Dr. Tatiana Engel
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Prof. D. Sheinberg
Search Committee Chair
Department of Neuroscience
Brown University
Providence, RI

Dear Prof. Sheinberg,

from your e-mail announcement I learned about an open Assistant Professor position in Computational Neuroscience in the Department of Neuroscience at Brown University. I feel very enthusiastic about this opening, as my scientific interests and plans closely align with the research objectives in the Department. My research is directed to uncover neural circuit mechanisms that underpin cognitive functions using a combination of theory and detailed biophysical modeling. I also employ neuromorphic hardware to emulate large-scale models of cognitive functions.

I became interested in biophysical modeling of cognitive processes during my postdoctoral research in the lab of Prof. X.-J. Wang at Yale University. There I worked on neural circuit models for context dependent decision making and category learning. Inspired by the idea to use existing knowledge of brain function for designing new technologies, I then moved to Stanford University to work on the neuromorphic hardware implementation of a large-scale model of attentional microcircuit together with Prof. K. Boahen and Prof. T. Moore.

My future research will be devoted to discovering how reward system in the brain controls and interacts with cognitive processes. In large part this work will focus on reward driven learning, which allows for collaborations with Prof. M.J. Frank and theoretical neuroscience labs of Prof. L.E. Bienenstock and Prof. J. Anderson. I also intend to establish collaborations with functional neuroimaging and animal neurophysiology labs at Brown University. Enclosed with this letter are my curriculum vitae, statements of my research and teaching interests, and three representative publications. Letters of recommendation should arrive to you shortly. I look forward to the opportunity to discuss with you my research and teaching goals in more detail. Thank you for your consideration.

Sincerely,
Tatiana Engel

CURRICULUM VITAE

Tatiana A. Engel, Ph.D.

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EDUCATION

2003 – 2007	**Ph.D. Physics**, *Summa Cum Laude* Humboldt University, Berlin, Germany Advisors: Prof. L. Schimansky-Geier and Prof. I.M. Sokolov
1997 – 2003	**Diploma Physics** (equivalent to M.Sc.), *with distinction* Lomonosov Moscow State University, Moscow, Russia Advisors: Prof. Y.V. Ponomarev and Prof. L. Schimansky-Geier

RESEARCH EXPERIENCE

2012 – present	**Postdoctoral research associate** Stanford University, Department of Bioengineering (Stanford, CA) Neuromorphic engineering, mentors: Prof. K. Boahen and Prof. T. Moore Project: large-scale biophysical model of attentional microcircuit with implementation on neuromorphic hardware platform Neurogrid
2008 – 2012	**Postdoctoral associate** (since 2009 **Swartz Fellow**) Yale University School of Medicine (New Haven, CT) Computational neuroscience, mentor: Prof. X.-J. Wang Projects: neural circuit models for similarity based decision making, category learning, and context dependent decision making
2007	**Postdoctoral associate** Max Planck Institute of Colloids and Interfaces (Golm, Germany) Statistical physics, mentor: Prof. R. Lipowsky Project: Statistical models for population dynamics of alga *Chlamydomonas*
2003 – 2007	**Graduate student** Humboldt University, Institute of Physics (Berlin, Germany) Theory of Stochastic Processes Advisors: Prof. L. Schimansky-Geier and Prof. I.M. Sokolov Projects: analytical solutions to non-Markovian first passage time problems, modeling and data analysis of spike-trains in neurons with subthreshold resonances
2001 – 2002	**Visiting student** Humboldt University, Institute of Physics (Berlin, Germany) Theory of Stochastic Processes, advisor: Prof. L. Schimansky-Geier Project: signal transmission by ensembles of FitzHugh-Nagumo oscillators
1999 – 2001	**Undergraduate research** Lomonosov Moscow State University, Department of Physics (Moscow, Russia) Nonlinear optics, advisors: Prof. Y.V. Ponomarev and Prof. P.V. Elyutin Project: susceptibility to perturbations of the Lorenz attractor

