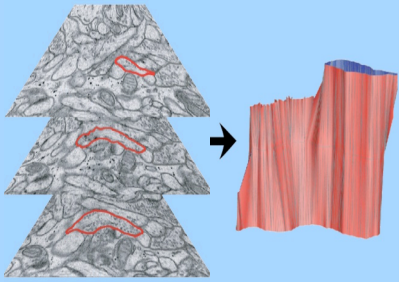
COMPONENTS



INSIDE:

Lab News

Terrence Sejnowski: Computational Neural Biology Laboratory

Theoretical Neuroscience

Notable among recently published papers is an investigation of traveling waves in coral. When coral are electrically stimulated a contraction wave of constant velocity spreads from polyp to polyp over the coral surface. These traveling waves were discovered by T. H. Bullock, one of the founders of neuroethology and a posthumous co-author of the paper. Dr. Bullock was collaborating with CNL when he died, at age 90, and his family passed along notebooks documenting his observations of coral traveling waves. Eugenia Chen, Dr. Klaus Stiefel and Dr. Terry Sejnowski applied genetic algorithms to produce a neural model of the coral traveling wave.

CNL researchers also published a paper on using 3D electrodiffusion models to simulate neural systems with too many particles for current computing technology to model (see reference below).

Former graduate student Dan Keller defended and earned a PhD. in the spring. His dissertation project used MCELL (see MCELL page 3) to model the dynamics of calcium ions whipping around dendritic spines--an ion/dendrite interaction which modifies the electrical and connectivity patterns of neurons.

Graduate student John Jacobson presented a plenary talk on volition and temporal illusions at the 2008 Center for Consciousness Studies Conference.

Selected Recent Publications

Chen, E.; Stiefel, K.M.; Sejnowski, T. J.; Bullock, T.H.; Model of Traveling Waves in a Coral Nerve Network, *Journal of Comparative Physiology A*, 194(2):195-200, 2008.

Lopreore, C.; Bartol, T.; Coggan, J.; Keller; D.; Sosinsky; G.; Ellisman; M.; Sejnowski, T. J.; Computational Modeling of 3D Electrodiffusion in Biological Systems: Application to the Node of Ranvier, *Biophysical Journal*, 95(6), 2008.

Keller, D.X.; Franks, K.M.; Bartol, T.M.; Sejnowski, T. J.; Calmodulin Activation by Calcium Transients in the Postsynaptic Density of Dendritic Spines, *PLoS ONE*, 3(4):e2045, 2008.

Low, P.S.; Shank, S.S.; Sejnowski, T. J.; Margoliash, D.; Mammalian-like Features of Sleep Structure in zebra-finches, *Proceedings of the National Academy of Sciences U.S.A.*, 105(26) 9081-9086, 2008.

Kerr, R.A.; Bartol, T.M.; Kaminsky; B.; Dittrich, M.; Chang; J.-C. J; , Baden; S.; Sejnowski, T. J.; T.J., Stiles; J.; Fast Monte Carlo Simulation Methods for Biological Reaction-Diffusion Systems in Solution and on Surfaces, SIAM Journal on Scientific Computing, 2008.

Prescott, S.A., Ratte, S.,De Koninck, Y., Sejnowski, T.J.; Pyramidal Neurons Switch From Integrators in vitro to Resonators Under in Vivo-like Conditions, *Journal of Neurophysiology*, 2008.

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Spin-offs

NeuroVigil Inc. a spin-off founded by Dr. Philip Low (right, with CNL PI Dr. Terry Sejnowski) of the Salk Institute, won two major entrepreneurial competitions back-to-back: UCSD's $50K Innovation Challenge and Draper Fisher Jurvetson (DFJ) $250K Winner-Take-All Venture Challenge. NeuroVigil Inc's flagship software, SPEARS, automatically scores sleep through a single EEG channel. SPEARS was created by Dr. Low during his graduate studies in Salk' s CNL. NeuroVigil has also developed algorithms which can be applied as a diagnostic tool. The company aims to provide sleep and EEG collection and analysis services for the medical, pharmaceutical and transportation

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Lab News

Howard Poizner Lab

Motor Control and Motor Disorders

The Poizner Lab pursues research in motor coordination and Parkinson's disease generally and the effects of dopamine replacement and deep brain stimulation. Other projects include studies of movement and reward with EEG, motor attention and eye-hand coordination.

