

David C. Somers, Ph.D.

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Research Overview

Research investigates neural mechanisms of visual perception and attention using both experimental and computational approaches. Experimental studies focus on human perception using functional magnetic resonance imaging (fMRI) and visual psychophysics. Computational studies focus on detailed modeling of the neural circuitry of visual cortex.

Academic Employment History

Research Scientist, Perceptual Science Laboratory, Department of Brain & Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA, March 1996-September 2000.

Research Scientist, Nuclear Magnetic Resonance Center, Department of Radiology, Massachusetts General Hospital, Charlestown, MA, March 1997-June 2000.

Assistant Professor, Department of Psychology, Rutgers University, Newark, NJ, January 2000-June 2000.

Adjunct Assistant Professor, Department of Radiology, University of Medicine & Dentistry of New Jersey, Newark, NJ, January 2000-June 2000.

Assistant Professor, Department of Psychology, Boston University, Boston MA, July 2000 – present.

Visiting Scientist, Nuclear Magnetic Resonance Center, Department of Radiology, Massachusetts Institute of Technology, July 2000 – present.

Assistant Professor, Program in Neuroscience, Boston University, Boston MA, Jan 2001-present.

Assistant Professor, Program in Mathematical and Computational Neuroscience, Boston University, Boston MA, Jan 2001- present.

Research Fellow, Department of Cognitive & Neural Systems, Boston University, Boston MA May 2001 - present

Education & Training

B.S., Mathematics and Computer Science, Harvey Mudd College, Claremont, CA. 1987.
Psychology Minor.

Ph.D., Cognitive and Neural Systems, Boston University, Boston, MA. 1993.

Research and training in cognitive science, neural networks, visual perception, and dynamical systems. Thesis research on coupled neural oscillators and perceptual feature binding. Thesis Advisors: Stephen Grossberg, founding president, International Neural Network Society, and Nancy Kopell, member, National Academy of Sciences and MacArthur Fellow.

Post-Doctoral Fellow, Computational & Cognitive Neuroscience, Department of Brain & Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA, 1992-1997. Neuroscience research and training in the laboratory of Mriganka Sur. Computational research focused on circuit-level models of visual cortex: orientation selectivity, non-classical receptive field properties.

Grants, Honors, & Awards

- Student Body President, Harvey Mudd College, 1985--86.
- Durfee Foundation Award, Study of Science & Engineering Education, China, 1987.
- College Fellow, Harvey Mudd College, 1986--87.
- Who's Who Among Students in American Colleges and Universities, 1987.
- Thomas J. Watson Fellow, Independent Study in England, India, & Nepal, 1987--88.
- Presidential University Fellow, Boston University, 1988--89.
- NASA Graduate Student Research Fellow, 1989--1992.
- McDonnell--Pew Fellow in Cognitive Neuroscience, 1992-1994.
- NIH Postdoctoral Research Fellow, Computational Neuroscience, NIMH, 1994-1997.
- NSF, Co-investigator, Human Cognition and Perception Program, Proposal Funded, 1999-2002.
- NIH/NEI, Co-investigator, National Eye Institute, Proposal Funded, 1999-2002.
- NSF grant BCS-0236737, "Mechanisms of Attentional Selection in Human Visual Cortex," Principal Investigator, Cognitive Neuroscience Program, 2003-2006
- NIH/NEI, Mentor/Sponsor, post-doctoral grant to Dr. Lotfi Merabet. "The Role of Visual Cortex in Tactile Object Processing."

National Organizational Committees

Society for Neuroscience, Education Committee, Board Member 2002-2005.

Selected Invited Research Lectures

NASA – Johnson Space Center, Houston, TX, 1991.

National Institute of Health, Bethesda, MD, 1992.

McMaster University, Hamilton, Ont, Canada, 1992.

Boston University, Boston, MA, 1994, 1999, 2000.

Harvard University, Cambridge, MA, 1995, 1999.

Johns Hopkins University, Baltimore, MD, 1995.

Neurosciences Institute, La Jolla, CA, 1995.