HONORS, AWARDS AND FELLOWSHIPS

2011	Qualcomm travel grant award for the Cosyne 2011 conference
2007	Award for outstanding young woman scientist of the Forschungsverbund Berlin
2007	Lise Meitner Award of the "Vereinigung der Freunde und Förderer der Physik" for the best Ph.D. dissertation in Physics
2003 – 2006	Graduate Program Fellowship, DFG GRK 268, Dynamics and Evolution of Cellular and Macromolecular Processes
2003	Award of the Lomonosov Moscow State University to the outstanding graduates
2001 – 2002	Humboldt University Scholarship sponsored by the Siemens AG

TEACHING EXPERIENCE

2008 – 2012	Supervised undergraduate summer student R. Dhodapkar and graduate students W. Chaisangmongkon and J. Motelow
2006 – 2007	Thermodynamics, teaching assistant
2004, 2007	Statistical Physics / Quantum Statistics, teaching assistant
2005 – 2006	Introductory Physics Laboratories, teaching assistant
2003 – 2004	Polymer Science, teaching assistant

CONFERENCE ORGANIZATION

Organized workshop "Understanding heterogeneous cortical activity: the quest for structure and randomness" at Computational and Systems Neuroscience (Cosyne) conference, Salt Lake City, UT, 2012 (together with S. Ardid and A. Bernacchia)

Participated in organization of the Sloan-Swartz Meeting on Computational Neuroscience, New Haven, CT, 2010

GRANT ACQUISITION

Co-wrote NIH grant R01MH092927 awarded to Wang lab at Yale University and Freedman lab at the University of Chicago for collaborative research on neural mechanisms of category learning

PROFESSIONAL SOCIETIES

Member of Society for Neuroscience
Member of the German Physical Society (DPG)
Associate member of the Bernstein Center for Computational Neuroscience, Germany

REFEREE SERVICES

Journal of Neurophysiology, Journal of Cognitive Neuroscience, Journal of Computational Neuroscience, Journal of Mathematical Biology, PLoS One, Biological Cybernetics, Journal of the Royal Society Interface, Naturwissenschaften, EURASIP Journal of Advanced Signal Processing

LANGUAGES

English	Fluent both oral and written
German	Fluent both oral and written
Russian	Native fluency
Spanish	Basic knowledge

RECENT INVITED TALKS

- Center for Theoretical Neuroscience, Columbia University, New York, NY, 2011
- Laboratory of Neurophysics and Physiology, Université Paris Descartes, Paris, France, 2011
- Group for Neural Theory, ENS, Paris, France, 2011
- Laboratory of Computational Neuroscience, EPFL, Lausanne, Switzerland, 2011
- Center for Brain Science, Harvard University, Boston, MA, 2010

CONFERENCE CONTRIBUTIONS

ORAL PRESENTATIONS

- Sloan-Swartz Meeting on Computational Neuroscience, Harvard University, Cambridge, MS, 2009
- "Noise in Life: Stochastic Dynamics in the Neurosciences", ESF Workshop, Dresden, Germany, 2007, *Invited talk*
- Computational Neuroscience meeting 2006, Edinburgh, UK, Workshop "Stochastic Dynamics of neurons and networks", *Invited talk*
- "Noise in Life", ESF Workshop on Stochastic Dynamics in Cell Biology, Barcelona, Spain, 2006
- German Physical Society (DPG) - spring meeting of the Division Condensed Matter, Dresden, Germany, 2006
- European Conference on Mathematical and Theoretical Biology - ECMTB, Dresden, Germany, 2005
- German Physical Society (DPG) - spring meeting of the Division Condensed Matter, Berlin, Germany, 2005
- German Physical Society (DPG) - spring meeting of the Division Condensed Matter, Regensburg, Germany, 2004
- Second Dutch Workshop on Molecular Systems Biology, Schoorl, the Netherlands, 2004

