

Frank H. Guenther

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OVERVIEW

I am a computational and cognitive neuroscientist specializing in speech and sensorimotor control. My research combines theoretical modeling with behavioral and neuroimaging experiments to characterize the neural computations underlying these faculties in humans. I also develop brain-computer interfaces to restore synthetic speech or other communication skills to paralyzed individuals.

POSITIONS

- **Associate Director, Graduate Program for Neuroscience, Boston University (1/2010 – present)**
Responsible for oversight of the Charles River Campus component of the newly formed university-wide Graduate Program for Neuroscience. This program unites faculty from the University's Medical School, College of Arts and Sciences, College of Engineering, and College of Health and Rehabilitation Sciences into a single program that provides training in all aspects of neuroscience, including coursework in molecular, cellular, systems, cognitive, and computational neuroscience. I am also on the curriculum committee for the computational neuroscience specialization.
- **Professor, Boston University (9/2008 - present)**
Responsibilities include teaching graduate-level courses in the Department of Cognitive and Neural Systems, supervising graduate student dissertation research, acting as Principal Investigator on research sponsored by the National Institutes of Health, and acting as an investigator on a number of other research projects. Research areas include neural modeling and functional brain imaging of speech production, speech perception, and communication disorders, as well as neural prosthetics for speech. I am Director of the CNS Speech Lab and Neural Prosthesis Lab, including supervision of 9 graduate students, 4 postdoctoral fellows, and 2 research assistant professors on NIH- and NSF-sponsored projects.
- **Faculty Member, Harvard University/MIT (9/1998 – Present)**
Responsibilities include graduate student dissertation research supervision and occasional teaching in the Harvard/MIT joint program in Speech and Hearing Bioscience and Technology, Division of Health Sciences and Technology.
- **Research Affiliate, Massachusetts Institute of Technology (4/1997 – Present)**
Perform collaborative research with Dr. Joseph Perkell and other members of the Speech Communication Group in the Research Laboratory of Electronics. This collaborative effort fuses our modeling work with the experimental program headed by Dr. Perkell.
- **Visiting Scientist, Massachusetts General Hospital (6/2003 – Present)**
Perform fMRI research at the MGH NMR Center in Charlestown, MA.
- **Associate and Assistant Professor, Boston University (9/1992 – 8/2008)**
Responsibilities included teaching graduate-level courses in the Department of Cognitive and Neural Systems, supervising graduate student dissertation research, and performing research sponsored by the National Institutes of Health, the Alfred P. Sloan Foundation, and the Air Force Office of

Scientific Research. Research involved studies of speech communication, adaptive sensorimotor control, spatial representation, and autonomous robot navigation.

- **Research Fellow, Boston University (9/1989 – 8/1992)**
Performed NSF-supported research on adaptive sensory-motor control with Professors Stephen Grossberg and Daniel Bullock. Projects included neural modeling of spatial representation and inverse kinematics transformations for targeted arm movements. Emphasis was on autonomous learning and motor equivalence properties such as tool use and the ability to overcome constraints on the limb.
- **Engineer, Raytheon Company (9/1987 – 8/1989)**
Performed specification, design, layout, and testing of VLSI chips and circuits. Wrote modeling software and application programs in C and PASCAL.
- **Teaching and Research Fellow, Princeton University (8/1986 – 6/1987)**
Served as a teaching/research assistant while obtaining a Masters degree in Electrical Engineering.

EDUCATION

- **PhD, Cognitive and Neural Systems, Boston University (1/1993)**
Thesis entitled "Neural models of adaptive sensory-motor control for flexible reaching and speaking." Research focused on biologically inspired models of spatial representation and movement control. Curriculum covered the study and mathematical modeling of neural systems, including motor control, reinforcement learning, vision, speech, and memory systems. 4.0/4.0 GPA.
- **MSE, Electrical Engineering, Princeton University (8/1987)**
Coursework included digital systems design, probability theory, signal processing, computer algorithm theory, and complex analysis. 3.9/4.0 GPA.
- **BS, Electrical Engineering, University of Missouri (5/1986)**
Ranked 1st in a class of over 500 students in the College of Engineering with a 4.0/4.0 GPA.