The lab renewed one grant and won two more; "Motor control deficits in Parkinson's disease" is funded for $1,689,844 for the next five years, the Veteran's Administration grant "Brain circuits and cognitive-motor Deficits in Parkinson's disease" (with D. Harrington) won $750,000 for three years, and the Office of Navel Research awarded the grant "An integrated motion capture, brain dynamics, brain imaging system' to the Poizner Lab.

Postdocs David Peterson who obtained his Ph.D. in Computer Science from Colorado State University, and Dongpyo Lee who obtained his Ph.D. in Biomedical Engineering from University of Illinois, Chicago recently joined the lab. And the lab is training two Cognitive Science graduate students on a one year research rotation; Vicente Malave and Doug Yovanovich. The neuroscience major Dan Lotz joined the lab as an undergraduate volunteer.

The lab is collaborating with Leanne Chikoskie, Tom Albright and Terry Sejonwoski on rewarded eye movements in Parkinson's patients and with labs at the Texas Health Science Center on Brain Imaging and Columbia University.

Selected Recent Publications

Hening, W., Harrington, D., and Poizner, H. Motor functions of the basal ganglia. *Encyclopedia of Neuroscience*, Springer Publishing, (*in press*).

Hammon, P.S., Makeig, S., Poizner, H., Todorov, E., de Sa, V. Extracting trajectories and target endpoints from human EEG during a reaching task, *IEEE Signal Processing*, 25, 69-77, 2008.

Krebs, H., Dipietro, L., Levy-Tzedek, S., Fasoli, S., Rykman, A., Zipse, J., Fawcett, J., Stein, J., Poizner, H., Lo, A., Volpe, B., Hogan, N. A Paradigm-Shift: Therapeutic NeuRobotics, *IEEE Engineering in Medicine and Biology*, (*in press*).

Lainscsek, C., Schettino, L., Rowat, P., van Erp, E., Song, D., Poizner, H. Nonlinear DDE analysis of repetitive hand movements in Parkinson's disease, *Proceedings of the International Conference on Applications in Nonlinear Dynamics, meeting on Complexity*, Springer Verlag, (*in press*).

Scott Makeig & Tzyy-Ping Jung: Swartz Center for Computational Neuroscience

Wireless EEG and motion-capture, EEGLAB development

Associate Director Tzyy-Ping Jung just won the Unsupervised Learning Pioneer Award from the Society for Photo-Optical Instrumentation Engineers. He has recently in collaboration with engineers at the Research Center of National Chiao Tung University, Taiwan, developed a portable, wireless EEG system. The system allows subjects or users to move naturally during recording, while a cap with dry electrodes transmits recordings via Bluetooth™ to a cellphone or computer. The lab is also collaborating with Howard Poizner's INC Lab to record from subjects in motion capture suits. (see a screen-shot of the system below).

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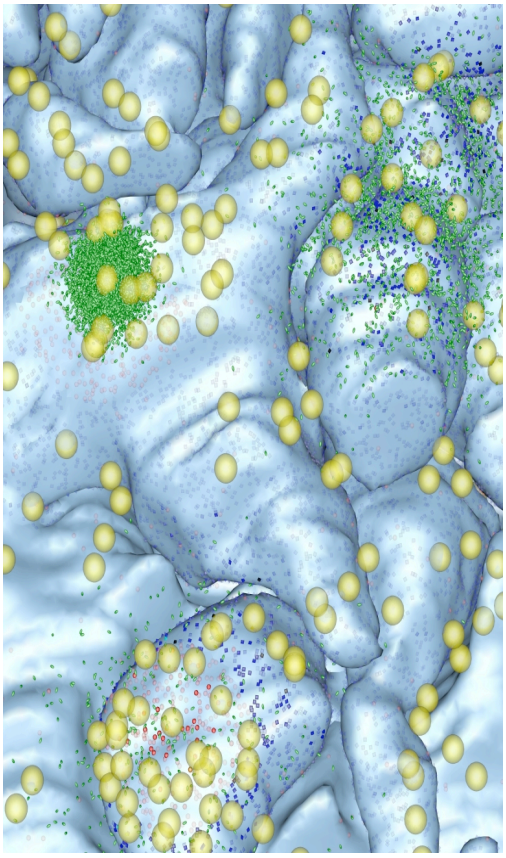
MCell Wins $2.5m, 5 Year NIH Grant

