DOMINIC STANDAGE, Curriculum Vitae

Department of Biomedical and Molecular Sciences / Centre for Neuroscience Studies, Queen's University
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DOB 1968.11.07
Citizenship Canadian / British

RESEARCH SUMMARY

My research addresses the neural mechanisms underlying cortical and basal ganglia function. I use spiking-neuron and firing-rate network models to simulate experiments investigating decision making, interval timing, executive control and memory. My current research addresses the cortical representation of elapsed time and the modulation of cortical and subcortical circuitry by this temporal coding. I work closely with experimentalists in Physiology and Psychology, including experimental design and implementation.

EDUCATION

DALHOUSIE UNIVERSITY, HALIFAX CANADA
Doctor of Philosophy, Computer Science, September 2003 – August 2007
Thesis title Mechanisms of short term and long term memory in cortex: neural fields and synaptic plasticity

UNIVERSITY OF WESTMINSTER, LONDON UK
Master of Science, Artificial Intelligence, October 1997- January 2001
Graduated with Distinction
Thesis title An electronic nose: a hybrid neural network architecture to classify bacteria from gas sensor data

DALHOUSIE UNIVERSITY, HALIFAX CANADA
Bachelor of Arts, Psychology, 1988-1991

BOOTH MEMORIAL HIGH SCHOOL, ST. JOHN'S CANADA
Graduated, 1983-1986

EMPLOYMENT HISTORY

QUEEN'S UNIVERSITY, CENTRE FOR NEUROSCIENCE STUDIES, KINGSTON CANADA
Postdoctoral research fellow, Canadian Institutes of Health Research Group in Sensory-Motor Integration / Department of Physiology / Department of Biomedical and Molecular Sciences, November 2007 – present
Computational modelling of neural systems

DALHOUSIE UNIVERSITY, FACULTY OF COMPUTER SCIENCE, HALIFAX CANADA
Postdoctoral research fellow, Computational Neuroscience Group, September 2007 – November 2007
Research Assistant, Computational Neuroscience Group, September 2003 – August 2007
Teaching Assistant, September 2003 – August 2007

THOMSON SCIENTIFIC, LONDON UK
Business Systems Developer, March 2002 – August 2003
Technical specification and development of internal business systems, including global intranet applications and language translation systems

BLOOMS OF BRESSINGHAM LTD, BERKSHIRE UK
Senior Developer / Webmaster, May 2000 – March 2002
Specification, development and administration of all technical facets of online business, transactional processing and financial reporting. Management of contract developers and designers

REVOLUTION LTD, LONDON UK
Senior Programmer, September 1997 - May 2000
Software applications specification and development, management of in-house and contract developers, and client liaison

FREELANCE, LONDON UK
Software developer, September 1995 - September 1997
Software development for clients including the British School of Motoring, IPC Magazines, Inland Revenue UK, and Sony

PUBLICATIONS

BOOK CHAPTERS

Dominic Standage and Thomas Trappenberg, Cognitive Neuroscience, *The Cambridge Handbook of Cognitive Science,* Keith Frankish and William Ramsey (eds.), Cambridge University Press, *in press*

REFEREED JOURNAL PUBLICATIONS

Dominic Standage and Martin Paré, Persistent storage capability impairs decision making in a biophysical network model, *Neural Networks*, 24:1062 - 1073, 2011, DOI: 10.1016/j.neunet.2011.05.004

Dominic Standage, Hongzhi You, DaHui Wang and Michael C. Dorris, Gain modulation by an urgency signal controls the speed-accuracy trade-off in a network model of a cortical decision circuit, *Frontiers in Computational Neuroscience*, 5:7, 2011, DOI: 10.3389/fncom.2011.00007

Dominic Standage, Sajiya Jalil and Thomas Trappenberg, Computational consequences of experimentally derived spike-time and weight dependent plasticity rules, *Biological Cybernetics*, 96:615 - 623, 2007, DOI: 10.1007/s00422-007-0152-6

Dominic I. Standage, Thomas P. Trappenberg and Raymond M. Klein, Modelling divided visual attention with a winner-take-all network, *Neural Networks*, 18, 5-6:620 - 627, 2005

Thomas P. Trappenberg and Dominic I. Standage, Multi-packet regions in stabilized continuous attractor networks, *Neurocomputing*, 65-66:617 - 622, 2005

