

# Jonathan S. Brumberg

## Curriculum Vitae

April 2012

Address: Department of Speech, Language and Hearing Sciences  
College of Health and Rehabilitation Sciences: Sargent College  
Boston University  
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Will be joining University of Kansas faculty, August 2012

### Education

- 2003–2008 Ph.D. Cognitive and Neural Systems Boston University  
Thesis: “*An electrophysiological investigation of human motor cortex and its application to speech restoration*”
- 1998–2002 B.S. Computer and Information Sciences University of Delaware
- 1998–2002 B.A. Philosophy University of Delaware

### Post-graduate research & employment

- August 2012 **Assistant Professor:** Department of Speech-Language-Hearing: Sciences & Disorders  
*University of Kansas, Lawrence, KS*
- Principal investigator for National Institutes of Health funded project to study EEG-based brain-machine interfaces for speech synthesis and communication
- 2011–present **Research Assistant Professor:** Department of Speech, Language and Hearing Sciences;  
Center for Computational Neuroscience and Neural Technology  
**Faculty Member:** Graduate Program for Neuroscience: Computational Neuroscience;  
Center of Excellence for Learning in Education, Science and Technology (CELEST)  
*Boston University, Boston, MA*
- Co-director of Neural Prosthesis Laboratory at Boston University, focusing on developing multi-modal and multi-sensory brain-machine interfaces using chronically implanted electrophysiology and non-invasive electroencephalography (EEG). The primary goal of these devices is for restoration of communication and mobility for individuals with profound speech and motor deficits (e.g. Locked-in Syndrome)
  - Supervise and mentor graduate and undergraduate research projects
  - Participate in Ph.D. dissertation committees
- 2011–present **Adjunct Professor:** Department of Electrical and Computer Engineering  
*Georgia Institute of Technology, Atlanta, GA*
- Student advising and participation in ECE Ph.D. dissertation committees
- 2010–2011 **Research Assistant Professor:** Department of Cognitive and Neural Systems  
**Faculty Member:** Center of Excellence for Learning in Education, Science and Technology (CELEST)  
*Boston University, Boston, MA*
- Co-director of Neural Prosthesis Laboratory
  - Supervise and mentor graduate and undergraduate research projects
  - Participate in Ph.D. dissertation committees

- 2009–present **Research Consultant:** Communication Analysis and Design Laboratory (CADLAB)  
*Northeastern University, Boston, MA*
- Involved with acoustic analysis software development.
  - Aid research program and grant proposal development.
  - Involved in mentoring of graduate student research activities.
- 2008–2010 **Research Associate:** Department of Cognitive and Neural Systems  
*Boston University, Boston, MA*
- Research included modeling and signal processing of extracellular neural activity and electroencephalography for use in real-time neural prostheses for speech production.
  - Development of modular software framework for neural prosthesis in conjunction with Neural Signals, Inc.
  - Development and maintenance of the Directions into Velocities of Articulators (DIVA) neurocomputational model for speech production.
- 2008–2009 **Research Scientist**  
*Neural Signals, Inc., Duluth, GA*
- Led neural decoding research for speech prosthesis brain computer interface (BCI) project.
  - Co-directed BCI software training for implant patients.

### Other research & employment

- 2003–2008 **Research Assistant:** Department of Cognitive and Neural Systems  
*Boston University, Boston, MA*
- Dissertation work: Design and implementation of a neural prosthesis for real-time control of a speech synthesizer by a completely paralyzed human. Featured on CNN, in Brainwork by the Dana Foundation, the Boston Globe, MIT Technology Review, the New Scientist, Scientific American Mind, Nature News, Esquire Magazine, Wired, Discover Magazine and Discovery News
  - Signal processing and analysis of neurobiological signals including extracellular neural recordings and magnetoencephalography.
  - Extensive computational modeling of a neural network for simulation of speech production.
- 2002–2003 **Research Assistant:** Psychology Department  
*Temple University, Philadelphia, PA*
- Conducted and analyzed experiments with human subjects pertaining to perception of Biological Motion and Illusory Contours.
- Summer 2002 **Research Assistant:** Psychology Department  
*University of Delaware, Newark, DE*
- Investigated numerical representations and visual attention through ERP studies of human subjects.