POSTER PRESENTATIONS

- Society for Neuroscience 51*th* annual meeting, Washington, DC, 2011
- Computational and Systems Neuroscience (Cosyne), Salt Lake City, UT, 2011
- Society for Neuroscience 50*th* annual meeting, San Diego, CA, 2010
- Gordon Research Conference on Neurobiology of Cognition, Waterville Valley, NH, 2010
- Sloan-Swartz Meeting on Computational Neuroscience, New Haven, CT, 2010
- Society for Neuroscience 49*th* annual meeting, Chicago, IL, 2009
- Computational and Systems Neuroscience (Cosyne), Salt Lake City, UT, 2009
- Sloan-Swartz Meeting on Computational Neuroscience, Princeton, NJ, 2008
- 7th Meeting of the German Neuroscience Society, Göttingen, Germany, 2007
- Sixth International Workshop on Bioinformatics and Systems Biology, Boston, MA, 2006
- Fourth International Workshop on Bioinformatics and Systems Biology, Kyoto, Japan, 2004

PUBLICATIONS

Some publications are under my maiden name: **Verechtchaguina**.

RESEARCH ARTICLES

T.A. Engel and X.-J. Wang. Flexible context-dependent behavior requires synaptic plasticity of feedback projections from decision neurons. *In preparation*

T.A. Engel, W. Chaisangmongkon, D.J. Freedman, and X.-J. Wang. Reward-dependent visual plasticity underlies mixed categorical and feature representations in cortical area LIP. *In preparation*

T.A. Engel and X.-J. Wang. Category learning from examples: how plastic synapses perform exact Bayesian inference. *In preparation*

T.A. Engel and X.-J. Wang. Same or different? A neural circuit mechanism of similarity based pattern-match decision making. *J. Neurosci.*, **31**, 6982–6996 (2011)

M.M. Rading, **T.A. Engel**, R. Lipowsky and A. Valleriani. Stationary size distributions of growing cells with binary and multiple cell division. *J. Stat. Phys.* **145**, 1–22 (2011)

T.A. Engel, B. Helbig, D.F. Russell, L. Schimansky-Geier, and A.B. Neiman. Coherent stochastic oscillations enhance signal detection in spiking neurons. *Phys. Rev. E*, **80**, 021919 (2009)

T.A. Engel, L. Schimansky-Geier, A.V.M. Herz, S. Schreiber, and I. Erchova. Subthreshold membrane-potential resonances shape spike-train patterns in the entorhinal cortex. *J. Neurophysiol.*, **100**, 1576–1589 (2008)

T. Verechtchaguina, I. M. Sokolov, and L. Schimansky-Geier. Interspike interval densities of resonate and fire neurons. *Biosystems*, **89**, 63–68 (2007)

T. Verechtchaguina, I. M. Sokolov, and L. Schimansky-Geier. First passage time densities in resonate-and-fire models. *Phys. Rev. E*, **73**, 031108 (2006)

T. Verechtchaguina, I. M. Sokolov and L. Schimansky-Geier. First passage time densities in non-Markovian models with subthreshold oscillations. *Europhys. Lett.*, **73** (5), 691-697 (2006)

T. Verechtchaguina, L. Schimansky-Geier, and I. M. Sokolov. Spectra and waiting-time densities in firing resonant and nonresonant neurons. *Phys. Rev. E*, **70**, 031916 (2004)

OTHER PUBLICATIONS

T.A. Engel and D. Andrieux. Forget before you remember: dynamic mechanism of memory decay and retrieval. (Commentary) *Front. Neurosci.* (2010)

T.A. Engel. Firing Statistics in Neurons as Non-Markovian First Passage Time Problem. *Ph.D. thesis*, Humboldt University, Berlin (2007)

T. Verechtchaguina. Resonance effects in ensembles of FitzHugh-Nagumo oscillators. *Diploma thesis*, Moscow State University (2003)

RECENT SCIENTIFIC ABSTRACTS

T.A. Engel and X.-J. Wang. Flexible context-dependent behavior requires synaptic plasticity of feedback projections from decision neurons. Society for Neuroscience Abstracts (2011)

T.A. Engel and X.-J. Wang. Learning flexible categorization from exemplars in a neural circuit model. *Front. Syst. Neurosci.*. Conference Abstract: Computational and systems neuroscience (2011)