AWARDS AND HONORS

- 2009 – Distinguished Lecturer in Cognitive Science, Michigan State University
- 2008 - Elected Fellow of the Acoustical Society of America
- 2007 Editor's Award for top article in speech, *Journal of Speech, Language, and Hearing Research*
- 2007 Editor's Award for top article in hearing, *Journal of Speech, Language, and Hearing Research*
- 2007 Willard R. Zemlin Lecture Award, American Speech-Language-Hearing Association
- 2006 M.D. Steer Distinguished Lecturer, Purdue University
- 2004 Distinguished Lecturer in Speech and Hearing Bioscience and Technology, Harvard/MIT
- 2002 - Nominated for Metcalf Cup and Prize for Excellence in Teaching
- 1998 - Awarded tenure at Boston University
- 1996-2001 - NIH FIRST Award
- 1995-1997 - Alfred P. Sloan Research Fellowship
- 1986 - Summa cum laude, University of Missouri (Valedictorian of College of Engineering)
- 1982-1986 - National Merit Scholar, University of Missouri
- 1982-1986 - Curators Scholar, University of Missouri
- 1982 - Valedictorian, Belton High School, Belton, Missouri

RESEARCH GRANTS

- **NIH R01 DC007683, Principal Investigator (4/1/2006-3/31/2011)**
\$1.56 million over five years. Project entitled “Sequencing and Initiation in Speech Production.” Application received a percentile rank of 1.1%. This project investigates the neural mechanisms involved in the motor sequencing of speech sounds using a combination of neural modeling and functional magnetic resonance imaging.
- **NIH R01 DC002852, Principal Investigator (8/1/2006-7/31/2011)**
\$1.68 million over five years. Project entitled “Neural modeling and imaging of speech.” The focus of this project is the continued development of a neural network model of speech production and perception (the DIVA model) and testing of this model using psychophysical experiments and functional magnetic resonance imaging at the Massachusetts General Hospital NMR Center.
- **NSF SMA-0835976, Governing Board Member and Investigator (3/01/2010-08/31/2011)**
\$6.6 million over 1.5 years. Project entitled “CELEST: A center of excellence for learning in education, science, and technology.” The primary goal of CELEST is to carry out state-of-the-art research and technology projects that combine quantitative behavioral and brain modeling of both normal and abnormal learning processes with behavioral, electrophysiological, and neuroimaging experiments. CELEST involves researchers from Boston University, MIT, Harvard University, and Brandeis University. In addition to acting as one of eight governing board members and mentor to several graduate students on the project, my investigative role involves the development of neural prostheses for restoring speech communication to profoundly paralyzed individuals.
- **NIH R01 DC03007, Investigator (12/1/2006 – 11/30/2011)**
\$2.8 million over 5 years. MIT/BU collaborative project entitled “Effects of hearing status on adult speech production” (J. Perkell, Principal Investigator). My role on the project involves the definition and refinement of a theoretical framework that accounts for the results of kinematic, acoustic, and neuroimaging studies of speech in hearing impaired individuals, as well as the design and interpretation of experiments to test this framework.
- **NSF SBE-0354378, Governing Board Member (10/1/2004– 09/30/2010)**
\$20 million over 5 years. Project entitled “CELEST: A center of excellence for learning in education, science, and technology.” This project was the largest of four NSF Science of Learning Centers chosen from the initial pool of over 100 applications.
- **NIH R01 DC01925, Investigator (12/1/1998 – 11/31/2008)**
\$3.6 million over 5 years. MIT/BU collaborative project entitled “Constraints and strategies in speech production” (J. Perkell, Principal Investigator). Application received the highest score in a pool of approximately 140 applications (percentile rank of 0.7%). Prof. Guenther’s role on the project involves the definition and refinement of a theoretical framework that accounts for kinematic, acoustic, and neuroimaging measures of speech in neurologically normal individuals, as well as the design and interpretation of experiments to test this framework.
- **NIH F32 DC006782, Principal Investigator (6/1/2004 – 5/31/2007)**
\$133,000 over three years. Postdoctoral training grant funding Dr. Kevin Reilly. The goal of this project was to identify brain networks involved in the acquisition and representation of a novel sensorimotor mapping involving the speech articulators using a combination of neural modeling and fMRI experiments.

