LABORATORY OF COMPUTATIONAL NEUROSCIENCE (LCN)

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Dr. Tim Vogels
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Brown University
Computational Neuroscience Faculty Search Committee
c/o David Sheinberg
Department of Neuroscience
Brown University
Providence, RI

Dear Search Committee Members:

I am writing to apply for the position of an Assistant Professor in Computational and Theoretical Neuroscience at Brown University.

I am currently a postdoctoral researcher at the Brain Mind Institute with Wulfram Gerstner at the EPFL in Lausanne, Switzerland. My research focuses on structural and functional models of cortical networks with regard to both long-term stability through excitatory and inhibitory synaptic plasticity, and short-term flexibility through (neuro-) modulated activity. My forte is theoretical and computational neurobiology, but I have learned a variety of techniques including electrophysiological recordings, two-photon imaging, pharmacology, and some biochemistry. I am no stranger to experimental work or experimental collaborations. I have supervised both undergraduate and graduate students, and I have taught / TA-ed general biology and computational neuroscience courses in the past.

I believe that my research focus and my publication record would match well with what you are looking for in a new faculty member (see for example my recent publication in Science). I have always seen myself as a “bridge-scientist” between theory and experiment, and I can imagine myself a good fit at your institute.

Attached to this document you will find my CV (with a list of my publications), my research and my teaching statement, and my favorite 3 publications. I will arrange for letters of recommendations from Larry Abbott, Wulfram Gerstner, Eve Marder, and Peter Dayan to be sent to your attention.

If you have any further questions, please don’t hesitate to contact me by phone or email.

Thank you for your consideration.

Sincerely,

Tim Vogels, PhD

Lausanne, April 25th 2012

Curriculum Vitae, Tim Vogels, PhD

Date of Birth:	26.09.1977
Place of Birth:	Munich, Germany
Marital Status:	Married, one child

Current Position

École Polytechnique Fédérale de Lausanne (EPFL) · SWITZERLAND — 2010 – present
Marie Curie Postdoctoral Fellow with W. Gerstner

Past Positions and Academic Training

Columbia University · New York, NY, USA — 2007 – 2010
Patterson Trust Postdoctoral Fellow with R. Yuste

Columbia University · New York, NY, USA — 2006 – 2007
Visiting Scholar at the Center for Theoretical Neuroscience (to finish thesis work)

Brandeis University · Waltham, MA, USA — 2001 – 2007
Ph.D. with L.F. Abbott · Signal Processing in Neuronal Networks

Technical University of Berlin · Berlin, GERMANY — 1998 - 2001
Vordiplom (Pre-Diploma) in Physics

Estia Agios Nikolaos · Galaxidi, GREECE — 1997 - 1998
Civil Service, Caretaker of mentally handicapped adults

Grants and Awards

Marie Curie International Reintegration Grant · Postdoctoral Fellowship — 2010 – present

Patterson Trust Award in Brain Circuitry · Postdoctoral Fellowship — 2008 – 2010

Pulin Sampat Memorial Teaching Fellow Award — 2002 – 2003

Fulbright Scholarship — 2001 – 2002

Summer Schools Attended

Schizophrenia & Related Disorders · Summer School in Cold Spring Harbor, NY — Summer 2006

Neural Systems & Behavior · Summer School in Woods Hole, MA — Summer 2004

Referee Activities

Agence Nationale De La Recherche, France · Biological Cybernetics · Cerebral Cortex · European Physical Journal B · Frontiers in Computational Neuroscience · Journal of Neuroscience · Nature Reviews · Neural Computation · Neural Networks · NSF Grant Divison, USA · Physica D · PLoS Computational Biology

Teaching Experience

Supervision

PhD Co-Supervision, Friedemann Zenke, EPFL — Expected Graduation: Fall 2013

PhD Co-Supervision, Guillaume Hennequin, EPFL — Expected Graduation: Fall 2012

PhD Co-Supervision, Christian Tomm, EPFL — Graduated: January 2012

BSc Project Supervision, Nicolas Menard, EPFL — Expected Graduation: Summer 2012

Classes & Summer School Courses

Computational Neuroscience · Teaching Assistant to W Gerstner, EPFL 2011
Europ. Summer School for Comp. Neurosci. · Teaching Assistant, Freiburg, Germany 2008
Europ. Summer School for Comp. Neurosci. · Teaching Assistant, Arcachon, France 2007
Europ. Summer School for Comp. Neurosci. · Teaching Assistant, Arcachon, France 2006
7th Grade Science Mentor ·, Motts High School, Harlem, NYC 2006
Computational Neuroscience · Teaching Assistant to L.F. Abbott, Brandeis University 2004
Bio Statistics · Teaching Assistant to L.F. Abbott, Brandeis University 2003
General Biology Lab · Teaching Assistant to J. Tsipis, Brandeis University 2002