REFEREED INTERNATIONAL CONFERENCE PROCEEDINGS

Dominic Standage and Thomas Trappenberg, The trouble with weight-dependent STDP, *Proceedings of the International Joint Conference on Neural Networks 2007, 1359 - 1364*

Dominic I. Standage, Thomas P. Trappenberg and Raymond M. Klein, A continuous attractor neural network model of divided visual attention, *Proceedings of the International Joint Conference on Neural Networks 2005,* 2897-2902

Dominic I. Standage and Thomas P. Trappenberg, Differences in the sub-threshold dynamics of leaky integrate-and-fire and Hodgkin-Huxley neuron models, *Proceedings of the International Joint Conference on Neural Networks 2005,* 396-399

MANUSCRIPTS IN REVIEW OR PREPARATION

Dominic Standage and Michael C. Dorris, Trading speed and accuracy by coding time: a coupled-circuit cortical model, *in review*

David M. Milstein, Dominic Standage and Michael C. Dorris, Motor planning processes are influenced by the value and timing of potential actions, *under revision*

Dominic Standage, Michael C. Dorris and Gunnar Blohm, Stochastic facilitation of decision making: using noise to filter noise, *in preparation*

Dominic Standage and Thomas Trappenberg, The dependence of LTP on post-synaptic bursting and the theta rhythm is explained by calcium flux in a dynamic model of CA3-CA1 plasticity, *in preparation*

NATIONAL AND INTERNATIONAL CONFERENCE ABSTRACTS

Dominic Standage and Michael C. Dorris, Trading speed and accuracy by coding time: a coupled-circuit cortical model, *Canadian Neuroscience Meeting 2011, May 29 – June 1, Quebec City, Canada*

Dominic Standage and Michael C. Dorris, A local-circuit cortical model supports timing in the hundreds of milliseconds range, *Society for Neuroscience Meeting, SfN 2010, November 13 – 17, San Diego, USA*

Dominic Standage and Martin Paré, A temporal signal provides flexible control of the speed and accuracy of decisions by gain modulation of circuit dynamics in a neural model of LIP, *Society for Neuroscience Meeting, SfN 2009, Chicago, USA*

Dominic Standage and Martin Paré, A canonical cortical model predicts persistent mnemonic activity in area LIP is afferently driven, *Canadian Physiological Society Meeting, CPS 2009, Mont St. Anne, Canada*

Dominic Standage and Martin Paré, A network of spiking neurons makes slower, more accurate decisions under parameters that do not support working memory, *Society for Neuroscience Meeting, SfN 2008, Washington, DC, USA*

Dominic Standage and Martin Paré, A network of spiking neurons predicts eye movement decisions in a visual discrimination task under impaired NMDA function, *Canadian Association for Neuroscience Meeting, Montreal, Canada*

Dominic Standage and Thomas Trappenberg, An efficient Ca^{2+} based plasticity rule with combined Ca^{2+} sources, *Proceedings of the Computational Neuroscience Meeting CNS*2007, Toronto, Canada*

Dominic Standage and Thomas Trappenberg, Probabilistic, weight-dependent STDP leads to rate-dependent synaptic fixed points, *Proceedings of the Computational Neuroscience Meeting CNS*2006, Baltimore, USA*

Dominic Standage, Sajiya Jalil and Thomas Trappenberg, A weight-dependent STDP rule leading to rate-dependent synaptic fixed points, *Proceedings of the International Conference of Cognitive and Neural Systems, 2006, Boston, USA*

Thomas Trappenberg, Dominic Standage, Sajiya Jalil and Alan Fine, A new interpretation of spike-time dependent plasticity data and their computational consequences, *The International Symposium of the Groupe de recherche sur le système nerveux central et le Centre de recherche en sciences neurologiques, Universite de Montreal, 2006*

Dominic I. Standage, Thomas P. Trappenberg and Raymond M. Klein, A topographic saliency map that accounts for divided visual attention, *Proceedings of the International Conference on Cognitive and Neural Systems, Boston, USA, 2005*

PROFESSIONAL ACTIVITIES

INVITED TALKS AND PRESENTATIONS

Decisions in space and time: a neural model of the speed-accuracy trade-off, *Queen's University, Department of Physiology Invited Speaker Series, March 8, 2010*

