is Graduate Student Christopher Kanan, a Cottrell Lab computer science researcher with a broad spectrum of experience beyond UC San Diego.

The Trainee Committee is composed of five trainee representatives, one from each of the four TDLC networks and one designated the iSLC representative. As committee leader, Chris's responsibilities range from setting the agenda for the committee and bringing trainee input into Center decisions and policies through

(See Trainee Committee on Page 3)

New Neurons and Timing

By Carolan Gladden

Featured in the July 10th issue of the journal Science is an intriguing study by TDLC's IMS Network PI and Salk Institute Professor Fred Gage, together with his team and a group of collaborative researchers from Cambridge University in the UK. For some time it has been known that we generate new brain cells throughout our lives, but until now the purpose of newborn cells has been a topic of great debate.

At the first clues that adult human brains continually sprout new neurons – contrary to an original tenet of neuroscience that we are born with all the brain cells we'll ever have – the paradigm began to shift. And a decade later the question is not whether neurogenesis exists but what all these new cells do.

The most active area of neurogenesis is in the hippocampus, where information is processed and distributed to appropriate 'storage' areas in the brain, ready for efficient memory recall. "Every day, we have countless experiences that involve time, emotion, intent, olfaction and many other dimensions," says Gage. "All the information comes from the cortex and is channeled through the hippocampus. There, they are packaged together before they are passed back out to the cortex where they are stored."

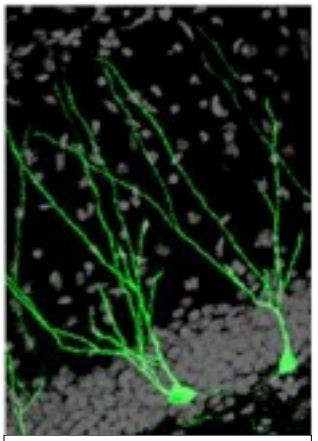


Figure: Human brains sprout new neurons (in green) throughout life, particularly in the hippocampus, the brain's learning and memory center.

Courtesy of Dr. Sebastian Jessberger, Swiss Federal Institute of Technology Zurich

The hypothesis is that the dentate gyrus (DG) of the hippocampus mediates pattern separation, the formation of distinct representation of information, and also undergoes neurogenesis throughout life. Previous studies by a number of labs including Gage's had shown that new neurons somehow contribute to hippocampus-dependent learning and memory but the exact function remained unclear.

Now come illustrations of the way young cells improve our ability to navigate our environment. Says Gage, "We believe that new brain cells help us to distinguish between memories that are closely related in space." And so, the researchers designed experiments that specifically challenged this function of the DG.

Using a set of focused experiments with two distinct strategies to selectively shut down neurogenesis in the DG of adult mice, the researchers found specific impairments in spatial discrimination. In the first, mice had to learn the location within a radial maze of a food reward presented in relation to the location of an earlier reward. Mice without neurogenesis had no trouble finding the new location, as long as it was far enough from the original, but they could not differentiate between the two when they were close together. Another experiment offered confirmation of the finding and also revealed that the mice had no problem recalling spatial information in general.

At this point it seems that pattern separation might not be the only role that new neurons have in adult brain function. Based on all available biological information, a computer model simulating the neuronal circuits in the DG suggested an additional function. "To our surprise," says Gage, "it turned out that newborn neurons actually form a link between individual elements of episodes occurring closely in time."

Thus, new experiments are in the planning stages with the teams of TDLC's Andrea Chiba and Janet Wiles. Focus: Investigate whether new neurons are also critical for coding temporal or contextual relationships.

The paper can be viewed on the Science Magazine website, or by visiting the link below:

http://www.sciencemag.org/cgi/content/abstract/325/5937/210

Acknowledging TDLC and NSF is Critical

Whenever an article is written, a news release sent or a video made that tells the Center story or conveys information about our people, projects or progress, National Science Foundation deems it crucial that we always include the following acknowledgment:

This work supported in part by NSF grant #SBE-0542013 to the Temporal Dynamics of Learning Center, an NSF Science of Learning Center.

Of course our continued NSF funding depends on many factors, but evidence of consistently acknowledging the Center and NSF in all media is definitely a big one.

Education

Update: TEN, Tertulia, and TDLC

By Doris Alvarez

The Educator Network (TEN) had two notable events last month. The first was the launching of the Social Networking Site where scientists and educators can begin to discuss various issues that have potential for research translation. To date, over a dozen educators and scientists have joined. The website is located at theeducatornetwork.ning.com. Because the site did not get started until the end of the traditional school year, teachers are signing up slowly. Expect many more educators to take part especially if we can offer some interesting and provocative questions and answers. If you're interested in joining, please log in to the website or let me know and I will issue a formal network invitation.