Organized Seminars and Workshops

COSYNE Workshop, Inhibitory Synaptic Plasticity · with H. Sprekeler & R. Froemke 02-2012
Michael Brainard, Yves DeKoninck, Robert Froemke, Matthieu Gilson, Julie Haas, Robert Liu, Arianna Maffei, Paul Miller, Henning Sprekeler, Corrette Wierenga, Melanie Woodin, Friedemann Zenke.

Weekly Computational Neuroscience Seminar · EPFL Fall 2011
Jaime de la Rocha, Udo Ernst, Robert Gütig, Marc Timme, Nicolas Brunel, Larry Abbott, Marc-Olivier Gewaltig,

Weekly Computational Neuroscience Seminar · EPFL Spring 2011
Idan Segev, Kris Bouchard, Matthieu Gilson, Susanne Schreiber, Jannis Hildebrandt, Nicolas Brunel, Gasper Tkacik, Pietro Berkes, Gordon Pipa.

Weekly Computational Neuroscience Seminar · EPFL Fall 2010
Abigail Morrison, Kerstin Preuschoff, Daniele Linaro, Corette Wierenga, Sami El Boustani, Eugene Izhikevich, Hans Peter Mallot, Alex Roxin, Fritz Sommer, Gaute Einevoll, Daniel Graham.

Publications

Articles

2012: Tomm C, Vogels TP, Avermann M, Petersen C, & Gerstner W.
The Influence of Structure on the Response Properties of Neuronal Network Models.
(in preparation)

Vogels TP, Araya R & Yuste R.
Modeling the Electrical Function of Spines.
(in preparation)

2012: Araya R, Vogels TP, & Yuste R.
Spine Neck Plasticity Regulates Synaptic Strength.
(submitted)

Hennequin G, Vogels TP, & Gerstner W.
Nonnormal amplification in random balanced neuronal networks.
(submitted, arXiv.org/abs/1204.2945)

2011: *Vogels TP, *Sprekeler H, Zenke F, Clopath C & Gerstner W.
Inhibitory plasticity balances excitation and inhibition in sensory pathways
and memory networks.
Science, 334(6062):1569-73,(4 / 1 citations, news & views by U. Ernst and K. Pawelzik)

Woodruff AR, McGarry LM, Vogels TP & Yuste R
State-dependent function of neocortical chandelier cells.
Journal of Neuroscience, 31(49):17872-86 (0 citations)

2009: Vogels TP & Abbott LF.
Gating Multiple Signals through Detailed Balance of Excitation and Inhibition in Networks
Nature Neurocience 12(4):483-91 (32 / 31 citations, news & views by E. Salinas)

2007: Vogels TP & Abbott LF.
Gating Deficits in Model Networks: A Path to Schizophrenia?
Pharmacopsychiatry, 40 Suppl. 1: S73-7 (7 / 6 citations)

2005: Vogels TP & Abbott LF.
Signal propagation and logic gating in networks of integrate-and-fire neurons,
Journal of Neuroscience, 25(46): 10786-95 (132 / 80 citations)

Vogels TP, Rajan R, & Abbott LF.
Neural Network Dynamics,
Annual Reviews of Neuroscience. 28:357-76 (164 / 103 citations)

Citation numbers were obtained from Google Scholar / ISI Web of Knowledge.

Invited & Contributed Lectures

2012: Computational Neuroscience Colloquium ETH Zürich -Vogels TP
COSYNE Workshops - Vogels TP, Sprekeler H, Zenke F, Clopath C & Gerstner W

2011: PhD Seminar Series - Bernstein Center Freiburg, Vogels TP
Gatsby Institute, London,Vogels TP, Sprekeler H, Zenke F, Clopath C & Gerstner W
COSYNE, Salt Lake City,Vogels TP, Sprekeler H, Zenke F, Clopath C & Gerstner W

2010: Dartmouth University, New Hampshire, Vogels TP & Gerstner W
Keck Center at UC San Francisco, Vogels TP & Gerstner W
Bernstein Center & Humbolt University Berlin, Vogels TP & Abbott LF