The NIH grant "Ionic cell signaling in small spaces" funds the further development and deployment of MCell, a software package for simulating synaptic behavior from ions up. Dr. Tom Bartol in Dr. Terry Sejnowski's Computational Neurobiology Lab directs the development of MCell and won the grant along with key personnel member Dr. Jay Coggan (of CNL).

Within synapses homogenous diffusion fails to predict local behavior. The MCell group incorporates 3D structure, neurotransmitter kinetics, and a variety of rate constants for receptors, transporters, binding proteins and other signaling participants to generate precise models of intra-synaptic dynamics. With MCell Coggan, Bartol et al. falsified the long-standing assumption that neurotransmitter release happens within a synapse's so called "active zone," so-called, partly because it was the area where all neurotransmitter release happened. Now, we must redefine the 'active-zone'; it is where most transmitter is released and where neuroreceptors are most densely packed, but it is not the only place of active release. Their *Science* paper combined MCell computation with wet work in the chick ciliary ganglia. Dan Keller, who recently won his PhD used MCell to study the temporal and spatial dynamics of the effects of calcium upon synaptic plasticity.



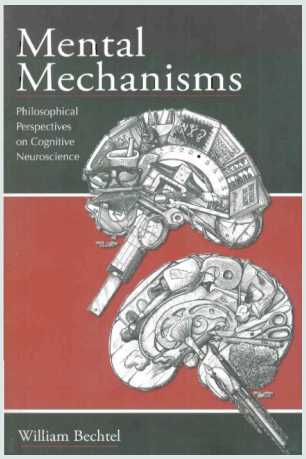
Pre-synaptic view of ectopic release: MCell image shows vesicles (yellow) spray not just above areas densely populated with receptors, (small spheres, variously colored), but also in nearly receptor–free regions.

Since MCell's success depends on the software's incorporation of the latest data on synaptic dynamics (channel distributions, vesicle release times, ion concentrations etc.), MCell not only models, but embodies a database, a library organized to describe synaptic mechanisms. The 3D topography MCell models is always arbitrary, but built from traces of cell membranes in micrographs, produced depth plane by depth plane.

Graduate student Justin Kinney works on transforming these tracings into MCell 3D surface meshes to study glutamate diffusion. Since tracings of micrograph shadows invariably produce surfaces with holes or geometric impossibilities, local and borrowed algorithms check the model, and Justin "debugs" topographies by flying, incredible-shrinking-man-style, through developing 3D models. Visit the MCell site for more information, to use MCell or to watch 3D synapse videos: http://www.mcell.cnl.salk.edu

Calendar

- *Nov. 15-19th Society for Neuroscience Meeting. in Washington, D.C.*
- *Dec. 8-11th NIPS Meeting in Vancouver, B.C.*



Book Release

Mental Mechanisms (2008) by INC faculty member, professor of philosophy and historian Dr. Bill Bechtel warns that a lack of sensitivity to the interaction of levels can confuse investigators and compares successful research programs (e.g. vision) with less successful ones (e.g. memory).

industries. Through a consortium with MIT and Google, NeuroVigil is set to build the world's largest database of sleep EEGs to automatically identify biomarkers for diseases before symptoms or changes in states are present. News about the impressive double wins as well as about the technology were recently covered by Forbes, the New York Times, Bloomberg, the International Herald Tribune, The New Scientist and many others.