T.A. Engel and X.-J. Wang. Category learning from examples: how plastic synapses encode exemplars and compute similarity. Society for Neuroscience Abstracts (2010)

T.A. Engel and X.-J. Wang. A neural circuit model for categorization and decision making: Computing with passive versus active short-term memory. Society for Neuroscience Abstracts (2009)

T.A. Engel and X.-J. Wang. Category learning and decision making: a cortical circuit model. *Front. Syst. Neurosci.*. Conference Abstract: Computational and systems neuroscience (2009)

REFERENCES

Prof. X.-J. Wang (postdoctoral mentor)
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Yale University School of Medicine
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Prof. A.V.M. Herz (colloborator)
Computational Neuroscience
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Research statement

Tatiana Engel

Humans and animals exhibit astonishing capabilities in solving complex cognitive tasks, such as making decisions in uncertain and volatile world. Cognitive functions have been studied in psychology by devising abstract mathematical models of behavior, while neurophysiology is now delivering more and more detailed data about neural processes involved in cognition. Yet the link between neural activity and behavior remains elusive.

My scientific goal is to unravel neural circuit mechanisms underlying cognition, and so to bridge the gap between cellular biophysics and behavior. Using a combination of theory and detailed biophysical modeling, I aim to explain cognitive processes as a result of dynamics in recurrent neural networks and to understand how synaptic plasticity shapes the network connectivity and so adjusts behavior to the task demands. I work in close collaboration with neurophysiologists in order to test model predictions as well as to design new experiments informed by theory. Currently I am also starting to employ neuromorphic hardware to emulate large-scale models of cognitive functions with faithful cortical microcircuit architecture.

Accomplished and ongoing research

As a postdoc I worked in the lab of Prof. Xiao-Jing Wang at Yale University. During this time my research was motivated by two main questions: How can working memory be used for flexible decision making? What neural processes underlie category learning?

Flexible decisions require context-dependent evaluation of sensory stimuli. For example, the decision whether your current driving speed is too fast or too slow depends on the last speed-limit sign you saw. Information about past stimuli, context or task rules is contained in the working memory and needs to be combined with sensory inputs. I proposed the first general neural circuit model that can learn and perform flexible decision making tasks in their entirety.

First I applied the model to simulate the delayed match-to-sample task [1], a widely used behavioral paradigm where subjects judge sameness/difference between a stimulus and a remembered item. The model not only captured a wide range of behavioral and neurophysiological observations in this task, but also inspired revisiting and new interpretation for some previously published data sets [2].

I then explored the problem of learning to use working memory, i.e. to form working memory representations tailored to the decision task at hand. Such representations have been recently reported in monkeys [3, 4]. I demonstrated that learning fails in feedforward networks and proposed a novel solution that relies on recurrent loop between decision and sensory/working memory circuits [5]. The model suggests a functional role for decision-related fluctuations ubiquitous in sensory neurons, which puts into new perspective the ongoing debate about their origin [6].

In collaboration with Prof. D.J. Freedman at the University of Chicago, I studied neural mechanisms that underlie learning of abstract categories. The original experimental work reported categorical neural tuning in area LIP [3]. However, the neural circuit model that I developed predicted a mixture of category and feature tuning with non-uniform distribution of preferred features across neural population. I co-supervised a graduate student Jah Chaisangmongkon, who performed more rigorous analysis of LIP data and confirmed model predictions. This work clarified the role area LIP plays in categorization [7]. This research is supported by the joint NIH grant R01MH092927 to Wang and Freedman labs, which I co-wrote.

Studying categorization, I also sought to relate to over a century of research in psychology, where the influential theory postulates that similarities between stimuli are dictated by inter-stimulus distances in a psychological space [8]. The most celebrated successes of this theory was the universal law of generalization by R. Shepard [9]. I derived a general normative theory of category learning, for which Shepard's original theory turned out to be a special case, and established a direct connection between this theory and a synaptic plasticity rule [10]. The new theoretical framework reconciles several controversies discussed in the psychology literature [11], and suggests a novel probabilistic population code whereby synaptic plasticity implements exact Bayesian inference.

