

LEE M. MILLER

Personal Information

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Areas of Interest

Auditory Perception and Speech Recognition

I study the neural bases of auditory perception and speech recognition. My neuro-engineering research uses techniques such as EEG, functional MRI, and machine learning to translate fundamental scientific results into real-world solutions for people with hearing loss. Among our current projects are a patented brain-based hearing loss diagnostic, an investigation into the auditory-visual brains of children with cochlear implants, and a wearable "attentional prosthesis" with mobile app that will help listeners understand speech in noisy environments.

Education

Education and Training

1994-2001	University of California, San Francisco & Berkeley, CA, PhD, Bioengineering (systems neuroscience) (PI: Christoph Schreiner)
1993-1994	Philipps-Universitat, Marburg, Germany, Fulbright Fellowship in Physics (Quantum Chaos)
1989-1993	Duke University, Durham, NC, BS, Physics, summa cum laude

Employment

Employment History

7/2020-present	University of California, Davis, CA, Professor, Dept. of Otolaryngology Head and Neck Surgery
7/2019-present	University of California, Davis, CA, Professor, Dept. of Neurobiology, Physiology, & Behavior
7/2010-6/2019	University of California, Davis, CA, Assoc. Professor, Dept. of Neurobiology, Physiology, & Behavior

8/2011-1/2012	University of Lausanne, Lausanne, Switzerland, Visiting Professor
7/2004-6/2010	University of California, Davis, CA, Asst. Professor, , Dept. of Neurobiology, Physiology, & Behavior
6/2001-6/2004	University of California, Berkeley, CA, Postdoctoral fellow
8/1993-8/1994	Philipps-Universitat, Marburg, Germany, Fulbright Fellow (Physics)

Grants and Contracts

Grants Active

10/01/2019 - 09/30/2022	Grant #CMMI 1934792, \$2,999,549, Co-Principal Investigator, Investigation of User-Interface and Human-Robot Performance for Supernumerary Robots, Joshi (Principal Investigator), National Science Foundation, Percentage Effort=2.9%
09/01/2018 - 3/31/2026	\$1,904,369, Collaborator, The SpokenWeb: Conceiving and Creating a Nationally Networked Archive of Literary Recordings for Research and Teaching, Camlot (Principal Investigator), Social Sciences and Humanities Research Council of Canada
07/01/2020 - 06/30/2023	Grant #E01 W81XWH2010485, \$1,530,177, Principal Investigator, Rapid, Multileveled Assessment of Hearing Dysfunction in Operational and Postdeployment Environments, Department of Defense (DoD): Congressionally Directed Medical Research Programs (CDMRP) / US Army, Percentage Effort=37%
07/01/2021 - 09/30/2022	\$24,997, Principal Investigator, Brain-Guided Augmented Reality to Enhance Speech Comprehension, UC Davis Academic Senate

Grants Completed

03/01/2016 - 02/28/2017	\$53,000, Principal Investigator, Gaze-directed acoustic beamforming for Android, Google Faculty Research Award
07/01/2016 - 06/30/2017	\$50,000, Co-Principal Investigator, Highly Innovative Award, Joshi (Principal Investigator), NIH-funded UC Davis Clinical and Translational Science Center (CTSC)
12/01/2016 - 11/30/2017	\$50,000, Principal Investigator, Starkey Collaborative Research Program, Oculus (Facebook) and Starkey Hearing Technologies
09/01/2017 - 8/31/2018	\$21,667, Principal Investigator, Clinical Feasibility of Patent-Pending EEG Assessment in Hearing Impaired Listeners, UC Davis Office of Research, STAIR Science Translation and Innovation Research Grant

01/01/2018 - 09/01/2018	\$15,000, Co-Investigator, Investment in Student Success Grant Program, Hori (Principal Investigator), UC Davis Division of Student Affairs
5/01/2018 - 04/30/2019	\$58,861, Principal Investigator, Audio-Visual Augmented Reality to Enhance Speech Perception, Google Faculty Research Award
1/1/2018 - 06/30/2019	Grant #HAA-258799-18, \$75,000, Collaborator, Tools for Listening to Texts-in-Performance, Macarthur (Principal Investigator), National Endowment for the Humanities (NEH): Digital Humanities Advancement Grant
12/01/2014 - 11/30/2019	Grant #R01- DC013543, \$1,887,337, Co-Investigator, Audiovisual integration for spoken language in adverse listening situations, Shahin (Principal Investigator), NIH/NIDCD, Percentage Effort=12.5%
07/17/2019	\$1,320, Principal Investigator, Seagate Hardware Grant Program
07/01/2015 - 06/30/2020	Grant #R01-DC014767, \$1,892,955, Co-Principal Investigator, Determinants of Cross Modal Plasticity in Children with Cochlear Implants, Corina (Miller from 9/2019-3/2020) (Principal Investigator), NIH/NIDCD, Percentage Effort=17%
04/01/2020 - 04/30/2021	\$0, Principal Investigator, Neuromorphic Computing for Real-Time Audio Separation (access to Loihi, Intel's state-of-the-art neuromorphic chip), Intel Corporation

