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Chair, Search Committee
Department of Neuroscience
Brown University

April 27, 2012

Re: Tenure-track Assistant Professor Position in Computational Neuroscience

Dear Professor Sheinberg

I am an experienced postdoctoral researcher seeking to make the transition to a faculty position. My area of expertise is computational and visual neuroscience. Should I be appointed to the position of assistant professor in your department, I would establish a computational neuroscience laboratory, and seek to develop an externally funded research program based on a revolutionary theoretical approach to the problem of perceptual representation—with important general implications for psychology, neuroscience, and computer science—that I have been developing over the past few years. I am supplying the search committee with three papers that showcase the promising nature of this new approach. One is a reprint published in *PloS Computational Biology*, and the other two are preprints currently under consideration at *Vision Research* and *Nature*, respectively. Please also find attached my curriculum vitae, contact information for my references, a research statement, and a teaching statement.

I would look forward to collaborating with researchers interested in fundamental computational aspects of perceptual representation. My new theoretical approach makes a number of psychophysical and neurophysiological predictions that could be tested in collaboration with experts in visual representation, such as Professors **Paradiso** and **Berson**. Professors **Bienenstock** and **Sheinberg** may be interested in collaborating on new computational opportunities for understanding the relationship between perceptual and cognitive object representation in the brain. I also have experience in the application of computational approaches to psychiatric diseases, such as autism and schizophrenia, and would look forward to collaborating with clinically oriented researchers with similar interests.

I look forward to hearing from you in the near future.

Yours sincerely

Tony Vladusich, PhD

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Contact Information

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Research Interests

Computational neuroscience: I am broadly interested in computational approaches to the problem of perceptual representation. My current research focuses specifically on visual surface representation, exploring the relationship between modes of perception (brightness and lightness), dimensions of perception (blackness and whiteness), dimensions of processing in the brain (ON and OFF channels), and dimensions of the physical world (luminance and reflectance)

Academic Appointments

Visiting Researcher 2009 to present
Center for Computational Neuroscience and Neural Technology (CompNet), Boston University, USA

- "Computational theory of visual surface representation"
- Mentor: Professor Eric Schwartz

Postdoctoral Researcher 2009 to present
Department of Biology, Brandeis University, USA

- "Cortical network models of taste processing: dynamics and plasticity" (NIH-NSF grant: R01DC00945)
- Supervisor (PI): Professor Paul Miller

Postdoctoral Researcher 2007 to 2009
Department of Cognitive and Neural Systems, Boston University, USA

- "Learning, categorization, and autism: Experimental and computational tests of a new neural model of autism" (NSF grant: SBE-0354378)
- Supervisor (PI): Professor Stephen Grossberg

Postdoctoral Researcher 2003 to 2007
Department of Ophthalmology, Groningen University, The Netherlands

- "Natural color constancy" (NWO grant: 051.02.080)
- Supervisor (PI): Dr Frans Cornelissen

Education

Ph.D., The Australian National University, 2004

- Thesis: *Navigation strategies of the honeybee*
- Adviser: Professor M. Srinivasan
- Area of Study: Neuroscience

B.Sc., The University of Queensland and The Australian National University, 1999

- *First Class Honors in Neuroscience*

PUBLICATIONS

[1] **Vladusich, T.** (2012c). Perceptual and physical dimensions are dissociated in brightness and lightness perception. (Submitted to *Nature*).

[2] **Vladusich, T.** (2012b). Simultaneous contrast and gamut relativity in achromatic color perception. (Submitted to *Vision Research*).

[3] Sadacca, B.F., **Vladusich, T.**, Miller, P. and Katz, D.B. (2012a). Behaviorally relevant network states revealed through analysis of trial-to-trial variability in cortical activity. (Submitted to *Nature Neuroscience*).

[4] Guenther, F.H. and **Vladusich, T.** (in press). A neural theory of speech acquisition and production. *Journal of Neurolinguistics*.

[5] Grossberg, S., and **Vladusich, T.** (2010). How do children learn to follow gaze, share joint attention, imitate their teachers, and use tools during social interactions? *Neural Networks*, 23, 940-965.