Gain modulation by the encoding of urgency controls the speed-accuracy trade-off in a network model of LIP, *Annual Retreat of the Canadian Action and Perception Network, Ingersol Canada, October 1 – 2, 2009*

Gain modulation by a signal encoding elapsed time controls the speed-accuracy trade-off in a network model of a decision circuit in LIP, *Queen's Centre for Neuroscience Studies, Neuroscience Research Day, September 24, 2009*

Working memory capability impairs decision making in a biophysical network model, *University of Montreal, Mathematical Neuroscience Group, March 24, 2009*

Neural field models of cortical microcircuits: neurons, neural populations and parametric issues, *Queen's Centre for Neuroscience Studies, Friday Fights, February 20, 2009*

TEACHING AND STUDENT SUPERVISION

Lecturer, Queen's University, Centre for Neuroscience Studies, January 2010 - present
NSCI 850: Introduction to Modelling in Neuroscience (graduate)
LSCI 426/826: Current Concepts in Sensorymotor Neuroscience (undergraduate / graduate)

Research supervisor, Queen's University, Centre for Neuroscience Studies, January 2011 – present
MSc. Research Thesis, Department of Biomedical and Molecular Science, September 2011 - present
Neuroscience 499: Honours Research Thesis (undergraduate) - September 2011 - present
Physics 590: Honours Research Thesis (undergraduate), January – May, 2011

Teaching Assistant, Dalhousie University, Faculty of Computer Science, September 2003 – December 2006
Curriculum development, lecturing, teaching tutorials, marking assignments

PEER REVIEWING

Biological Cybernetics, Brain Research, Computational and Systems Neuroscience (Cosyne), European Journal of Neuroscience, Frontiers in Computational Neuroscience, International Joint Conference on Neural Networks (IJCNN), PLoS Computational Biology, Workshop on Development and Learning in Artificial Neural Networks (DevLEANN)

COMMITTEE WORK

Postdoctoral representative, Strategic Research Committee, Queen's University, January – July, 2011
Postdoctoral representative, Executive Committee, Queen's Centre for Neuroscience Studies, January – December, 2011
Graduate student rep., Faculty Graduate Committee, Faculty of Comp. Sci., Dalhousie University, Jan – December, 2006

FUNDING AND AWARDS

Canadian Institutes of Health Research (2007 - 2012)
Natural Sciences and Engineering Research Council (2011 – 2012)
Human Frontiers Science Program (2009 – 2010)
Natural Sciences and Engineering Research Council (2003 - 2007)
Faculty of Graduate Studies Scholarship, Dalhousie University (2003 – 2007)
Travel Award, 16th Annual Computational Neuroscience Meeting *CNS*2007*, Toronto, Canada (2007)
Travel Award, 9th International Conference on Cognitive and Neural Systems, Boston, USA (2005)

VOLUNTEER WORK

CATARAQUI CLIPPERS SOCCER CLUB
Head Coach, 2002 Girls, January 2010 – present
Asst Coach, 1997 Boys, September 2011 - present
Member of Board of Directors, January – December 2011

HALIFAX CITY SOCCER CLUB
House League Coach, May 2006 – August 2007
Assistant Coach, 1997 Boys, September 2006 – August 2007
Member of Board of Directors, December 2006 – November 2007

REFERENCES

Available on request

Dominic Standage - research statement

As a theoretical neuroscientist, I am interested in the computational properties of neural tissue, predominantly the cerebral cortex and basal ganglia. I use computational models to investigate neural information processing within and between these brain regions, ranging from abstract mathematical descriptions of neural systems to detailed simulations of their underlying biophysical processes. Broadly speaking, the goals of my research are to provide mechanistic explanations of brain function and to make specific predictions for experimental enquiry (see Standage and Trappenberg, Cambridge Handbook of Cog Sci, 2012).