- Fall 2000      **Research Assistant:** Department of Computer and Information Sciences  
*University of Delaware, Newark, DE*
- Developed new instruction manual for Introduction to Computer and Information Sciences course.

### Teaching experience

- Spring 2011      **Guest Lecturer:** Department of Speech-Language Pathology and Audiology  
*Northeastern University, Boston MA*
- Motor Speech Disorders: Special lecture on brain implants for deep brain stimulation and brain-machine interfacing.
- Fall 2010      **Guest Lecturer:** Department of Health Sciences  
*Boston University, Boston MA*
- Introduction to Computational Neuroscience of Speech, Language and Hearing: Special lecture on speech neuroscience & brain computer interfacing for speech, communication and control
- Fall 2009      **Guest Lecturer:** Department of Cognitive and Neural Systems  
*Boston University, Boston MA*
- Topics in Sensory Motor Control: Special lecture on brain machine interfacing for speech communication
- Fall 2004      **Teaching Fellow:** Department of Cognitive and Neural Systems  
*Boston University, Boston MA*
- Lab instructor for graduate-level introduction to mathematical methods for computational simulation and signal processing.
  - Instructed students on methods for numerical solution of differential equations. @inproceedingsBrumberg2012embc, address = San Diego, CA, author = Brumberg, Jonathan S. and Lorenz, Sean D. and Galbraith, Byron V. and Guenther, Frank H., booktitle = Proceedings of the 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC '12)., title = The unlock project: a python-based framework for practical BCI communication "app" development, year = 2012
- 2000-2002      **Teaching Assistant:** Department of Computer and Information Sciences  
*University of Delaware, Newark, DE*
- Instructed classes for undergraduate-level courses ranging from beginner to intermediate level.
  - Courses: Introduction to Computer and Information Science, General Computer Science (C programming), Introduction to Computer Science (C++ programming), Machine Organization and Assembly Language (SPARC architecture).

### Advising and mentorship

- Ph.D. Dissertation      Robert Law: "Calculation of synchronous activity on arbitrary networks of non-linear cells with application to brain-computer interface design." Program in 2<sup>nd</sup> reader      Cognitive and Neural Systems, Boston University. May 2012, expected

Ph.D. Dissertation 2 <sup>nd</sup> reader	Sean Lorenz: “Context-specific user interface design for a brain-computer communication device.” Program in Cognitive and Neural Systems, Boston University. July 2012, expected
Ph.D. Dissertation committee member	Brett Matthews: topic area – efficient automated neural spike detection and classification. Department of Electrical and Computer Engineering, Georgia Institute of Technology. 2012, expected
Masters Thesis advisor	Anh Nguyen: topic area – clinical augmentative and alternative communication applications of brain-machine interfaces. Department of Speech, Language and Hearing Sciences, Boston University. May 2013, expected
Doctoral students	Boston University (Program in Cognitive and Neural Systems & Graduate Program in Neuroscience) <ul style="list-style-type: none"> <li>• Misha Panko, Emily Stephen (Co-sponsored NIH F31: predoctoral fellowship), Nan Jia, Spencer Torene, Andrès Salazar-Gomez, Byron Galbraith</li> </ul>
Undergraduates	Boston University (Biomedical Engineering & Neuroscience) <ul style="list-style-type: none"> <li>• Student volunteer research: Dante Smith, Nadia Lonsdale, Matt Kramer, Sean Manton</li> <li>• Former students: Allison Song, Caroline Pardee, Michael Zu, Conrad Nied</li> </ul>