2009: LCN Seminar Series, EPF Lausanne, Vogels TP & Abbott LF

2007: Gatsby Neuroscience Unit, University College, London, Vogels TP & Abbott LF
Max Planck Institute & LMU Martinsried, Munich, Vogels TP & Abbott LF

2006: Mathematical Biology Seminars, NJIT, New Jersey, Vogels TP & Abbott LF
BCCN Seminar Series, Freiburg, Vogels TP & Abbott LF
Computational Approaches to Schizophrenia, Munich, Vogels TP & Abbott LF
Computational Approaches to Cortical Functions, Banbury, Vogels TP & Abbott LF
NYU Computational Neuroscience Forum, New York, Vogels TP & Abbott LF

2004: Sloan-Swartz Summer Meeting, Los Angeles, Vogels TP & Abbott LF

Conference Abstracts

2012: COSYNE, Salt Lake City - Zenke F, Sprekeler H, Vogels TP & Gerstner W
COSYNE, Salt Lake City - Sprekeler H, Clopath C & Vogels TP
COSYNE, Salt Lake City - Hennequin G, Vogels TP & Gerstner W

2011: SfN, Washington DC - Vogels TP, Sprekeler H, Zenke F, Clopath C & Gerstner W
CRIM, Marseille - Vogels TP, Sprekeler H, Zenke F, Clopath C & Gerstner W
Champalimaud, Lisbon - Vogels TP, Sprekeler H, Zenke F, Clopath C & Gerstner W
CNS, Stockholm - Hennequin G, Vogels TP, & Gerstner, W
CNS, Stockholm - Zenke F, Hennequin G, Sprekeler H, Vogels TP, & Gerstner W
CNS, Stockholm - Tomm C, Vogels TP, Gerstner W, Petersen CCH, & Avermann M
COSYNE, Salt Lake City - Sprekeler H, Vogels TP, Zenke F, Clopath C & Gerstner W
COSYNE, Salt Lake City - Zenke F, Hennequin G, Sprekeler H, Vogels TP, & Gerstner W

2010: SfN, San Diego - Vogels TP, Sprekeler H, & Gerstner W
Bernstein Conference, Berlin - Vogels TP, Sprekeler H, & Gerstner W

2009: SfN, Chicago - Araya R, Vogels TP, & Yuste R
COSYNE, Salt Lake City - Vogels TP, Araya R & Yuste R

2008: SfN, Washington DC - Vogels TP, Araya R & Yuste R
Dendrites, Janelia Farm - Araya R, Nikolenko V, Vogels TP, Eisenthal K & Yuste R

2007: SfN, San Diego - Araya R, Nikolenko V, Vogels TP & Yuste R

2006: SfN, Atlanta - Vogels TP, & Abbott LF
CNS Edinburgh - Vogels TP, & Abbott LF
CNS Edinburgh - Peelle JE, Vogels TP & Abbott LF

2005: SfN Washington DC - Vogels TP & Abbott LF
SfN Washington DC - Peelle JE, Vogels TP & Abbott LF
COSYNE, Salt Lake City - Vogels TP, Rumsey C & Abbott LF

2004: SfN, San Diego - Vogels TP & Abbott LF
COSYNE, Cold Spring Harbor - Vogels TP & Abbott LF

The focus of my interest is the cognitive control of cortical circuits, and the interaction between cortical activity and the neuronal architecture accommodating it.

Behavioral responses must be generated from a myriad of different stimulus combinations, signals must be propagated or shut off, and the effective connectivity of cortical networks must change within seconds. How is this possible? The answer could lie in the balance of excitatory and inhibitory synaptic currents, a phenomenon that is emerging as a fundamental principle of cortical function. I have previously introduced a gating mechanism that utilizes this balance of excitation and inhibition to control the functional connectivity of neuronal networks; more recently I described how such structures could self-balance with the help of inhibitory synaptic plasticity. It is now the time to study how higher-order mechanisms like attention or arousal states can control both, the *ad hoc* performance of a circuit and also the long term stability of neuronal networks. With my group, I want to study the interaction between neuronal activity and excitatory & inhibitory plasticity and investigate if it is possible to "learn" preferred, balanced pathways of signal transmission within recurrent networks. We will aim to build large networks of self-assembling gate modules that can unite or separate multiple simultaneous signal streams and thus filter and propagate task-specific information. The often talked-about cocktail party problem, in which a listener must gather a single multi-faceted signal from a rich and noisy background, is an intuitive example of such a task and should be generally solvable by the networks we will implement.