- **NIH R01 DC02852, Principal Investigator (2/1/2001-1/31/2006)**
\$1.8 million over five years. Project entitled “Neural modeling and imaging of speech.” Application received the highest score in a pool of approximately 170 applications (percentile rank of 0.6%). The focus of this project was the development of a neural network model of speech perception and production and testing of this model using functional magnetic resonance imaging at the Massachusetts General Hospital NMR Center and magnetoencephalography at the KIT/MIT MEG Joint Research Lab.
- **NIH FIRST Award, R29 DC02852, Principal Investigator (2/1/1996-1/31/2001)**
\$578,000 over five years. Project entitled “Neural network modeling of speech production.” Application received the second highest score in a pool of approximately 120 applications (percentile rank of 1.7%).
- **Alfred P. Sloan Foundation Research Fellowship, Principal Investigator (9/1/1995-8/31/1997)**
\$30,000 over two years. One of fifteen awardees nationwide in neuroscience.

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- Brunner, J., Hoole, P., Guenther, F.H., and Perkell, J.S. (2010). Dependency of compensatory strategies on the shape of the vocal tract during speech perturbed with an artificial palate. *Proceedings of the 159th Meeting of the Acoustical Society of America. Baltimore, MD*. Full paper in *Proceedings of Meetings on Acoustics*, vol. 9.

OTHER PUBLICATIONS

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INVITED LECTURES

- “Skill acquisition, coarticulation, and rate effects in a neural model of speech production.” Boston University Center for Adaptive Systems Colloquium Series, April 12, 1994.
- “Acquisition, coarticulation, and rate effects in a neural model of speech production.” Haskins Laboratories, New Haven, Connecticut, June 23, 1994.
- “Neural models of sensory-motor interactions for flexible movement control.” Cognition, Brain, and Neural Nets Workshop on Brain and Space, Ruhr-Universitat, Bochum, Germany, July 21-22, 1994.
- “Skill acquisition, coarticulation, and rate effects in a neural model of speech production.” Massachusetts Institute of Technology RLE Speech Group Seminar Series, October 7, 1994.
- “A modeling framework for speech motor development and kinematic articulator control.” 1/3 plenary lecture at the XIIIth International Congress on Phonetic Sciences, Stockholm, Sweden, August 15, 1995.
- “Motor control issues in speech production.” Brandeis University Department of Psychology Colloquium Series, November 9, 1995.
- “Neural network modeling of speech production.” Boston University College of Engineering Speech Processing Seminar Series, March 26, 1996.
- “The perceptual magnet effect as an emergent property of neural map formation.” Boston University Biomedical Engineering Department Hearing Research Center Seminar Series, May 31, 1996.
- “A computational view of infant babbling.” Marsh Chapel ‘Food for Thought’ lecture series, Boston University, November 26, 1996.
- “A neural modeling view of speech development in infants.” Massachusetts General Hospital Center for Morphometric Analysis, April 8, 1997.
- “The perceptual magnet effect as a consequence of auditory map formation.” Eaton Peabody Laboratory Seminar Series, April 18, 1997.
- “The perceptual magnet effect as an emergent property of auditory map formation.” Massachusetts Institute of Technology RLE Speech Group Seminar Series, May 7, 1997.
- “Articulatory tradeoffs reduce acoustic variability during /r/ production.” Massachusetts Institute of Technology RLE Speech Group Seminar Series, Oct. 1, 1997.
- “A neural network model of speech production.” Invited 90-minute talk with ensuing panel discussion, 1997 Annual Convention of the American Speech-Language-Hearing Association, Boston, MA, November 20, 1997.
- “A theoretical framework for speech acquisition and production.” Boston University Psychology Department’s Brain, Behavior, and Cognition Seminar Series, March 20, 1998.
- “A theoretical framework for speech acquisition and production.” Second International Conference on Cognitive and Neural Systems, Boston University, Boston, MA, May 29, 1998.