## Publications

### Refereed research papers

1. Brumberg, J. S., Wright, E. J., Andreasen, D. S., Guenther, F. H., and Kennedy, P. R. (2011). Classification of intended phoneme production from chronic intracortical microelectrode recordings in speech-motor cortex. *Frontiers in Neuroscience* 5, 65.
2. Maguire, M. J., Brumberg, J., Ennis, M., and Shipley, T. F. (2011). Similarities in Object and Event Segmentation: A Geometric Approach to Event Path Segmentation. *Spatial Cognition & Computation* 11(3), 254–279.
3. Brumberg, J. S. and Guenther, F. H. (2010). Development of speech prostheses: current status and recent advances. *Expert review of medical devices* 7(5), 667–79.
4. Brumberg, J., Nieto-Castanon, A., Kennedy, P., and Guenther, F. (2010). Brain-computer interfaces for speech communication. *Speech communication* 52(4), 367–379.
5. Denby, B., Schultz, T., Honda, K., Hueber, T., Gilbert, J., and Brumberg, J. (2010). Silent speech interfaces. *Speech Communication* 52(4), 270–287.
6. Guenther, F. H., Brumberg, J. S., Wright, E. J., Nieto-Castanon, A., Tourville, J. A., Panko, M., Law, R., Siebert, S. A., Bartels, J. L., Andreasen, D. S., Ehirim, P., Mao, H., and Kennedy, P. R. (2009). A Wireless Brain-Machine Interface for Real-Time Speech Synthesis. *PLoS ONE* 4(12), e8218.
7. Terband, H., Maassen, B., Guenther, F. H., and Brumberg, J. (2009). Computational Neural Modeling of Speech Motor Control in Childhood Apraxia of Speech (CAS). *Journal of Speech Hearing and Language Research* 52(6), 1595–1609.

### Papers in conference proceedings

1. Guenther, F. H and Brumberg, J. S. (2011). Brain-machine interfaces for real-time speech synthesis. In: *Proceedings of the 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC '11)*. Boston, MA.
2. Matthews, B., Kim, J., Brumberg, J. S., and Clements, M. (2010). A Probabilistic Decoding Approach to a Neural Prosthesis for Speech. In: *2010 4th International Conference on Bioinformatics and Biomedical Engineering*. IEEE, pp.1–4.
3. Brumberg, J. S., Kennedy, P. R., and Guenther, F. H. (2009). Artificial speech synthesizer control by brain-computer interface. In: *10th Annual Conference of the International Speech Communication Association (Interspeech 2009)*. Brighton, U.K.: International Speech Communication Association.