Past Research Accomplishments

Graduate Research: My graduate work focused on how different neuronal coding schemes can be supported in large networks of simulated neurons. I studied neuronal networks that displayed asynchronous irregular activity, similar to background spiking in cortex, and showed that strengthening specific sets of synapses was enough to establish either temporal or rate code propagation without destabilizing network activity. However, simple propagation of signals is a useless feature for neuronal networks, unless the signal path can be changed and gated dynamically, according to the information content of the signal. Starting with the idea of simple neuronal logic gates, I explored an idea that combines signal propagation with aspects of balanced networks, creating a situation in which balanced inhibition cancels out incoming excitatory signals. Transmission can be gated "on" by modulating neuronal gains to spoil this "detailed balance", offering a unique and biologically plausible mechanism to change the functional connectivity in neuronal networks. **My research led to four first-author publications, including a review and a study in Nature Neuroscience**.

Postdoctoral Research: Looking for the experimental basis of my graduate work, I joined Rafael Yuste's lab at Columbia University to study the dynamics of both excitatory and inhibitory synapes. In collaboration with Roberto Araya I modeled the electrodynamic underpinnings of a recent finding showing electrical compartmentalization that is correlated to the shape of a spine, but not to its location along the dendritic tree, in a multi-compartmental NEURON model. I learned to perform the parallel experiments and developed analysis tools for single sweep calcium imaging experiments of electrically stimulated spines. **This work will lead to one first author publication (in preparation) and a co-authored**

paper with Roberto Araya, currently under review. In a second project, I designed experimental protocols and analysis tools to investigate the excito-inhibitory effect of the GABA-ergic synapses of chandelier neurons onto the axon initial segment of their neighboring pyramidal cells. **This work lead to a co-authored paper in Journal of Neuroscience with Alan Woodruff.**

For a second postdoc, I moved to Wulfram Gerstner's lab at the EPFL in Lausanne, Switzerland, and returned to work on models of balanced cortical networks. In collaboration with Henning Sprekeler I showed that a simple Hebbian learning rule acting on inhibitory synapses creates a detailed balance of correlated excitatory and inhibitory synaptic currents that reproduces a surprising number of experimental phenomena and allows effortless embedding of static memory patterns in recurrent networks. **This work led to a first author publication in Science**. Additionally, I am currently co-supervising 3 PhD students in Wulfram Gerstner's lab, helping to guide their progress in projects that investigate the relationship of a network's structure and its dynamics, and the interplay between homeostasis and plasticity in large cortical nets. **Their work will lead to 4 (±1) co-authored publications in the near future.**

Future Directions

The work of my group will aim to illuminate which factors contribute to the brain's ability to recruit and activate small cell populations for distinctive stimuli in a context-dependent manner. In other words, we will study how a nervous system assembles a neuronal representation of its environment, from the moment it receives stimuli for the first time and begins to sort out different stimulus facets to the point when it establishes a complete and detailed image of the task-relevant stimulus features. We will aim to build neuronal networks that autonomously learn neuronal architectures that are able to dynamically propagate some signals and deny passage to others. Understanding the mechanisms that enable networks to "learn" excitatory, gate-able pathways into its connectivity would be a first step towards solving the wiring requirements for more complex processing tasks. In the long run, we will aim to close the link between the (still dramatically improving) ten thousand-cell resolution activity signals that fMRI scanners can provide and the one hundred-cell resolution of state of the art imaging experiments. Given the assumptions of our model, we will predict activity of different layers of processing in a context and attention dependent manner.

My research plan, as described below, is threefold: to investigate the general principles for imprinting balanced gating modules in a feedforward network through synaptic plasticity; to generalize the findings to recurrent networks with plastic synapses and multiple, correlated input signals; and finally to test if large networks with self-assembling gating modules will be able to solve biologically relevant tasks such as filter several facets from a broad band stimulus.

Research Plan: Controlling Balanced Network Dynamics on Multiple Timescales.

1) Excitatory and inhibitory plasticity in feedforward networks

The reliable propagation of relevant sensory signals through the brain as an essential basis for the generation of neuronal representations has been the focus of many recent studies. However, all recent attempts to "learn" an excitatory pathway into a network, i.e. strengthening specific signal-relevant excitatory synapses with an unsupervised learning rule, have failed because the mechanisms for potentiation and depression are self-amplifying and thus intrinsically unstable: Activity that is fed into a plastic network model will either be too weak to elicit any response at all, or lead to run-away potentiation of all synapses and subsequently to epilepsy-like network dynamics.