Past research

My research methods are grounded in my academic background in Artificial Intelligence (MSc Distinction, 1997 - 2001) and my industry experience in software development (1995 - 2003). As a PhD student at the Faculty of Computer Science, Dalhousie University (2003 - 2007), I studied neural field models of cortex and synaptic plasticity. As a member of the Computational Neuroscience Group under the tutelage of Thomas Trappenberg, my use of neural fields focused on the local-circuit mechanisms underlying capacity constraints of short term memory (Trappenberg and Standage, Neurocomputing, 2005) and the role of executive processing in the flexible allocation of visuospatial attention (Standage et al, Neural Networks, 2005; Standage et al, IJCNN, 2005). My research on synaptic plasticity focused on spike timing dependent plasticity (STDP), notably the relationship between spike timing and spike rate under STDP and the putative dependence of plasticity on synaptic strength (Standage et al, Bio Cyb, 2007; Standage and Trappenberg, IJCNN, 2007).

Since November, 2007, I have been a postdoctoral research fellow at the Centre for Neuroscience Studies, Queen's University, where the dominant focus of my research has been decision making. As a member of the Visual Information Processing Laboratory at the Department of Physiology, I studied the encoding of visual salience in parietal cortex with Martin Paré. We used biophysically-detailed cortical models to identify processing regimes suited to different stages of decisions. We controlled network dynamics by parameters with biophysical correlates and made successful predictions of the effects of pharmacological intervention during decision tasks (Standage and Paré, Neural Networks, 2011).

In May, 2009, I joined the Laboratory for the Neural Basis of Decision Making at Queen's. My research with Mike Dorris has predominantly focused on the modulation of decision processing by the neural encoding of time. In simulations of perceptual tasks, we have demonstrated a mechanism by which temporal coding controls the trade-off between the speed and accuracy of decisions. The model provides an explanation for a longstanding issue in neuroscience, doing so in a manner consistent with neural and behavioural data and according to theoretical optima (Standage et al, Front Comput Neurosci, 2011).

Present research

My recent work in the Decision Lab extends our earlier work by investigating the biophysical basis of coding time. We have recently demonstrated that a generic local-circuit model can rapidly learn to

encode time by simulated dopamine (DA) modulation of synaptic conductance, consistent with a large body of experimental and theoretical work. The model further demonstrates executive control of downstream decisions according to task demands (Standage and Dorris, in review). We are also investigating the neural circuitry underlying value judgements and their influence on motor planning, where a neural model of the mid-brain superior colliculus provides mechanistic explanations that bridge neural and behavioural data from the lab (Milstein, Standage and Dorris, under revision). I am currently supervising an MSc student and an honours undergraduate student, who are testing the predictions of our timing and decision models with behavioural experiments.

In September, 2011, I joined the Computational Neuroscience Laboratory at the Department of Biomedical and Molecular Sciences, Queen's University, retaining my position in the Decision Lab. My research with Gunnar Blohm addresses stochastic facilitation in cortex and basal ganglia, that is, we are studying improvements in signal processing with increased noise. Students in the lab are currently testing the predictions of our models with behavioural experiments, with a view to clinical application. For example, we are investigating the plausibility of using low levels of noise to mimic the effect of DA in the dorsal striatum. This approach has the potential to re-instate the reduced depolarization of dorsal striatal neurons in Parkinson's Disease (PD) and to limit pathological oscillations (see respectively Nicola et al, Annu Rev Neurosci, 2000; Hammond et al, TiNS, 2007). If so, it may be possible to lower the dosage of DA medication given to PD patients, preventing some cognitive side effects (see MacDonald and Monchi, PD, 2011).

Future research

My research interests can be characterized from two perspectives: the principles of neural computation, and the cognitive and behavioural functions supported by these principles. I subscribe to the view that cortex evolved to provide a model of the world for action, so from a computational perspective, I am interested in the representational power supported by its anatomy and physiology, and its ability to adapt as the world changes. Broadly speaking, I believe these abilities are supported by generic learning mechanisms that shape processing pathways between generic circuits. I will therefore continue to investigate the computations supported by local circuits and their interactions, as well as the modulation of these computations by the basal ganglia. From a cognitive and behavioural perspective, I am primarily interested in the overlapping constructs of executive control, decision making and learning.