Brandeis University, Waltham, MA, 1995.
New York University, New York, NY, 1995.
MIT Artificial Intelligence Laboratory, Cambridge, MA, 1995.
Frei Universitat, Berlin, Germany, 1996.
Georgetown Medical School, Washington, D.C., 1997.
Duke University, Durham, NC, 1997.
Brown University, Providence, RI, 1997.
Universidad Autonoma de Madrid, Madrid, Spain, 1998.
Maryland Psychiatric Research Institute, Baltimore, MD, 1998.
Courant Institute of Applied Mathematics, New York, NY, 1998
Institute for Mathematics and its Applications, Minneapolis, MN, 1998.
Instituto Juan March, Madrid Spain, 1998.
West Virginia School of Medicine, Morgantown, WV, 1999.
Boston University Medical School, Boston MA, 1999.
Harvard Medical School, Boston, MA, 1999.
Dartmouth University, Hanover, NH, 2000.
NEC Research Labs, Princeton, MA, 2000.
Japanese Winter Workshop on Mind & Brain, Rusutsu, Hokkaido, Japan, 2001.
NTT Research Laboratory, Atsugi, Japan, 2001.
Brigham & Women's Hospital, Boston, MA 2001.
Brigham & Women's Hospital, Boston, MA 2005.

Invited Address

Convocation Address, Harvey Mudd College, Claremont, CA., August 2000.

Seminars & Symposia Organized

MIT Cognitive Neuroscience Colloquium Series Coordinator, 1993-1994.

Computational Neuroscience *94 -- "Recurrent models of cortical circuitry"

Computational Neuroscience *96 -- "Visual Cortical Orientation Selectivity, (w/ M. Carandini).

Teaching

Summer Course in Methods in Computational Neuroscience, Marine Biological Laboratories, Woods Hole, MA, 1996.

Models of Visual Perception, (graduate-level), Boston University, Invited Lecturer, 1996, 2001.

Computational Neuroscience, (graduate-level), Boston University, Invited Lecturer, 1997.

International Mathematical Association Workshop on Computational Neuroscience, Invited Lecturer, 1998.

Introduction to Cognitive Psychology, (undergraduate-level), Boston University, Professor, Spring '01, Fall '01, Spring '02, Fall '02, Spring '03, Summer I '03, Fall '03, Spring '04, Summer I '04, Fall '04, Spring '05.

Systems & Cognitive Neuroscience, Boston University, Participating Lecturer, Spring '01, Spring '02, Spring '03, Spring '04, Spring '05

Seminar in Human Brain Mapping (Contemporary Trends in Psychology), (mixed graduate & undergraduate), Boston University, Professor, Fall '01, Fall '02, Fall '03, Spring '05

Research Methods in Perception & Cognition (mixed graduate & undergraduate), Boston University, Professor, Spring '02, Spring '03, Spring '04

Referee Duties

Study section reviewer, temporary member, NIH, Sensorimotor Integration NRSA panel, Feb 2005.

Study section reviewer, temporary member, NIH, NEI, Central Visual Processes panel, Oct 2004.

Ad hoc grant reviewer, NSF, Program in Computational Neuroscience, 1994--95, 1999.

Ad hoc grant reviewer, NIH, NEI, Visual Section B, 1999.

Grant Reviewer, Biomedical Research Council of Singapore, 2001.

Grant Reviewer, Binational Science Foundation, 1999, 2004.

Grant Reviewer, NSF, 2002.

Conference Referee, Neural Information Processing Seminars (NIPS), 1996

Conference Referee, International Conference on Neural Networks (ICNN), 1997.

Journal Referee, Neural Networks, 1993, 1995, 1997, 1998.

Journal Referee, Journal of Neuroscience, 1995, 1997, 1998, 1999, 2001, 2002.

Journal Referee, Visual Neuroscience, 1996.

Journal Referee, Neural Computation, 1996, 1998, 1999, 2000.

Journal Referee, Journal of Computational Neuroscience, 1996, 1998.

Journal Referee, Physica D, 1996.

Journal Referee, Proceedings of the National Academy of Sciences, (USA), 1996, 1998, 2002.

Journal Referee, Nature, 1999, 2000, 2001.

Journal Referee, Nature Neuroscience, 2000, 2002.

Journal Referee, Network, 2000.

Journal Referee, Vision Research, 2000, 2003.

Journal Referee, Journal of Optical Society of America, 2001.

Journal Referee, Journal of Neurophysiology, 2001, 2003.

Journal Referee, *Neuron*, 2001, 2002, 2003, 2004

Journal Referee, *NeuroImage*, 2002, 2003

Journal Referee, *Current Biology* 2003

Journal Referee, *Cerebral Cortex*, 2004

Cover Artwork Credits

Journal of Neuroscience, Vol. 15, No. 8, August 1995.

Cerebral Cortex, Vol. 8, No. 3, April/May 1998.