In a recent publication with Wulfram Gerstner, Henning Sprekeler, and colleagues we hint at what could prove to be the remedy for this problem: Inhibitory synaptic plasticity, in the form of a simple Hebbian learning rule, combined with a presynaptic depression term, could stabilize such plastic networks, by creating a inhibitory mirror image of the excitatory pathway that carves itself into a network. In this picture, excitatory "disturbances", i.e. newly strengthened connections along sensory pathways, are stabilized by bootstrapping inhibitory"anti-pathways", which in turn provide the stable background activity to further specify the excitatory connectivity.

The combined action of excitatory and inhibitory plasticity could thus create balanced signal pathways, in which upstream stimuli always cause excitatory as well as inhibitory activity in its downstream targets. I will test these predictions in simple feed forward networks of integrate-and-fire neurons with initially weak connections between all layers. By controlling the initial tuning profiles of each cell, as well as the correlations of the inputs the cells in the lowest layer receive, it will be possible to favor certain synapses to be strengthened, and subsequently balanced. We will study the interplay of excitatory and inhibitory learning rules and their time constants, and the role of inter-layer connectivity and sparseness in these simulations to establish a frame work for analyzing the network dynamics in the recurrent case with multiple input signals. An integral part of this study will be the the effect of neuro-modulators on the emergent structure of the network through their differential effect on excitatory and inhibitory cells and their respective learning rules.

2) Growing a recurrent network of detailedly balanced gate modules

I have discussed detailedly balanced network architectures in a previous study with Larry Abbott, though not for their stabilizing effect on the slow timescales of synaptic plasticity, but rather as a gating mechanism to control signal flow on the much faster time scales of milliseconds. A"detailedly" balanced signal pathway turns signal propagation 'off' by default. We argued that the off-state was desirable from the point of view that most incoming sensory stimuli must be ignored by the nervous system most of the time, and detailedly balanced signal pathways require no active maintenance to do just that. If a stimulus is deemed propagation-worthy, it is easy to spoil the balance of excitation and inhibition in favor of the excitation, for example by down-regulating the gain of the inhibitory population. Additionally, each switch-mechanism can handle as many signals as there are individually controllable groups of inhibitory neurons, creating a biologically plausible neuronal multiplexer and a promising candidate to change the functional connectivity in neuronal networks.

Based on these assumptions we will investigate if it is possible to "grow" gating networks simply through the interaction of excitatory and inhibitory plasticity in recurrent networks. While the simulation of a large number of interconnected neurons with multiple correlated input signals will be a relatively standard procedure, it will necessary to develop new analysis tools to evaluate the changing connectivity of the network and to observe its ability to combine and propagate desired signals by down-regulating specific inhibitory cells. Feedforward networks of such neuronal gates can make strong predictions about the activity of each processing (i.e. cortical) layer based on the gate-state of each previous layer. Although confounded by the diverse and entwined cortical connectivity as well as the resolution of current techniques, it should be possible to test some of these predictions over the next decades, when fMRI resolution will improve to the sub-millimeter voxel regime.

<u>3) Performing simple processing tasks with multiple detailedly balanced modules</u>: One of the most descriptive challenges a real cortical network is faced with is what is commonly described as the "cocktail party problem": A single voice needs to be filtered out of a multitude of background sounds. For auditory cortex, where the environment presents itself as a tonotopically dis-entwined rate signal reflecting the amplitude envelope of each frequency band, the challenge is formidable (but not impossible). The mechanism of detailed balance, incorporated into a gating network of many modules as outlined in 2) should be able to solve a simplified cocktail party problem similarly well. In other words, this network should be able to gather the temporal structure of a few combined signals despite a noisy background input with similar statistics. Initially the choice of which signals to propagate could be manual. Later on, we could also study how the network could make this choice autonomously, based on the activity profile of the input and the feed-back from various downstream layers.

By building a network of self-assembling pathways, we depart from the stage of simple signal propagation. Like a real cortical network, my model will effectively create a neural representation of its (albeit simple) reality, the input that is being fed into its "peripheral" neurons. But unlike an experimentalist who studies real cortical dynamics, I will have the advantage of being able to control all aspects of the system. I argue that it should be possible to observe patterns of activity in these networks that are as unique as the signals they describe. These patters must be robust to noise and similar to each other when describing similar input signals. Implementing such networks will, for the first time, give rise to a canonical, generally applicable yet stimulus specific processing circuit in cortical networks. Through continuous communication with experimentalists in the field it will be possible to develop testable predictions and to readjust the model when shortcomings become apparent. Ultimately, the overall goal of my work is to understand the processing of sensory information from its entry point into the cortex to its behavioral response, mastering the challenges of a complex environment.