SoftMax Acquired by Qualcomm

About ten years ago Dr. Te-Won Lee, Dr. Tzyy-Ping Jung, and Dr. Terry Sejnowski began what became SoftMax, an award winning software and design company that developed noise reduction technologies for cellphone headsets. SoftMax headsets use two spatially separated microphones and signal separation algorithms, and obtained contracts with several headset manufacturers before the acquisition.

Lab News

Find a movie of Research Scientist Klaus Gramann simultaneously recording EEG and tracking movement on a mobile EEG system here: http://sccn.ucsd.edu/~klaus/download/EEGMoCapWeb.mov

Last Fall Julie Onton and Arnaud Delorme lead a workshop on EEGLAB, SSCN's application for EEG analysis. The software package, which applies ICA to locate dipole sources is constantly elaborated, and the developers recently released updates with new muscle artifact removal filters.

SCCN just recruited a new post-doc, Yijun Wang, from China. He will be working on brain-computer interfaces at SCCN.

Selected Recent Publications

Delorme A, Westerfield M, Makeig S, Medial prefrontal theta bursts precede rapid motor responses during visual selective attention. J Neurosci 27:11949-59, 2007

Toellner, T., Gramann, K., Mueller, H.J. & Eimer, M. (in press). The anterior N1 component as an index of modality shifting. *Journal of Cognitive Neuroscience (*in press).

Huang, R-S, Jung, T-P., Delorme A, Makeig, S.Tonic and phasic electroencephalographic dynamics during continuous compensatory tracking," *NeuroImage*, 39:1896–1909, 2008.

Hsu, J-L., Jung, T-P., Hsu, C-Y., Hsu, W-C, Chen, Y-K., Duann, J-R., Wang, H-C, Makeig, S. Regional CBF Changes in Parkinson's Disease: A Correlation with Motor Dysfunction, *European Journal of Nuclear Medicine and Molecular Imaging*, 34:1458-66, 2007.

Lin, C-T., Ko, L-W, Chiou, J-C, Duann, J-R., Chiu, T-W., Huang, R-S., Liang, S-F, Jung, T-P., "Noninvasive neural prosthesis using mobile & wireless EEG *Proceedings of the IEEE, (in press)*.

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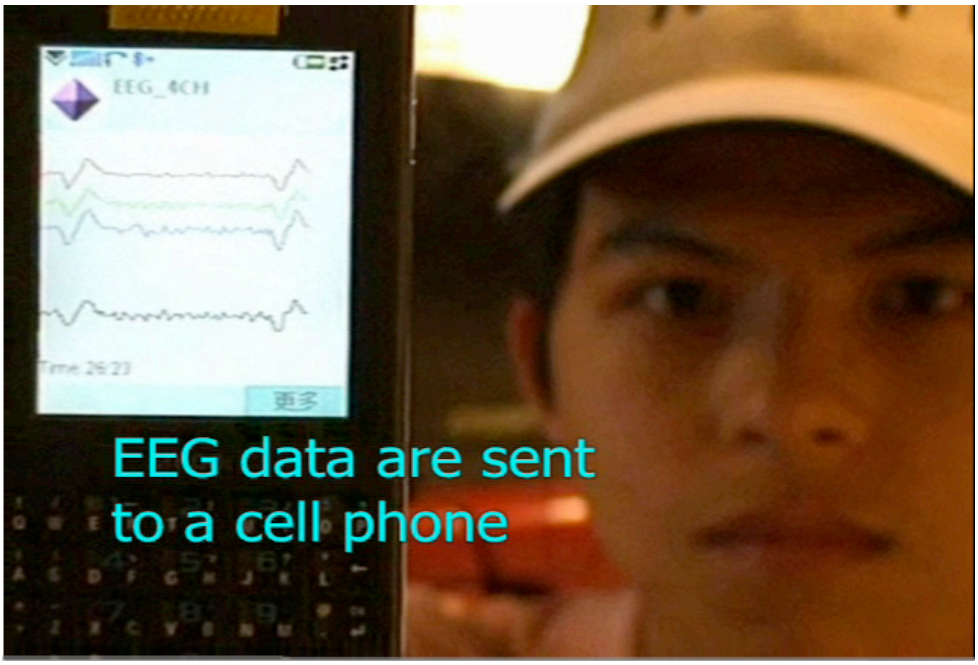


Dry electrode wireless EEG cap: Tzyy-Ping Jung in collaboration with researchers in Taiwan has developed EEG systems which can monitor brainwaves remotely, and without the tiresome application of gel electrodes.