Journal of Cognitive Neuroscience, Vol. 12, No. 3, May 2000.

Cognitive Neuroscience of Memory: An Introduction (by H. Eichenbaum), Oxford Univ. Press, 2002.

Group Exhibition

“In the mind’s sky: Intersections of art and science.” Ruth Chandler Williamson Gallery, Scripps College, Claremont, California. Aug.-Oct. 2000.

“Intrinsic Profiles” Grand Opening Ceremonies, Center for Mind and Brain, University of California, Davis, California, April 2004.

Research Papers

1. *Grossberg, S., and Somers, D.C. (1991) Synchronized oscillations during cooperative feature linking in a cortical model of visual perception. *Neural Networks*, 4, 453--466.
2. *Grossberg, S., and Somers, D.C. (1992) Synchronized oscillations for binding spatially distributed features into pre-attentive brain representations. *Structure: From Physics to General Systems*. E. R. Caianello, M. Marinaro, and G. Scarpetta, (Eds.) World Scientific Press.
3. *Grossberg, S., and Somers, D.C. (1992) Synchronized oscillations for binding spatially distributed feature codes into coherent spatial patterns. *Neural Networks for Vision and Image Processing*. G.A. Carpenter and S. Grossberg (Eds.) Cambridge, MA: MIT Press.

(*)-- Ph.D.~Thesis research papers written with S. Grossberg were published in accordance with departmental policy of listing authors alphabetically.

4. Somers, D.C., and Kopell, N. (1993) Rapid synchronization through fast threshold modulation. *Biological Cybernetics* 68, 393-407.
5. Somers, D.C. (1993) Synchronization in networks of neural relaxation oscillators: visual cortical processing and intrinsic oscillator properties. Ph.D. Thesis.

6. Kopell, N., and Somers, D.C. (1995) Anti-phase solutions in relaxation oscillators coupled through excitatory interactions. *Journal of Mathematical Biology* 33, 261--280.
7. Somers, D.C., Nelson, S.B., and Sur, M. (1995) An emergent model of orientation selectivity in cat visual cortical simple cells. *Journal of Neuroscience*, 15, 5448-5465, August cover feature.
8. Somers, D.C., Todorov, E.V., Siapas, A.G., and Sur, M. (1995) Vector-based integration of local and long-range information in visual cortex. MIT Artificial Intelligence Laboratory Memo No. 1556. & Center for Biological and Computational Learning Memo No. 127.
9. Somers, D.C., Todorov, E.V., Toth, L.J., Rao, S.C., Kim, D.-S., Nelson, S.B., Siapas, A.G., and Sur, M. (1995). Variable gain properties of local cortical circuitry support context-dependent modulation by fixed strength long-range horizontal connections. *Computational Roles of Lateral Connections in the Cortex*. J. Sirosh, R. Miikkulainen (Eds.) Univ. of Texas, Electronic Book. URL: <http://www.cs.utexas.edu/users/nn/web-pubs/htmlbook96/somers/>
10. Somers, D.C., and Kopell, N. (1995) Waves and synchrony in networks of oscillators of relaxation and non-relaxation type. *Physica D: Nonlinear Phenomena*, 89, 169-183.
11. Somers, D.C., Nelson, S.B., and Sur, M. (1995) An emergent model of visual cortical orientation selectivity. *The Neurobiology of Computation*. J.M. Bower (Ed.) Norwell, MA: Kluwer Academic Press.
12. Toth, L.J., Rao, S.C., Kim, D.S., Somers, D.C., and Sur, M. (1996) Subthreshold facilitation and suppression in primary visual cortex revealed by intrinsic signal imaging. *Proceedings of the National Academy of Sciences*, 93, 9869-9874.
13. Todorov, E.V., Siapas, A.G., Somers, D.C., and Nelson, S.B. (1997) Modeling visual cortical contrast adaptation effects. *Computational Neuroscience, Trends in Research, 1997*. J.M. Bower (Ed.), pp 525--531. New York: Plenum Press.
14. Todorov, E.V., Siapas, A.G., and Somers, D.C. (1997) A model of recurrent interactions in primary visual cortex. *Advances in Neural Information Processing Systems*, vol. 9 M.C Mozer, M.I. Jordan, T. Petsche (Eds.), pp 118-124. Cambridge, MA: MIT Press.
15. Somers, D.C., Todorov, E.V., Siapas, A.G., and Sur, M. (1997) A local circuit integration approach to understanding visual cortical receptive fields. *Computational Neuroscience, Trends in Research, 1997*. J.M. Bower (Ed.), pp 505--510. New York: Plenum Press.
16. Somers, D.C., Todorov, E.V., Siapas, A.G., Toth, L.J., Kim, D.S., and Sur, M. (1998) A local circuit integration approach to understanding visual cortical receptive fields, *Cerebral Cortex*, 8, 204-217. Cover Feature.
17. Somers, D.C., Dale, A.M., Seiffert, A.E., and Tootell, R.B.H. (1999) Functional MRI reveals spatially specific attentional modulation in human primary visual cortex, *Proc. Natl. Acad. Sci. USA.*, 96, 1663-1668.
See also Commentary by M.I. Posner & C.D. Gilbert, pp. 2585-2587.