## Posters & Abstracts

1. Brumberg, J. S., Salazar-Gomez, A., and Guenther, F. H. (2012). Controlling a formant synthesizer using a non-invasive brain-machine interface. In: *2012 Motor Speech Conference*. Santa Rosa, CA.
2. Brumberg, J. S. and Guenther, F. H. (2011). A non-invasive brain-machine interface for control of a speech synthesizer. In: *Neuroscience Meeting Planner 2011*. Program No. 816.02. Washington, DC: Society for Neuroscience.
3. Lorenz, S. D., Brumberg, J. S., and Guenther, F. H. (2011). Adaptive tablete application design for a mobile EEG brain-computer interface. In: *The 8th International Conference & Expo on Emerging Technologies for a Smarter World, CEWIT 2011*. Hauppauge, NY.
4. Panko, M., Brincat, S., Brumberg, J., Salazar-Gomez, A., Roy, J., Overduin, S., Kennedy, P., Miller, E. K., and Guenther, F. (2011). Signal stability in chronic invasive brain-machine interfaces. In: *Neuroscience Meeting Planner 2011*. Program No. 280.13. Washington, DC: Society for Neuroscience.
5. Stephen, E. P., Brumberg, J. S., and Guenther, F. H. (2011). Distinguishing imagined movement from rest using electroencephalography. In: *Neuroscience Meeting Planner 2011*. Program No. 711.05. Washington, DC: Society for Neuroscience.
6. Brumberg, J. S., Kim, J., Matthews, B., Wright, E. J., Guenther, F. H., Clements, M., and Kennedy, P. R. (2010). Evaluation of supervised classification techniques for direct phoneme prediction by a brain-computer interface. In: *Neuroscience Meeting Planner 2010*. Program No. 86.11. San Diego, CA: Society for Neuroscience.
7. Law, R., Brumberg, J., and Guenther, F. (2010). Nonlinear Bayesian filters for EEG-based speech prostheses. In: *Proceedings of the Fourteenth International Conference on Cognitive and Neural Systems (ICCN)*. Boston, MA.
8. Kennedy, P., Andreasen, D., Brumberg, J., Clements, M., Guenther, F., Kim, J., Matthews, B., Ramos, C., Velliste, M., and Wright, E. (2009). Human speech cortex [2]: Tuning of single units during listening and imagined singing of tones and musical notes using feedback. In: *Neuroscience Meeting Planner 2009*. Program No. 181.11. Chicago, IL USA: Society for Neuroscience.
9. Panko, M., Brumberg, J. S., Nieto-Castanon, A., Wright, E. J., Law, R., Kennedy, P. R., and Guenther, F. H. (2009). Decoding intended speech with a brain-machine interface utilizing a Neurotrophic Electrode. In: *Berlin Brain-Computer Interface Workshop: Advances in Neurotechnology, July 8-10, 2009*.
10. Velliste, M., Brumberg, J. S., Perel, S., Fraser, G. W., Spalding, M. C., Whitford, A. S., McMorland, A. J. C., Wright, E. J., Guenther, F. H., Kennedy, P. R., and Schwartz, A. B. (2009). Modular software architecture for neural prosthetic control. In: *Neuroscience Meeting Planner 2009*. Program No. 985.1. Chicago, IL USA: Society for Neuroscience.
11. Brumberg, J., Nieto-Castanon, A., Guenther, F., Bartels, J., Wright, E., Siebert, S., Andreasen, D., and Kennedy, P. (2008). Methods for construction of a long-term human brain machine interface with the Neurotrophic Electrode. In: *Neuroscience Meeting Planner 2008*. Program No. 779.5. Washington, DC: Society for Neuroscience.
12. Guenther, F., Brumberg, J., and Nieto-Castanon, A. (2008). A brain-computer interface for real-time speech synthesis by a locked-in individual implanted with a Neurotrophic Electrode. In: *Neuroscience Meeting Planner 2008*. Program No. 712.1. Washington, DC: Society for Neuroscience.
13. Terband, H., Maassen, B., Brumberg, J. S., and Guenther, F. H. (2008). Increased levels of neural noise as the core deficit in childhood apraxia of speech (CAS). In: *Conference on Motor Speech*. Monterey, CA.
14. Brumberg, J. S., Andreasen, D. S., Bartels, J. L., Guenther, F. H., Kennedy, P. R., Siebert, S. A., Schwartz, A. B., Velliste, M., and Wright, E. J. (2007). Human speech cortex long-term recordings [5]: formant frequency analyses. In: *Neuroscience Meeting Planner 2007*. Program No. 517.17. San Diego, CA.
15. Siebert, S. A., Andreasen, D. S., Bartels, J. L., Brumberg, J. S., Guenther, F. H., Kennedy, P. R., and Wright, E. J. (2007). Human speech cortex long-term recordings [1]: spike sorting and noise reduction. In: *Neuroscience Meeting Planner 2007*. Program No. 728.14. San Diego, CA: Society for Neuroscience.
16. Terband, H., Maassen, B., and Brumberg, J. (2007). Motor speech in adults and children: computational-neurological modeling of childhood apraxia of speech (CAS). In: *American Speech-Language Associate Conference 2007*. Boston, MA.
17. Wright, E. J., Andreasen, D. S., Bartels, J. L., Brumberg, J. S., Guenther, F. H., Kennedy, P. R., Miller, L., Rebesco, J., Schwartz, A. B., Siebert, S. A., and Velliste, M. (2007). Human speech cortex long-term recordings [3]: neural net analyses. In: *Neuroscience Meeting Planner 2007*. Program No. 517.18. San Diego, CA: Society for Neuroscience.
18. Shipley, T. F., Maguire, M. J., and Brumberg, J. (2004). Segmentation of event paths. *Journal of Vision* 4(8), 562–562.
19. Shipley, T. F., Maguire, M. J., and Brumberg, J. S. (2003). Top down effects on search for biological motion. *Abstracts of the Psychonomics Society* 8(51).

## PhD thesis

1. Brumberg, J. (2008). "An electrophysiological investigation of human motor cortex and its application to speech restoration". PhD thesis. Boston, MA, p. 147.