Recently I joined the labs of Prof. K. Boahen and Prof. T. Moore at Stanford University as a research associate. Here I am working on a laminar model of attention. The goal is to understand how sensory and attentional signals are integrated across layers in a cortical microcircuit. The model is based on new experimental data collected in Prof. T. Moore's lab, where neural activity is simultaneously recorded in frontal eye fields and in all layers of area V4. To incorporate the required level of biophysical detail into the large-scale model, I am implementing the model on the neuromorphic hardware Neurogrid developed in Prof. K. Boahen lab [12]. Neurogrid is a versatile programmable platform that can emulate one million neurons in real time.

Future research directions

The focus of my future research will be on discovering how the reward system in the brain controls and interacts with cognition, specifically in attention, decision making and rule-guided behavior.

The cognitive and reward systems are parts of a tight loop. On the behavioral level, for example, animals perform better in a task when higher reward is expected. Anatomically, the midbrain structures involved in reward-driven learning and reward seeking behaviors form closed loops with the cortex.

Most of the recent progress in understanding midbrain dopaminergic neurons has been driven by the link between dopamine activity and reinforcement learning theory. Phasic activity of dopamine neurons signals the difference between received and expected rewards, the reward prediction error (RPE). Reinforcement learning provides a computational theory of how the RPE is used as a teaching signal, while dopamine is known to modulate plasticity throughout the cortex and striatum. Despite these inspiring discoveries neural circuits underlying the computation of RPE in the midbrain and the role of dopamine in the cortex are poorly understood.

Historically, activity of dopamine neurons have been studied almost exclusively in conditioning paradigms that do not offer meaningful choice between different alternatives. On the other hand, cortical encoding of value and reward has been explored mostly in decision tasks, that by design require learning of dependencies between reward and actions. Only recently experiments started to record activity of dopamine neurons in cognitive tasks, and to explore how reward modulates cognitive processes in the cortex independently of actions. These experiments provide the scope for revising existing computational theories of dopamine function and for developing neural circuit models of the recurrent interactions within the midbrain and corticostriatal loops.

I will develop biophysical models of neural circuits within the cortico-striato-midbrain-thalamocortical loop with the focus on cognition and reward-based learning. Combining a realistic neural circuit for the midbrain reward system with cognitive-type cortical circuits in a single network model will allow me to study theoretically interactions between reward and cognitive processes. Specific research projects are outlined on the next page.

I intend to establish several collaborations at Brown University. I plan to collaborate with Prof. M.J. Frank based on our common interest in reinforcement learning and decision making. Jointly with Prof. D. Badre I intend to explore human rule learning as outlined in the project below. I plan to establish contacts with Prof. D. Sheinberg to collaborate on neural circuit modeling of attention and visual plasticity based on animal neurophysiology data. I also expect fruitful interactions with theoretical neuroscience labs of Prof. L.E. Bienenstock, Prof. L. Cooper and Prof. J. Anderson who are experts on learning in artificial and biological neural networks. I will continue working on implementations of large-scale neural circuit models using neuromorphic hardware, which can be of interest to Prof. S. Jones.

Research projects

• **Neural circuit mechanisms underlying computations of value and RPE.** A neural circuit model of the recurrent loop between the cortex and midbrain will be developed. The goal is to explain how responses of dopamine neurons to rewarding and aversive stimuli emerge from the network dynamics and synaptic plasticity. Existing models are of connectionist or hybrid type. They map on the known neural circuitry only to a limited extend and face several computational challenges [13, 14].

Recently optogenetic tools made possible to identify cell types of functionally distinct neural populations in the midbrain [15]. These data are suggestive of value being computed in the cortex or striatum and RPE in the midbrain. The model will elucidate neural circuit mechanisms underlying these computations. Whereas reinforcement learning models require task-specific adjustments, e.g. to explain the context dependence of dopamine activity [16], the objective of circuit modeling is to identify general mechanisms valid across experimental settings. The circuit model will allow for making testable predictions about alterations in conditioning behavior, when neural subpopulations in the midbrain are selectively (de-)activated with optogenetic tools. The model will then be extended by incorporating a cortical decision circuit to simulate value-based decision paradigms. The aim here is to resolve controversies about the computational role of dopamine signal in decision tasks [17, 18].