The second TEN event occurred in early June when scientists from TDLC and the Machine Perception Laboratory gathered for a discussion of an article entitled "The Future of Educational Neuroscience." The article detailed how a sound grounding in research and teaching could be accomplished by bringing together biology, cognitive science, human development and education. It suggested creating research schools, as well as a new generation of interdisciplinary researchers with training in neuroscience.

TDLC's Andrea Chiba, Gary Cottrell and Javier Movellan were all participants at the article discussion, along with Marni Barnett and Gwen Littlewort. Also participating were Grad student Jake Whitehill and project manager Andrew Kovacevic. The discussion was spirited and lively. The plan is to meet periodically, have a person present a paper or a presentation followed by a "Chat" among the members present. Teachers will be encouraged to present an issue or problem that could be discussed among the group. In fact, we will call these meetings, "Tertulia," which is Spanish for "Chat" and reflects the relaxed atmosphere we wish to convey. Plans are to have the next meeting in early Fall.

On the agenda for next year is the development of online sessions for educators on "Learning how the Brain Learns." Doris Alvarez and Paula Tallal will head this project.

Trainee Committee Gets New Leader

(continued from page 1)

participation in weekly Executive Committee meetings, to publicizing to all TDLC trainees opportunities for learning and advancement (such as grant possibilities, Boot Camp, Temporal Huddle, Brains R Us) and working closely on many fronts with Faculty Representative Isabel Gauthier and the Network Leaders.

Chris is also the iSLC rep, with duties that include fostering communication between TDLC and the other five Science of Learning Centers, and assisting with planning/coordinating the important Annual iSLC Conference. As he says, "The inter-Science of Learning Center Conference is sponsored by the

(See New Trainee Leader on Page 4)

Where Have They Gone?

Catch up with former TDLC trainees

Serena Butcher, Post-Doc at Carnegie Mellon, is now Assistant Professor, Hamilton College, NY

Shana Carpenter, Post-Doc at UC San Diego, is now Assistant Professor, Iowa State University

Shantanu Jadhav, Grad Student at UC San Diego, has begun a Post-Doc position with Loren Frank at UC San Francisco.

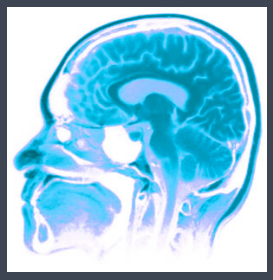
Lara Pierce, Undergrad at University of Victoria, is now a Grad Student in Cognitive Development at McGill University.

Jeremy Reynolds, Post-Doc at University of Colorado is now Assistant Professor of Cognitive Neuroscience at University of Denver.

Jean Vettel, Grad Student at Brown University, is now a civilian employee with the US Air Force Research Labs in Aberdeen, MD.

Marjo Virnes, Visiting Scholar in the UC San Diego MPLab returned home to the University of Joensuu, Finland.

Luke Barrington, while remaining a Grad Student at UC San Diego but no longer a TDLC member, has launched a human computation game on Facebook©. He says, "In order for the search engine to work (and for me to finish my thesis!) lots of people should play ***Herd It."*** Here's the link: www.herdit.org



Brain Trivia

Which of the following typically houses a neuron's nucleus?

a) Soma
b) Axon
c) Dendrite
d) Myelin
e) Node of Ranvier

Look for the answer in the next newsletter.

Last issue's answer:
b) Vision

Valuable TDLC Cog Moves On

Since earning his B.S. degree at UC San Diego in 2007, Mitch Datlow has been Webmaster and a lot more for TDLC, while still active in classes and cognitive science research. But he is soon leaving, as he has been accepted into a PhD program in neuroscience at Johns Hopkins University.

In his TDLC tenure, Mitch took a pedestrian website into the stratosphere and was instrumental in developing the eye-catching, news-filled ONTime newsletter. But his progression within the realm of research began even before TDLC saw the light of day, doing human psychophysics research with Virginia de Sa. Following that, he delved into rodent psychophysics work with Andrea Chiba and then became interested in neuromodulation and neural mechanisms of sensory processing. It's this last interest that he will pursue in graduate school.