Honors & Awards

1993	Graduation with Distinction in Physics, summa cum laude. Duke Univ., Durham, NC
1993-1994	Fulbright Research Fellowship in Physics. Marburg, Germany
1994-1999	Whitaker Foundation Graduate Fellowship in Biomedical Engineering
1996	Full scholarship to Summer Research Seminar "Mind, Body, Brain" with Professor of Philosophy John Searle. Univ. Calif., Berkeley
1998	National Science Foundation travel grant to NATO Advanced Studies Institute on Computational Hearing. Barga, Italy
2002	National Science Foundation travel grant to NATO Advanced Studies Institute on Dynamics of Speech Production and Perception. Barga, Italy
2002-2004	National Institutes of Health, Ruth L. Kirschstein National Research Service Award, through the National Institute on Deafness and other Communication Disorders
2003	Award for outstanding scientific contribution to the International Conference on Auditory Cortex: Toward a synthesis of human and animal research. Magdeburg, Germany
2007	Chair of "Auditory Cortex" Session, Society for Neuroscience Annual Meeting

- 2011 Swiss National Science Foundation (SNSF) International Short Visit award
- 2012 Academic Senate Research Travel Award (to Lausanne, Switzerland)

Publications

Journals

- 2004 Sun FT, **Miller LM**, D'Esposito M. Measuring interregional functional connectivity using coherence and partial coherence analyses of fMRI data. Neuroimage, 21(2): 647-658.
- 2005 Curtis CE, Sun FT, **Miller LM**, D'Esposito M. Coherence between fMRI time-series distinguishes two spatial working memory networks. Neuroimage, 26(1): 177-183.
- 2005 **Miller LM**, D'Esposito M. Perceptual fusion and stimulus coincidence in the cross-modal integration of speech. The Journal of Neuroscience, 25(25): 5884-5893.
- 2005 Escabi MA, Nassiri R, **Miller LM**, Schreiner CE, Read HL. The contribution of spike threshold to acoustic feature selectivity, spike information content, and information throughput. The Journal of Neuroscience, 25(41): 9524-9534.
- 2005 **Miller LM**, Sun FT, Curtis CE, D'Esposito M. Functional interactions between oculomotor regions during prosaccades and antisaccades. Human Brain Mapping, 26(2): 119-127.
- 2005 Sun FT, **Miller LM**, D'Esposito M. Measuring temporal dynamics of functional networks using phase spectrum of fMRI data. Neuroimage, 28(1): 227-237.
- 2005 Winer JA, **Miller LM**, Lee CC, Schreiner CE. Auditory thalamocortical transformation: structure and function. Trends in Neurosciences, 28(5): 255-263.
- 2006 Sun FT, **Miller LM**, Rao AA, D'Esposito M. Functional connectivity of cortical networks involved in bimanual motor sequence learning. Cerebral Cortex, 17(5): 1227-1234.
- 2007 Shahin AJ, Roberts LE, **Miller LM**, McDonald KL, Alain C. Sensitivity of EEG and MEG to the N1 and P2 auditory evoked responses modulated by spectral complexity of sounds. Brain Topography, 20(2): 55-61.
- 2008 Shahin AJ, Roberts LE, Chau W, Trainor LJ, **Miller LM**. Music training leads to the development of timbre-specific gamma band activity. Neuroimage, 41(1): 113-122.