In the immediate future, I will continue to investigate the neural encoding of time and its role in cortical processing. In particular, I will extend my current work to more systematically investigate the modulation of cortical timing circuitry by the basal ganglia, believed to play an important role in interval timing (see Jones and Jahanshahi, Front Integr Neurosci, 2011). There is rapidly growing interest in the mechanisms underlying temporal coding, with particular interest in the timing of decisions and their consequent actions (see *e.g.* Durstewitz and Deco, EJN, 2008). I am well-positioned in this emerging field by my recent work, which I will use as seed for grant applications. These applications will include health research grants to investigate Attention Deficit Hyperactivity Disorder, extensively correlated with timing disturbances in the relevant range (see Rubia, Phil Trans R Soc B, 2009). I will also continue to

investigate stochastic facilitation as a mechanism for overcoming DA depletion in PD patients, extending my current work to more detailed simulations of striatal circuitry and its modulation by DA.

In the intermediate term, I plan to study decisions in a framework of reinforcement learning, thereby integrating my research on synaptic plasticity, executive control, cortico-basal-ganglia circuitry and decision making. This approach considers goal-directed interactions with the environment, where learning is based on rewards procured over varying timescales. Machine learning algorithms have been successful in characterizing this framework and accounting for behavioural data, but there is a need for biophysically-detailed models to address the neural mechanisms that may implement these algorithms (*e.g.* Urbanczik and Senn, Nat Neurosci, 2009). This area has tremendous scope for research on addiction and gambling (see *e.g.* Reddish et al, Psych Rev, 2007; Platt and Huettel, Nat Neurosci, 2008), as well as the side effects of medications used to treat PD, known to include addictions and compulsions (see Dagher and Robbins, Neuron, 2009).

In the long term, I intend to investigate more detailed cortical biophysiology and more extensive interactions between local circuits. Two well-established principles of cortical organization are its layered structure and hierarchical pathways (see Douglas and Martin, Annu Rev Neurosci, 2004). The flow of information between cortical layers is well characterized (see Silberberg et al, TiNS, 2005) and the functional implications of laminar processing constitute an exciting direction for future work. The computational power of hierarchical processing is also well characterized, while executive control is typically defined in terms of bidirectional processing within this framework. It is my long term goal to investigate cognitive function within this systems-level motif. This research direction not only satisfies my personal interests, but will extend the applicability of my research to deficiencies of executive control, such as in schizophrenia.

Dominic Standage – teaching statement

My approach to teaching is informed by my experience as a student, teaching assistant and lecturer. I believe that teaching is an integral part of research. Intermittent revision of one's area of expertise is always insightful and there is no better way to identify the gaps in one's knowledge than to teach. In my experience, the best teachers consider learning and teaching to comprise a single process, and are therefore actively engaged with their subject matter and their students.

In general, my philosophy for teaching is to promote intellectual curiosity in a comfortable and enthusiastic learning environment. At the early undergraduate level, I emphasize the intrinsic interest of the material and its importance and relevance beyond the classroom. In advanced courses with smaller class sizes, my philosophy is to emphasize open-minded, critical evaluation of the relevant literature, where students learn from original research articles and develop their presentation and writing skills by leading seminars and writing scientific reports.

At the early undergraduate level, I am confident in my ability to teach courses in systems neuroscience and computer science. As a PhD student, I served as a teaching assistant, tutor and guest lecturer in many undergraduate courses, contributing to curriculum specification and development, tutorial design and supervision, and evaluation of student grades. At the senior-undergraduate and graduate levels, I have the skills and experience to teach more specialized courses in computational neuroscience, neural networks and decision making. As a postdoctoral fellow, I have regularly served as a guest lecturer in graduate courses in computational and systems neuroscience. Currently, my responsibilities in these courses include curriculum specification and development, student supervision, and evaluation of grades. I would enjoy the challenge of teaching computational neuroscience to students with limited background in computational methods, as well as to more junior undergraduate students. Such a course would be more conceptual than at the graduate level, but would emphasize the important role of models in neuroscience and the mechanistic understanding of brain function.

As a mentor, I have served as a thesis supervisor to undergraduate (Honours) and Masters students in neuroscience, including theoretical and experimental projects. As a faculty member, I intend to recruit students and postdoctoral researchers to undertake modelling studies that address various aspects of brain function (described in my research statement). I intend to train members of my lab in these methods, as well as in scientific communication, both through conference presentations and journal publications. I will also undertake joint research supervision with experimentalists and clinicians. As much as possible, my teaching and research programs will be informed and motivated by each other.