18. Kwong, K.K., Somers, D.C., Wu, O. and Chesler, D. A. (1999) High temporal resolution event-related fMRI. *Ultrafast Magnetic Resonance Imaging in Medicine*. S. Naruse and H. Watari (Ed.) pp 149-152. Amsterdam: Elsevier Science.
19. Somers, D.C., Dragoi V., and Sur, M. (2001) Orientation selectivity and its modulation by local and long-range connections in visual cortex. *Cerebral Cortex*, Volume 15, Cat Primary Visual Cortex. B. Payne and A. Peters (Eds.) New York: Academic Press.
20. Seiffert, A.E., Somers, D.C., Dale, A.M., and Tootell, R.B.H. (2003) Functional MRI studies of human motion perception: Texture, luminance, attention, and after-effects. *Cerebral Cortex* 13, 340-349.
21. McMains, S. and Somers, D.C. (2004) Multiple Spotlights of Attentional Selection in Human Visual Cortex. *Neuron*, 42, 677-686.
See also Commentary by F. Tong, pp. 524-526.
22. Somers, D.C. and McMains, S. (2004) Spatially-Specific Attentional Modulation Revealed by fMRI. *Neurobiology of Attention*. L. Itti, G. Rees, J. Tsotsos (Eds.) New York: Academic Press, in press.
23. Logvinenko, A.D., Adelson, E.H., Ross, D.A. & Somers, D.C. (2005). Straightness as a cue for luminance edge classification. *Perception & Psychophysics*, in press.
24. Merabet, L.B., Rizzo, J.F., Somers, D.C., Pascual-Leone, A.(2005) What blindness can tell us about seeing again. *Nature Reviews Neuroscience*, 6, 71-77.

ABSTRACTS

- Grossberg, S., and Somers, D.C. (1991) Synchronized oscillations during cooperative feature linking in visual cortex. *Proceedings of the International Joint Conference on Neural Networks*, 1991 SEATTLE, Vol. 2, 249--254.
- Somers, D.C., and Grossberg, S. (1991) Synchronized oscillations during cooperative feature linking in a model of visual cortex. *Society for Neuroscience Abstracts*, 17, 479.2.
- Somers, D.C., and Kopell, N. (1992) Threshold properties of individual model neural oscillators contribute to rapid network synchronization and may potentially play a role in perceptual feature binding. *Society for Neuroscience Abstracts*, 18, 131.6.
- Somers, D.C., Nelson, S.B., and Sur, M. (1993) A computational investigation of the role of short—range intracortical excitation in orientation selectivity in visual cortex. *Society for Neuroscience Abstracts*, 19, 263.5.
- Somers, D.C. (1993) Dynamic feature binding properties of neural relaxation oscillators. *Invest. Ophthalmol. Vis. Sci. Suppl.*, 34 (4), 457.
- Somers, D.C., Nelson, S.B., and Sur, M (1994) Effects of long-range connections on gain control in an emergent model of visual cortical orientation selectivity. *Society for Neuroscience Abstracts*, 20, 646.7.