[6] **Vladusich, T.**, Lafe, F., Kim, D.S, Tager-Flusberg, H. and Grossberg, S. (2010). Prototypical category learning in high-functioning autism. *Autism Research*, 3, 226-236.

[7] **Vladusich, T.** (2008). Towards a computational neuroscience of autism-psychosis spectrum disorders. *Behavioral and Brain Sciences*, 31, 282-283.

[8] Pietersen, C.Y., Bosker, F.J., **Vladusich, T.**, Doorduin, J., Jongsma, M.E., Postema, F., and den Boer, J.A. (2007). An animal model of emotional blunting in schizophrenia. *PloS ONE*, 2: e1630.

[9] **Vladusich, T.**, Lucassen, M.P. and Cornelissen, F.W. (2007). Brightness and darkness as perceptual dimensions. *PloS Computational Biology*, 3: e179.

[10] **Vladusich, T.** (2007). Chromatic aberration and the roles of double-opponent and color-luminance neurons in color vision. *Neural Networks*, 20, 153-155.

[11] Van Es, J.J., **Vladusich, T.** and Cornelissen, F.W. (2007). Local and relational judgments of surface color: constancy indices and discrimination performance. *Spatial Vision*, 20, 139-154.

[12] Cornelissen, F.W. and **Vladusich, T.** (2006). What gets filled-in during filling-in? *Nature Reviews Neuroscience*, 7, doi:10.1038/nrn1869-c1.

[13] **Vladusich, T.**, Lucassen, M.P. and Cornelissen, F.W. (2006). Edge integration and the perception of brightness and darkness. *Journal of Vision*, 6, 1126-1147.

[14] **Vladusich, T.**, Lucassen, M.P. and Cornelissen, F.W. (2006). Do cortical neurons process luminance or contrast to encode surface properties? *Journal of Neurophysiology*, 95, 2638-2649.

[15] Cornelissen, F.W, Wade, A.R., **Vladusich, T.** Dougherty, R.F. and Wandell, B.A. (2006). No functional magnetic resonance imaging evidence for brightness and color filling-in in early human visual cortex. *Journal of Neuroscience*, 26, 3634-3641.

[16] **Vladusich, T.**, Hemmi, J.M. and Zeil, J. (2006). Honeybee odometry and scent guidance. *Journal of Experimental Biology*, 209, 1367-1375.

[17] **Vladusich, T.**, Hemmi, J.M., Srinivasan, M.V. and Zeil, J. (2005). Interactions of visual odometry and landmark guidance during food search in honeybees. *Journal of Experimental Biology*, 208, 4123-4135.

[18] **Vladusich, T.** and Broerse, J. (2002). Color constancy and the functional significance of the McCollough effect. *Neural Networks*, 15, 775-809.

[19] **Vladusich, T.** (2001). Perceptual filling-in and the resonant binding of distributed cortical representations. *Behavioral and Brain Sciences*, 24, 1136-1137.

[20] Broerse, J., **Vladusich, T.** and OShea, R.P. (1999). Colour at edges and colour spreading in the McCollough effect. *Vision Research*, 39, 1305-1320.

References

Professor Eric Schwartz
- Computational Neuroscience Laboratory, Department of Cognitive and Neural Systems, Boston University
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Professor Stephen Grossberg
- Former Director, Department of Cognitive and Neural Systems, Boston University
- e-mail: steve@bu.edu; phone: +1 617 353 9481

Professor Paul Miller
- Computational Neuroscience Laboratory, Department of Biology, Brandeis University
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RESEARCH STATEMENT

TONY VLADUSICH

1. Executive summary

I am interested in identifying the fundamental computational properties of the brain underlying perceptual representation, particularly the perception of black, white and gray shades in human vision. I believe that the identification of the computational properties of this perceptual system will reveal key generic insights into the relationship between the mind, the brain and the outside world. My long-term goal is to establish a computational research program to understand aspects of both perceptual and cognitive representation in health and disease.

2. Past research

I have extensive experience in experimental and computational neuroscience, having conducted research on topics ranging from honeybee navigation to visual pattern recognition in autism. The common thread running through this research background is my desire to understand the nature of perceptual representation.