• **Representation of reward, value and attention in posterior parietal cortex.** Recent experiment demonstrated, that spatial attention is modulated by the presence of cues predicting reward delivery [19]. Neurons in the area LIP encoded attentional priority gained by reward cues independently of action values.

With the circuit model, I aim to elucidate neural mechanisms by which reward predictors modulate spatial attention. My modeling hypothesis is that encoding of reward, value and attention in LIP emerges from visual plasticity modulated by dopamine. The key idea is that timing of dopamine signal determines the ensuing representation. Once reward cues are fully conditioned, the phasic dopamine activity and plasticity are triggered at the time of cue presentation, but not at the time of an action. This mechanism could explain independence between attentional modulation in LIP and action value as was found in [19]. The same mechanism could also account for the notion that LIP encodes action values, derived from recordings in tasks where each reward cue represented a decision alternative [20, 21]. In contrast with reinforcement learning models that operate on *a priori* assumed representations (e.g. action values), neural representations in the circuit model arise from plasticity and change in different tasks.

The proposed mechanism implies, that if reward cues are only partially informative about expected reward, the action values can be learned and encoded in LIP at the time of action selection. With the model I will make quantitative predictions about neural activity in LIP, when reward probability is systematically manipulated for each action, while total reward probability is fixed for each reward cue. I collaborate with Prof. J. Gottlieb at Columbia University on data analysis and on design of new experiment based on these model predictions, which will be conducted in her laboratory.

• **Learning to abstract rules from experience.** Actions associated with stimuli often need to be adjusted to behavioral context or rule. Frequently, rules change without explicit cue. If the rule change happens repeatedly, learning an explicit rule representation can benefit performance. To explore how uncued rules are learned from experience, I plan to combine computational modeling with human psychophysics and fMRI. To this end, I intend to establish collaboration with Prof. D. Badre. The idea is to use a categorization task, where the category boundary shifts between two possible values (two rules). Conditions under which subjects infer rules will be established by manipulating the frequency of shifts and the distance (similarity) between the category boundaries. Bayesian models with and without rule factor will be fitted to behavior to test whether subjects learned the rules, and if so which brain regions encode the inferred rules and drive switching between rules based on reward feedback.

I will then study underlying mechanisms with a neural circuit model. The preliminary hypothesis is that rule representations are formed in cortex, while fast plasticity in striatum facilitates reward-based switching between rules. This view is supported by findings, that striatum plays a greater role in stimulus-response association, while prefrontal cortex in abstraction [22, 23]. The cortico-striatal connectivity has been shown to change when animals switch between two behavioral contexts [24]. Human fMRI in the rule-based categorization task will provide more detailed data to underpin modeling. The model will be the first to address how a new neural representation (state) is learned from reward feedback.

- **Multiple time scales of plasticity in task switching.** Switching between cognitive tasks requires reconfiguration of mental resources, which is manifested in switch costs: responses are slower and less accurate after a task switch [25]. Switch costs are not eliminated even if task is cued and ample preparation time is provided. Switch costs arise from interference between the previous and new task sets [26], but the underlying neural mechanisms are unknown.

With a neural circuit model I will explore the hypothesis that switch costs originate from interactions between fast subcortical plasticity and slower cortical plasticity. Subcortical plasticity tracks recent reward history to compute RPE, while cortical plasticity, instructed by the RPE signal, acquires neural representations for each task. For successful learning, subcortical plasticity is computationally required to be faster than cortical, in order to provide a valid RPE signal consistent with the current cortical representation. However, these fast reward-dependent plastic changes can introduce trial-to-trial interferences resulting in switch costs. Difference in time scales of subcortical and cortical plasticity is supported experimentally [27]. Using the circuit model, I will derive predictions of how switch costs alter when the reward schedule is manipulated in each task. I plan to test these predictions in human psychophysics experiments to verify the model hypothesis.