- Somers, D.C., Nelson, S.B., and Sur, M (1995) Analysis of temporal dynamics of orientation selectivity in feedback and feedforward models of visual cortex. Society for Neuroscience Abstracts, 21, 162.1.
- Siapas, A.G., Todorov, E., and Somers, D.C. (1995) Computing mean firing rates of ensembles of realistic neurons. Society for Neuroscience Abstracts, 21, 649.4
- Somers, D.C., Todorov, E.V., Siapas, A.G., and Nelson, S.B. (1996) Contrast adaptation effects modeled as thalamocortical and intracortical synaptic transmission changes. Society for Neuroscience Abstracts, 22, 254.19
- Somers, D.C. and Adelson, E.H. (1997) Junctions, transparency, and brightness. Invest. Ophthalmol. Vis. Sci. Suppl., 38 (4), 2126
- Dragoi, V. and Somers, D.C. (1997) Short and long-term plastic effects induced by the multiple time scales of events at the cellular and synaptic level in a model of spiking neurons in primary visual cortex. Invest. Ophthalmol. Vis. Sci. Suppl., 38 (4), 1791.
- E.H. Adelson and Somers, D.C. (1997) Statistics and configuration in lightness perception. European Conference on Visual Perception, oral presentation.
- Mazer, J.A., Somers, D.C, and Adelson, E.H. (1997) Sensitivity of area V1 neurons to apparent brightness in awake behaving macaque monkeys. Society for Neuroscience Abstracts, 23, 178.3.
- Somers, D.C., Dale, A.M., Mendola, J.D., Adelson, E.H., and Tootell, R.B.H. (1997) A functional magnetic resonance imaging investigation of apparent brightness perception. Society for Neuroscience Abstracts, 23, 178.22.
- Somers, D.C., Seiffert, A.E., Dale, A.M., and Tootell, R.B.H. (1998) Second-order motion stimulus-induced activation and attentional modulation of human visual cortical areas MT and V3A. Invest. Ophthalmol. Vis. Sci. Suppl., 39, S1129.
- Somers, D.C., Seiffert, A.E., Dale, A.M., and Tootell, R.B.H. (1998) fMRI analysis of 2nd-order visual motion perception and attentive tracking. NeuroImage, 7, S323.
- Somers, D.C., Seiffert, A.E., Dale, A.M., and Tootell, R.B.H. (1998) An fMRI investigation of second-order visual motion processing with attentional modulation. Society for Neuroscience Abstracts, 24, 213.4.
- Somers, D.C., Seiffert, A.E., Dale, A.M., and Tootell, R.B.H. (1999) fMRI investigations of motion aftereffects with 1st and 2nd-order stimuli. Invest. Ophthalmol. Vis. Sci. Suppl., 40, S1049.
- Tootell, R.B.H., Hadjikhani, N., and Somers, D.C. (1999) fMRI reveals subthreshold activation in human visual cortex: implications for consciousness. Society for Neuroscience Abstracts, 25, 6.12
- Somers, D.C., Seiffert, A.E., Dale, A.M., and Tootell, R.B.H. (1999) Effects of task difficulty and stimulus contrast on attentional modulation in human striate and extrastriate cortex revealed by fMRI. Society for Neuroscience Abstracts, 25, 6.10

- Somers, D.C., Nichols, K.R., and Adelson, E.H. (2000) Temporal dynamics reveal multiple mechanisms of brightness perception. *Invest. Ophthalmol. Vis. Sci. Suppl.*, 41, S956.
- Adelson, E. H. and Somers, D.C. (2000) Shadows are fuzzy and straight; paint is sharp and crooked. *European Conference on visual Perception* 142.
- Adelson, E.H., and Somers, D.C (2001) Straightness, Structure, and Shadows. *Journal of Vision*, vol. 1, no. 3, A204.
- McMains, S.A. and Somers, D.C. (2002) Functional MRI investigation of multiple foci of visual spatial attention: More than one spotlight? *Cognitive Neuroscience Society Meeting*.
- McMains, S.A. and Somers, D.C. (2002) Multiple Spotlights of Attentional Selection in Human Visual Cortex .*Society for Neuroscience Meeting*.
- Somers, D.C., and McNally, R. (2003) Kinesthetic Visual Capture Induced By Apparent Motion. *Journal of Vision*, vol. 3, no. 7, TA43.
- Swisher, J., Brooking, C., Somers, D. (2004) Spatial frequency and facial expressions of emotion, *Vision Sciences Society Meeting* (to be published in *Journal of Vision*, vol 4.)
- McMains, S.A. and Somers, D.C. (2004) fMRI cost-benefit analysis of split spotlight and zoom lens spatial attention mechanisms in human visual cortex. *Society for Neuroscience Meeting*.
- Halko, M.A. and Somers, D.C. (2004) Robust, moving illusory contours induced by ‘munching’ pacman Kanizsa display. *Society for Neuroscience Meeting*.
- Swisher, J.D. and Somers, D.C. (2004) Multitaper analysis of phase-encoded functional imaging data. *Society for Neuroscience Meeting*.