## Tech reports

1. Brumberg, J. S., Kennedy, P. R., and Guenther, F. H. (2011). *An auditory output brain-computer interface for speech communication*. Tech. rep. BCI Award 2011.
2. Shipley, T. F. and Brumberg, J. S. (2003). *Markerless motion-capture for point-light displays*. Tech. rep. Philadelphia, PA: Temple University, Temple University Vision Laboratory.

## Submitted papers

1. Brumberg, J. S., Lorenz, S. D., Galbraith, B. V., and Guenther, F. H. (2012). The unlock project: a python-based framework for practical BCI communication "app" development. In: *Proceedings of the 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC '12)*. San Diego, CA.
2. Terband, H., Maassen, B., Guenther, F. H., and Brumberg, J. Neurocomputational modeling of speech motor control in developmental speech disorders: testing hypotheses about underlying neurological mechanisms.

## Presentations

1. "Improving and restoring communication through combined study speech, neuroscience and computer technology." Department of Speech-Language-Hearing: Sciences & Disorders Colloquium, University of Kansas, Lawrence, KS, January 9, 2012.
2. "Combining speech, neuroscience, and modeling for communication neural interfaces." Department of Electrical and Computer Engineering, Biomedical Research Group, Northeastern University, Boston, MA, October 20, 2011.
3. "Bridging speech, neuroscience and engineering for speech rehabilitation" Department of Speech, Hearing and Language Sciences Research Colloquium Series, Boston University, Boston, MA, February 16, 2011.
4. "Brain-computer interfaces for communication." Science of Learning Centers PI Awardee Meeting, Washington, DC, October 14, 2010.
5. "Brain-computer interfaces for artificial speech synthesis." Department of Speech, Hearing and Language Sciences Research Colloquium Series, Boston University, Boston, MA, April 27, 2010.
6. "Artificial speech synthesizer control by brain-computer interface." Interspeech 2009, Brighton, UK, September 7, 2009.
7. "Real-time speech synthesis for neural prosthesis." Acoustical Society of America, Portland, OR, May 18, 2009.
8. "Speech restoration by brain computer interface." CELEST Education Curriculum Workshop, July 11, 2008. [invited]
9. "An electrophysiological investigation of human motor cortex and its application to speech restoration." Boston University, June 11, 2008. [Dissertation defense]

## Grant funding

**NIH R03 DC011304, Principal Investigator**

09/21/2011 – 08/31/2014

National Institute of Deafness and Other Communication Disorders (NIDCD)

*Investigating output modality for a brain-computer interface for communication* (\$300,000 over 3 years)

### Mentored student funding

NIH F31 DC011663, Co-sponsor (PI: E. Stephen)

08/01/2011 – 05/31/2014

National Institute of Deafness and Other Communication Disorders (NIDCD)

*Decoding imagined vowel productions using electroencephalography*

### Academic memberships, awards and service

- 2011 BCI Award Finalist (top ten out of 64 entries)
- Awarded Conference Fellowship, 2011 ASHA/NIDCD Lessons for Success Research Conference
- Ad hoc reviewer for *Journal of Speech, Language and Hearing Research*, *Neuroscience*, *Journal of Cognitive Neuroscience*, *Sensors*, *IEEE Transactions on Neural Systems and Rehabilitation Engineering*.
- Faculty Judge, 2010-2012 Boston University Science and Engineering Symposium
- Member, Society for Neuroscience, 2007–present
- Boston University Graduate Research Fellowship, 2003-2008
- University of Delaware Honors Program, 1998–2002

### Technical skills

- Advanced knowledge of computer and web programming languages including C, C++, Matlab, Pascal, Java, Perl/CGI, Python, PHP, HTML,  $\LaTeX$ , SQL and Microsoft .NET (C# and VB)
- Administration of Linux server clusters and Microsoft Windows Server
- Extensive experience using Microsoft Office suite and Adobe Photoshop
- Proficiency with statistical analysis software packages S/R and speech synthesis including text-to-speech (Festival), formant-based (e.g. Klatt) and articulatory-based (e.g. Maeda).