Lab News

Makeig, S. Multiscale electrophysiology: Modeling large-scale and neural-scale dynamics in multi-resolution human data. *Sloan-Swartz Meeting*, Princeton, New Jersey. 2008.

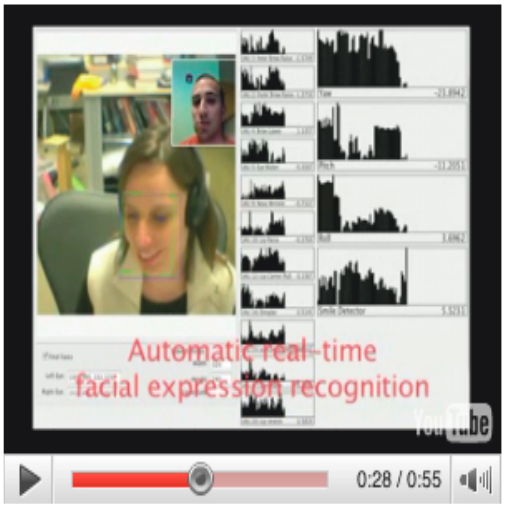
Onton, J. and Makeig, S. Temporal relationships between independent EEG frequency modulations COSYNE. Salt Lake City, Utah. 2008.

Tsai, Y.F., Viirre, E., Strychacz, C., Chase, B, and Jung, T-P., Task Performance and Eye Activity Relating to Cognitive Workload, *Aviation, Space, and Environmental Medicine*, 78(5):B176-85, 2007.

Movellan, Barlett & Littlewort: Machine Perception Laboratory

Expression & Eye Tracking

The Machine Perception Laboratory transformed its webpage into a Wordpress blog where members of the lab contribute updates on the Lab's projects and links to research related news. In late June, *The Chronicle of Higher Education* featured a story describing graduate student Jacob Whitehill's research on facial expression recognition software. He has developed a system which tracks human expressions--to detect boredom and smiles--to inform the dynamics of automated learning systems.



Automated facial expresion recognition system: Jacob Whitehill and others in the Machine Perception Laboratory developed systems for monitoring students' interest online.

Dr. Nicholas Butko and Dr. Javier Movellan recently published an article advancing a formal hypothesis to describe how the brain directs eye-movements. Rarely do we consciously control where our eyes look, but since our vision is only high-resolution in the very center of our visual field, we constantly search visual scenes, much like the blind tap their canes. The searching of scenes is intelligent. Eyes focus on important items in scenes; lips and eyes in face-to-face conversation, the key card in gambling, along the path of our next move in video games. Yet, brain scientists have struggled for 50 years with theories attempting to describe where eyes go next. Butko & Movellan point out that most models direct eyes 'greedily,' to get the most information in the very next eye-movement, and propose a new model which recognizes that, happily, most of the time our next eye movement is not our last.

Selected Recent Publications

Nicholas J. Butko, Lingyun Zhang, Garrison W. Cottrell, and Javier R. Movellan, "Visual Saliency Model for Robot Cameras", Proceedings of the 2008 IEEE International Conference on Robotics and Automation (ICRA), pp. 2398–2403, Pasadena, CA, USA, May 19–23, 2008.

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BRAINS R US
THE SCIENCE OF EDUCATING

The Temporal Dynamics of Learning Center and The Science Network presented The Brains "R" Us Conference in early March to connect educators, cognitive scientists, and administrators and to initiate a new scientific investigation of learning. Participants included neuroscientist and founder of Scientific Learning Corporation Dr. Mike Merzenich, Dr. Terry Sejnowski, Dr. Hal Pashler, and Nobel Laureate Dr. Leon Lederman. Session transcripts and videos are available on-line at http://thesciencenetwork.org/home.php and at http://www.calit2.net/newsroom/article.php?id=192.