- “Using computational models to investigate speech perception and production.” UCLA Department of Linguistics, Los Angeles, CA, June 11, 1999.
- “Effects of categorization and discrimination training on auditory perceptual space.” Massachusetts Institute of Technology RLE Speech Group Seminar Series, October 27, 1999.
- “Neural network models of speech perception and production.” Invited 80-minute lecture with commentary, International Institute for Advanced Studies Neuroscience of Language Workshop, Kyoto, Japan, November 20, 1999.
- “Neural models of speech perception and production.” Laboratoire Parole et Langage, Université de Provence, Aix-en-Provence, France, May 19, 2000.
- “Neural modeling of speech production.” Institut de la Communication Parlée, Institut National Polytechnique de Grenoble, Grenoble, France, May 24, 2000.
- “A model of speech motor control and supporting data: Influences of quantal effects.” Special session on Kenneth Stevens’ contributions to speech research, 140th Meeting of the Acoustical Society of America, Newport Beach, CA, December 7, 2000.
- “Neural modeling of speech perception and production.” School of Communication Sciences and Disorders, McGill University, March 19, 2001.
- “Neural modeling of speech production and perception.” Department of Neurology, Yale University School of Medicine, March 29, 2001.
- “A model of cortical and cerebellar interactions in speech.” Massachusetts Institute of Technology RLE Speech Group Seminar Series, May 16, 2001.
- “Neural modeling of speech production.” Keynote Lecture, 4th International Nijmegen Speech Motor Conference, Nijmegen, The Netherlands, June 13, 2001.
- “The effects of categorization training on auditory perception and cortical representations.” Speech Recognition as Adaptive Pattern Classification Workshop, Nijmegen, The Netherlands, July 11, 2001.
- “A model of the neural bases of speech motor control.” Massachusetts Eye and Ear Infirmary/Harvard Medical School, Boston, Massachusetts, January 15, 2002.
- “A model of the neural bases of speech motor control.” Sixth International Conference on Cognitive and Neural Systems, Boston, Massachusetts, May 29, 2002.
- “Effects of category learning on auditory perception and cortical maps.” 143rd Meeting of the Acoustical Society of America, Pittsburgh, Pennsylvania, June 4, 2002.
- “A model of the neural bases of speech production.” NTT Basic Research Laboratories, Atsugi, Japan, October 15, 2002.
- “Effects of category learning on auditory perception and cortical maps.” ATR International, Kyoto, Japan, October 17, 2002.
- “A model of the neural bases of speech production.” ATR International, Kyoto, Japan, October 18, 2002.
- “Elucidating the neural bases of speech.” Boston University Linguistics Association, Boston, Massachusetts, April 24, 2003.
- “Introductory remarks on neural modeling in speech perception research.” 145th Meeting of the Acoustical Society of America, Nashville, Tennessee, April 29, 2003.
- “Using a neural model to investigate the learning of speech motor skills.” Conference on Ontogeny and Phylogeny of Syllable Organization, Barcelona, Spain, August 3, 2003.