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[2] LL Lui and T Pasternak. Representation of comparison signals in cortical area MT during a delayed direction discrimination task. *J Neurophysiol*, 106:1260–1273, 2011.

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[4] VP Ferrera, M Yanike, and C Cassanello. Frontal eye field neurons signal changes in decision criteria. *Nat Neurosci*, 12:1458–62, 2009.

[5] TA Engel and X-J Wang. Flexible context-dependent behavior requires synaptic plasticity of feedback projections from decision neurons. *In preparation.*

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[7] TA Engel, W Chaisangmongkon, DJ Freedman, and X-J Wang. Reward-dependent visual plasticity underlies mixed categorical and feature representations in cortical area LIP. *In preparation.*

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[9] RN Shepard. Toward a universal law of generalization for psychological science. *Science*, 237:1317–1323, 1987.

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[21] LP Sugrue, GS Corrado, and WT Newsome. Matching behavior and the representation of value in the parietal cortex. *Science*, 304:1782–7, 2004.
[22] CA Seger and CM Cincotta. Dynamics of frontal, striatal, and hippocampal systems during rule learning. *Cereb Cortex*, 16:1546–55, 2006.
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[25] S Monsell. Task switching. *Trends Cogn Sci*, 7:134–140, 2003.
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Teaching statement

Tatiana Engel

On the publication of the first major work by the great Russian poet Pushkin, his mentor and life-long friend Zhukovsky presented the younger poet with a portrait of himself, over the inscription: "To the victorious disciple from his vanquished tutor". I think, this sentence expresses the essence and purpose of teaching. A teacher succeeds when the students excel her.

Teaching in a classroom

Throughout my career I have been fortunate to have great mentors, who provided a model for my perspective on teaching. As a high-school student, I attended Kolmogorov physics and mathematics school at Lomonosov Moscow State University. As one of the co-founders of the school, A.N. Kolmogorov taught there for many years and established a scientific tradition well-maintained until now. There I learned that teaching sciences is more than just a transmission of knowledge, but is aimed to develop in students a special way of thinking. The students learn to think creatively and independently, and they learn to ask what is the next open question after solving a text-book exercise. These are my guiding principles in a classroom.

As an undergraduate, I served as a high-school physics teacher in Moscow, and as a graduate student, I was a teaching assistant for undergraduate courses in statistical physics, thermodynamics, polymer science and introductory physics labs at Humboldt University in Berlin. In the future, I would like to teach the following courses, which will be of interest to students in the Neuroscience Graduate Program as well as in the Department of Computer Science at Brown University.

- **Neural circuits of cognition.** This course in a journal club format will involve critical reading and discussion of seminal research papers. Starting with sensory and motor systems, the topics in decision making, neuroeconomics and reinforcement learning will be covered. Discussed methodologies include neurophysiology, functional neuroimaging and computational modeling.

- **Computational neuroscience.** This introductory course will be accessible on graduate and undergraduate levels. Students will be exposed to mathematical methods in neuroscience including dynamical system models of neurons and networks, statistical models, information theory, models of synaptic plasticity and learning. Relation with experiments will be emphasized. Practice sessions will involve model implementation with Matlab or Python.

- **Learning algorithms for neural networks.** This will be a technically oriented course with the focus on machine learning and artificial neural network methods. Classical algorithms (perceptron and backpropagation), as well as modern techniques (support vector machines, kernel density estimators, Bayesian inference) will be discussed.

In the future I will also be interested to design and teach undergraduate and graduate courses according to needs in the Department of Neuroscience and students' interest.

Lab mentoring

Large part of teaching in science happens outside of the classroom during discussions between the mentor and students. This type of teaching demands certain qualities on the mentor's side. The mentor has to carefully think through what project to suggest to her students. The project has to be at the cutting-edge of science, but at the same time adjusted to the student's educational level and abilities. The mentor also has to communicate to the students that science is a sequence of successes and failures, and that learning from the failures is a part of discovery. I will try to be attentive and to establish open communication with my students, such that the students do not hesitate to talk about difficulties they are experiencing. I am disposed to improve and grow as a mentor through critical assessment of day-to-day successes and failures.