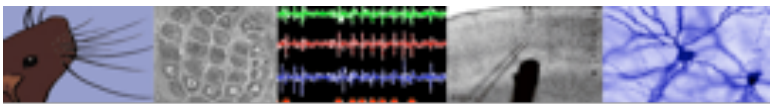
Mitch wrote a National Science Foundation Fellowship on the topic, also incorporating education and outreach, which received high marks and was awarded. So he takes his own money to Johns Hopkins and says happily that Baltimore's cost of living is way lower than San Diego.

Anyone who came in contact with Mitch -- whether by phone, email or in person – may not have understood that the understated, smart, positive, unflappable attitude that they encountered is indeed the real deal. And there is no doubt that these very qualities, combined with a great work ethic and sly smile, will take him all the way to prestigious Johns Hopkins University and far beyond.

Who/What is TDLC *(Continued from page 1)*

Also utilized is a unique network-of-networks organization. This allows researchers from each laboratory to interact intensively with other laboratories, focusing on shared research projects from a variety of disciplines and bringing multiple perspectives to key questions in learning. Examples include:

How are temporal sequences represented in the brain?
People and animals learn temporal patterns in the world, such as the rapid sequence of sound frequencies that make up a speech, or the pattern of notes in a familiar melody. The inability to efficiently learn these patterns is thought to be a major cause of language impairment in some people. To understand how the brain learns temporal patterns (and how this process can fail), investigators are testing how animals learn temporally structured sequences.



Ongoing experiments are testing how neurons in the brains of rodents learn and recognize temporal sequences in different sensory modalities. The goal is a mechanistic understanding of sequence learning and generation of computational models that can be extended to explain sequence learning in humans.

The temporal organization of long-term memory
It is known that as time passes after learning, and recent memory becomes remote memory, a number of changes occur in the neural organization of memory. Utilizing functional Magnetic Resonance Imaging (fMRI) to create 3-D maps of activity in the brain, the goal is to determine how regional brain activation changes as recent recognition memory becomes remote memory.

Myriad other research projects encompass inquiries into a wide range of specialized subjects. And, in addition, currently underway are many activities and projects relating to inreach, outreach, diversity or translation (bringing the science into the classroom). Figuring heavily in the translational arena is the Machine Perception Lab (MPLab) at UCSD.

Perhaps capping the recent accomplishments of RUBI is the cover story in the current *Smithsonian* magazine. Interestingly, writer Abigail Tucker also posed the question, "What if a robot could learn like a child, as it goes along?"

Well, TDLC's Javier Movellan and his team are tackling just such a question, and TDLC contributed critical seed funding for the development of the amazing Project One: A focus on the first year of development that will involve a "baby robot."

Yes, since its founding in 2006, the Temporal Dynamics of Learning Center can point to a number of important accomplishments. And there is no doubt that even more are on the drawing boards, as Center scientists are currently teaming to submit their best research project proposals for the next two years.

New Trainee Leader *(Continued from page 3)*

National Science Foundation (NSF) for some 90 graduate students and post-docs. Due to substantial interest, we sent 22 students to iSLC 2009 at the LIFE Center (Learning in Informal and Formal Environments) at the University of Washington. And planning is already well underway for iSLC 2010 at CELEST (Center of Excellence for Learning in Education, Science, and Techology) at Boston University."

While all of this might be daunting to some, it's hard to imagine any of it posing difficulties for Chris, since expansive multi-level activity would seem to be his norm. After all, while still in high school in rural Oklahoma, when the first internet service provider opened he applied himself to exploring artificial intelligence, creating "bots" to play text-based multiplayer role-playing games.

Just five years ago Chris earned a BS in Computer Science and Philosophy at Oklahoma State. But oh those five years!

- Westward to California
- Mentored English-as-a-second-language Los Angeles middle school students
- Created "Small World," a student program to break cultural stereotypes
- His "Small World Afghanistan" awarded Best Diversity Program, National Association of College and University Residence Halls, Pacific Region
- Earned MS in Computer Science from USC, with coursework in artificial intelligence, machine learning, neural networks, computational neuroscience, robotics, fMRI
- Peer-reviewed article, conference proceedings, patent application onto CV
- Mentor to Preuss students on the world of research and graduate school

As to his current research efforts, Chris explains, "I'm working on an object recognition model that attempts to solve real-world computer vision problems by sequentially gathering visual data using simulated eye movements." But to be sure, Chris is not all work. There's passion for exercise, growing subtropical fruits, hiking, experiencing a variety of different cuisines. And, after all that, a PhD is within site for 2012.