- “A model of cortical and cerebellar function in speech.” XVth International Congress of Phonetic Sciences, Barcelona, Spain, August 7, 2003.
- “A neural model of speech production.” Keynote lecture, 6th International Seminar on Speech Production, Sydney, Australia, December 8, 2003.
- “A neural model of speech production and supporting data.” National Institutes of Health, Bethesda, Maryland, June 1, 2004.
- “A neural model of speech production and supporting data.” University of Maryland Dental School, Baltimore, Maryland, June 2, 2004.
- “A neural model of speech production and supporting experiments.” Plenary lecture, From Sound to Sense: Fifty+ Years of Discoveries in Speech Communication, Cambridge, Massachusetts, June 12, 2004.
- “Auditory, somatosensory, and motor interactions in speech production.” Distinguished Lecture in Speech and Hearing Bioscience and Technology, Harvard-MIT Division of Health Sciences and Technology, Cambridge, Massachusetts, December 9, 2004.
- “Auditory, somatosensory, and motor interactions in speech production.” CELEST Science of Learning Seminar, Boston University, Boston, Massachusetts, December 10, 2004.
- “Cortical interactions underlying the production of speech sounds.” American Speech and Hearing Association (ASHA) Research Institute, San Diego, California, November 18, 2005.
- “Using modeling and neuroimaging to investigate normal and disordered speech.” 2005 American Speech and Hearing Association (ASHA) Convention, San Diego, California, November 19, 2005.
- “Auditory, somatosensory, and motor interactions in speech production.” M.D. Steer Distinguished Lecture, Department of Speech, Language, and Hearing Sciences, Purdue University, February 23, 2006.
- “Auditory, somatosensory, and motor interactions in speech production.” Department of Cognitive and Linguistic Sciences, Brown University, March 13, 2006.
- “Auditory, somatosensory, and motor interactions in speech acquisition and production.” Symposium on Efference Copy, Auditory Feedback, and Speech Production, University of California at San Francisco, April 7, 2006.
- “Neural modeling and imaging of the cortical interactions underlying speech.” Experimental and Computational Cognitive Neuroscience: Towards a Synthesis, Satellite Symposium at the 2006 Annual Meeting of the Cognitive Neuroscience Society, San Francisco, California, April 8, 2006.
- “Auditory, somatosensory, and motor interactions in speech production.” University of Texas Health Science Center, San Antonio, Texas, September 19, 2006.
- “Brain Mechanisms of Speech Perception and Production”. From Synapse to Schoolroom: The Science of Learning, Satellite Symposium at the 2006 Annual Meeting of the Society for Neuroscience, Atlanta, Georgia, October 13, 2006.
- “Auditory, somatosensory, and motor interactions in speech production.” Department of Linguistics, University of Maryland, December 8, 2006.
- “Auditory, somatosensory, and motor interactions in speech production.” CONTACT International Workshop, Is a Neural Theory of Language Possible? Lecce, Italy, June 30, 2007.
- “The neural control of speech.” Willard R. Zemlin Lecture in Speech Science, Annual Convention of the American Speech-Language-Hearing Association, November 16, 2007.
- “The neural control of speech.” Department of Speech-Language Pathology, Northeastern University, December 14, 2007.

- “The neural control of speech.” Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany, June 27, 2008.
- “Involvement of auditory cortex in speech production.” Acoustics ‘08 Paris, France, July 3, 2008.
- “A neurocomputational model of speech production and its application to communication disorders and neural prosthesis.” 5th International Workshop on Language Production, Annapolis, Maryland, July 30, 2008.
- “How oscillatory is speech production?” Workshop on Brain Rhythms in Speech Perception and Production, Cambridge, MA, November 9, 2008.
- “Investigating the neural bases of normal and disordered speech.” Nancy Lurie Marks Family Foundation Boston Club, Wellesley, MA, November 14, 2008.
- “Investigating the neural bases of normal and disordered speech.” Gabrieli Lab, Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA, December 12, 2008.
- “Investigating the neural bases of normal and disordered speech.” Center for Language and Speech Processing, The Johns Hopkins University, Baltimore, Maryland, April 7, 2009.
- “Development of a speech prosthesis in a locked-in individual.” Plenary talk, American Society for Artificial Internal Organs, Dallas, Texas, May 28, 2009.
- “Neural mechanisms of speech.” Keynote Speech, Foundation Ugo Bordononi Meets Frank Guenther, Rome, Italy, September 22, 2009.
- “The neural control of speech.” Distinguished Lecture in Cognitive Science, Michigan State University, December 7, 2009.

PERSONAL INTERESTS

- Avid go player (5 kyu ranking) and golfer.
- Placed 10th out of 398 entries in the brisket category of the 2003 American Royal Barbeque Competition.