"When I was a little boy...."

> "... as the war was ending, soldiers were rushing towards the mitochondria hidden deep within the inner structures of each cell ..."
>
> "...there was love in the air when Sam Adams met Pocahontas..."

Every great teacher I've ever had has always been a great story teller; engaging students into journeys into the unknown, wrapping facts and mechanisms into layers of adventure, puzzles, and provocation. Admittedly, learning for - and scoring highly on - final exams often requires fastidious studying rather than adventures, but great teachers can convert memorization into recalling the milestones of an imaginary trip:

> "Imagine Hodgkin and Huxley, working away in their laboratory in Plymouth, UK. (and also in Woods Hole, by the way, where squids are ubiquitous during the summer months) - You know, they worked on squids, or rather squid axons, particularly because those axons were huge - by the standards of neuron size, huge means up to 1 mm in diameter, and thus large enough to hand-thread - hand-thread !! - an electrode (a custom-made silver wire) down the middle of the nerve fiber. They essentially built their own equipment for these experiments and were finally able to show that sodium as well as potassium flux across the cell membrane were involved in the generation of action potentials. Remember, pretty much nothing (NOTHING) was known about these things. Bernstein had proposed that the neuronal membrane potential changed due to ion flux, and Cole and Marmount had invented the Voltage Clamp, but that was it. How do nerves work? Nothing was known! ..."

Slowly, a teacher fills the gaps between the pieces of information, shows the student how to fill one's head, so that she can begin to effortlessly navigate within the newly created knowledge spaces:

> Ions flow through channels. - Zoom in - What is a channel? Folded chains of amino-acids that sit their hydrophobic butts right into the cell membrane and form a hole in the membrane that is conductive to specific, often electrically charged ions. - Zoom out - Charge flow, what does that mean for the membrane potential? - Well, the Nernst equation tells you about the equilibrium between field potentials and diffusive forces. So we can calculate what happens. Nernst, by the way, was one of the few Germans who voiced his criticism of the Nazis loud enough to lose his job, despite his 1920 Nobel Prize for the third law of thermodynamics. Dang!"

This type of navigation requires independent thought and confidence in one's own knowledge base, and sometimes this can be trained by provoking, or providing challenges to a student's preconceptions, or by making connections where there are none and then let the student cry foul (Soldiers and mitochondria!?). A great teacher recognizes that he must meet the student "where they are at." This expression, borrowed from a therapy technique called "Motivational Interviewing", acknowledges that students come from different backgrounds, and with different aptitudes. This is especially true in computational neuroscience, where listeners are often from a diverse array of fields. So at the beginning of such a course (which this candidate would be likely to teach), there should always be catch-up||up-to-speed||repeat-the-basix-sessions, preferably to be held in a setting that allows "dumb" questions (for example with a tutor rather than the grading professor).

Meeting students where they are at also means to recognize that there are many ways of grasping something. Some students will prefer a formula to describe a phenomenon, while others prefer an image or a metaphor. Fortunately, this plays into another basic fact of teaching: Learning is a cyclical process.

One learns, understands, and forgets the same thing many times over, before it settles into a steady state of universal recallability. So if a teacher has to repeat the same thing over and over again anyhow, why not present it differently every time? (Did you know channels have butts?) And that moment - when something settles into universal recallability, when one starts fully understanding something, owning a concept completely, intuitively knowing when there is an error somewhere - that moment should be the goal of teaching.

Getting to the point of owning anything intellectually is not the work of just one course, or one teacher. It often requires hard work, failure, restructured thoughts, homework, and the pressure of exams. But a good teacher will be able to communicate the joy of understanding, the reward of the epiphany, even the minor epiphany. Once a student is hooked on the epiphany, (s)he's 90 percent there. This candidate will enthusiastically try to be a good teacher.

Homework: Read the following items out-loud three times:

- This candidate is excited about teaching!
- He wants to engage students by drawing images of the context in which the course material was discovered.
- He believes that teaching really means finding what is cool/exciting/amazing about seemingly dry facts.
- He knows that it is important to meet students "where they are at", and he acknowledges that this is no easy feature in courses like Computational Neuroscience.
- This candidate can teach the basic neurobiology course load, but his favorite course would be a course on Cortical Network Dynamics.
- Pocahontas never met Sam Adams, it was John Smith she was said to have fallen with (but you already knew that).