3. Current research

My current post-doctoral work at Brandeis University is primarily of a computational nature, involving theoretical analyses of taste perception. I am also conducting research as a visiting researcher at Boston University, investigating the computational basis of the perception of black, white and gray shades. This latter research activity has resulted in a revolutionary computational approach to the representation of black, white and grays shades. I have two manuscripts documenting these findings under consideration at *Vision Research* and *Nature* (preprint versions of these manuscripts appear in my application materials). The nature of the conclusions drawn from this work are such to suggest some far reaching implications concerning the relationship between the mind, the brain and the outside world. I therefore believe that this work may have the potential to profoundly influence the fields of psychology, neuroscience and computer science.

4. Future research

Firstly, I envisage that my research program in the short-term would largely involve further development of the new computational approach indicated above, as it applies directly to the representation of black, white and gray shades. I believe this program may hold some collaborative appeal with respect to Professor **Paradiso's** interests in lightness perception and Professor **Berson's** interests in neural coding in the early visual system. Secondly, I have have also developed and written a research proposal relating to the topic of spatial surface representation in vision (i.e. filling in). This project would require a collaboration with experts in functional magnetic resonance imaging, such as Professor **Sanes**, and putative filling-in processes in early visual cortex, such as Professor **Paradiso**. My longer-term vision is to generalize the ideas inherent in my new computational approach to create a research program that addresses a broader range of issues in neuroscience and psychology. I am particularly interested in the computational relationship between perceptual and cognitive object representation in the brain, and how this nexus breaks down in mental disorders,

such as autism and schizophrenia. I believe these interests may provide a basis for collaborations with Professor **Bienenstock**, Professor **Sheinberg** and other researchers at Brown.

5. Fit to the department

I believe my areas of expertise in computational neuroscience complement the department's existing strengths. As indicated above and in my cover letter, I would look forward to collaborating with a number of experimentally and computationally inclined researchers in both the Neuroscience Department and the wider Brown neuroscience community. I believe the novelty and explanatory power of the approach that I plan to develop can only contribute in a positive way to these established research programs, and conversely, that these established programs will provide valuable data and insights to catalyze future fundamental computational discoveries.

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TEACHING STATEMENT

TONY VLADUSICH

1. Executive summary

I am interested in teaching a unique set of courses aimed at introducing undergraduate and graduate students to the 'problem of representation' in computational neuroscience. (I define the problem of representation loosely as the problem of specifying the data structures, algorithms and neural implementations in the brain that underlie perception.) My approach would focus primarily on providing students with a firm grounding in historically important approaches and methods, particularly with respect to spatial representation in vision science. My long-term goal is to develop a curriculum that provides students with a unique combination of computational skills to tackle multi-disciplinary research problems with confidence and competence.

2. Spatial vision as a microcosm of the representation problem

I would attempt to set in a historical context various applications of the following (and related) methods in spatial vision research: Gradient and Laplacian operators, wavelet pyramids, diffusion, Fourier transforms, and log-polar maps. Although typically treated as separate representational approaches in conventional courses and research applications, these techniques share common threads that I would seek to synthesize into a deep conceptual understanding at the advanced level. Many of these techniques are also generically useful in various branches of neuroscience.

3. Undergraduate teaching

At the early undergraduate level, I would seek to emphasize the key aspects of visual perception that require computational understanding and explore the elementary structure and function of the primate visual system in terms of extant computational techniques. This material will incorporate critical appraisals of the relative successes and failures of various techniques (e.g. the proposal that primary visual cortex performs a Fourier transform). At the higher undergraduate level, this expository material will be complemented with class projects involving the design and programming of computational methods.

4. Post-graduate teaching

At the post-graduate level, I would aim to teach research-level material, directly analyzing key publications in the vast literature on spatial vision. Class projects will encourage students to think critically and independently as preparation for post-graduate research activities.

5. Teaching Experience

My teaching experience involves guest lectures in the Perception and Attention class of Dr Broerse at University of Queensland, and the Computational Neuroscience class of Professor Schwartz at Boston University. I've always enjoyed these experiences and look forward to more-structured teaching opportunities in the future. I have, furthermore, given many oral and poster presentations at international scientific conferences, such as the European Conference on Visual Perception, Society for Neuroscience, and Vision Sciences Society.

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