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Banner background: Makeig S, Debener S, Onton J, Delorme A.; Mining event-related brain dynamics. *Trends Cogn Sci.* 2004; May; 8(5): 204-10.

Page 2: INC photo.

Page 3: provided by Jay Coggan and described Coggan, J.S., Bartol, T.M., Esquenazi, E. et al. *Science* 309(5733):446-451, 2005.

Page 3: cover of Bechtel, W. (2008). *Mental Mechanisms: Philosophical perspectives on cognitive neuroscience*. New York: *Taylor & Francis Group*.

Page 4: Jung, T, *New Mobile EEG* [video]. Retrieved 12 August 2008 from http://www.sccn.ucsd.edu/~jung/NewMobileEEG.wmv.

Page 5: Young, Jeffery R. Linked from Facial-recognition software could give valuable feedback to online professors. *Chronicle of Higher Education*. 27 June 2008. Retrieved August 12, 2008 from http://www.youtube.com/user/jrwpork.

Lab News

Nicholas J. Butko and Javier R. Movellan, "I-POMDP: An Infomax Model of Eye Movement", Proceedings of the 2008 IEEE International Conference on Development and Learning (ICDL), August 9–12, 2008

Ruvolo, P. and Movellan, J. R. Automatic Cry Detection in Early Childhood Education Settings. International Conference on Development and Learning.

Ruvolo, P., Whitehill, J., Virnes, M., and Movellan, J. R. Building a More Effective Teaching Robot Using Apprenticeship Learning. International Conference on Development and Learning.

Ruvolo, P., Fasel, I., and Movellan, J. R. Auditory Mood Detection for Social and Educational Robots. IEEE International Conference on Robotics and Automation.

Whitehill, J., Bartlett, M.S., and Movellan, J.R. Measuring the Difficulty of a Lecture Using Automatic Facial Expression Recognition. Intelligent Tutoring Systems 2008

Whitehill, J., Bartlett, M.S., and Movellan, J.R. Automatic Facial Expression Recognition for Intelligent Tutoring Systems. CVPR 2008 Workshop on Human Communicative Behavior Analysis.

Peter Rowat Lab: Dynamics of Motor Behavior

Delay Differential Equation Methods

Dr. Peter Rowat and Dr. Robert C. Elson compose the lab, and work on developing and applying delay-differential equation (DDE) analyses and techniques to a variety problems. The lab recently began collaborating with two groups to generate new analyses of the lobster stomatogastric ganglion (STG), a set of about thirty neurons which coordinate chewing and early digestion. We have long known how STG neurons are connected to one another, what muscles they activate, and what sensory information modulates their activity, yet, because of complex feedback dynamics, neuroscientists have long struggled with understanding the system. And it is hoped that the new mathematical methods which render clear the dynamics of the STG will help us understand other living brain systems. Rowat is applying (DDE) analyses in a collaboration with Dr. Jorge Golowasch of the NJIT Mathematics Department to study the role of different ion channels on STG variability. And the lab is collaborating with Dr. Richard Hall at the University of the Virgin Islands to quantify the dependence of STG variability on temperature.

In a recent conference paper, Dr. Rowat and others (see below) described how one can use a DDE technique to precisely quantify the disruptions to rhythmic movement suffered by Parkinson's patients, and thus track the progress of the disease.

Selected Recent Publications

Laincscek, Schettino, Rowat, van Erpe, Song, and Poizner. Nonlinear delay-differential equation (DDE) analysis of repetitive hand movements in Parkinson's disease. (*in press*)

Task Force Report

UCSD's Office of Research Affairs (ORA) produced a Taskforce Report on Organized Research Units, such as INC. The report develops a discussion about evaluating ORUs, proposes methods for linking evaluations with budgetary allocations, reports that a search is underway to fill a position for a fundraiser dedicated to ORUs, introduces new guidelines for establishing ORUs, and outlines and the kinds of support the University can provide ORUs. Find more at: http://research.ucsd.edu/orus.html