- 2008 Read HL, **Miller LM**, Schreiner CE, Winer JA. Two thalamic pathways to primary auditory cortex. Neuroscience, 152(1): 151-159.
- 2008 Bishop CW, **Miller LM**. A multisensory cortical network for understanding speech in noise. Journal of Cognitive Neuroscience, 21(9): 1790-1804.
- 2009 Shahin AJ, Bishop CW, **Miller LM**. Neural mechanisms for illusory filling-in of degraded speech. Neuroimage, 44(3): 1133-1143.
- 2009 Shahin AJ, Picton TW, **Miller LM**. Brain oscillations during semantic evaluation of speech. Brain and Cognition, 70(3): 259-266.
- 2009 Shahin AJ, **Miller LM**. Multisensory integration enhances phonemic restoration. The Journal of the Acoustical Society of America, 125(3): 1744-1750.
- 2009 **Miller LM**, Recanzone GH. Populations of auditory cortical neurons can accurately encode acoustic space across stimulus intensity. Proceedings of the National Academy of Sciences of the United States of America, 106(14): 5931-5935.
- 2009 Hill KT, **Miller LM**. Auditory attentional control and selection during cocktail party listening. Cerebral Cortex, 20(3): 583-590.
- 2010 Shahin AJ, Trainor LJ, Roberts LE, Backer KC, **Miller LM**. Development of auditory phase-locked activity for music sounds. Journal of Neurophysiology, 103(1): 218-229.
- 2010 Kerlin JR, Shahin AJ, **Miller LM**. Attentional gain control of ongoing cortical speech representations in a "cocktail party" The Journal of Neuroscience, 30(2): 620-628.
- 2010 Backer KC, Hill KT, Shahin AJ, **Miller LM**. Neural time course of echo suppression in humans. The Journal of Neuroscience, 30(5): 1905-1913.
- 2011 Read HL, Nauen DW, Escabí MA, **Miller LM**, Schreiner CE, Winer JA. Distinct core thalamocortical pathways to central and dorsal primary auditory cortex. Hearing Research, 274(1-2): 95-104.
- 2011 Bishop CW, London S, **Miller LM**. Visual influences on echo suppression. Current Biology, 21(3): 221-225.
- 2011 Hill KT, Bishop CW, Yadav D, **Miller LM**. Pattern of BOLD signal in auditory cortex relates acoustic response to perceptual streaming. BMC Neuroscience, 12(1): 85.
- 2011 Bishop CW, **Miller LM**. Speech cues contribute to audiovisual spatial integration. PLoS ONE, 6(8): e24016.

- 2011 Shahin AJ, Kerlin JR, Bhat J, **Miller LM**. Neural restoration of degraded audiovisual speech. NeuroImage, 60(1): 530-538.
- 2012 Campbell T, Kerlin JR, Bishop CW, **Miller LM**. Methods to Eliminate Stimulus Transduction Artifact From Insert Earphones During Electroencephalography. Ear and Hearing, 33(1): 144-150.
- 2012 Hill KT, Bishop CW, **Miller LM**. Auditory grouping mechanisms reflect a sound's relative position in a sequence. Frontiers in Human Neuroscience, 6: 158.
- 2012 Bishop CW, London S, **Miller LM**. Neural time course of visually enhanced echo suppression. Journal of Neurophysiology, 108(7): 1869-1883.
- 2013 London S, Bishop CW, **Miller LM**. Spatial attention modulates the precedence effect. Journal of Experimental Psychology: Human Perception and Performance, 38(6): 1371-79.
- 2013 Da Costa S, Van der Zwaag W, **Miller LM**, Clarke S, Saenz M. Tuning in to sound: frequency-selective attentional filter in human primary auditory cortex. The Journal of Neuroscience, 33(5): 1858-63.
- 2013 **Miller LM**. Shaken, not stirred: emergence of neural selectivity in a "cocktail party" Neuron, 77(5): 806-809.
- 2014 Bishop CW, Yadav D, London S, **Miller LM**. The effects of preceding lead-alone and lag-alone click trains on the buildup of echo suppression. The Journal of the Acoustical Society of America, 136(2): 803-17.
- 2015 Bhat J, **Miller LM**, Pitt MA, Shahin AJ. Putative mechanisms mediating tolerance for audiovisual stimulus onset asynchrony. Journal of Neurophysiology, 113(5): 1437-1450.
- 2016 Van Diepen R, **Miller LM**, Mazaheri A, Geng J. The role of alpha activity in spatial and featured-based attention. eNeuro, 3(5): 0204-0216.
- 2018 MacArthur MJ, Zellou G, **Miller LM**. Beyond Poet Voice: Sampling the (Non-) Performance Styles of 100 American Poets. Journal of Cultural Analytics.
- 2018 Anderson MH*, Yazel BW*, Stickle MPF, Espinosa Iñiguez FD, Gutierrez NG, Slaney M, Joshi SS, **Miller LM**. Towards mobile gaze-directed beamforming: a novel neuro-technology for hearing loss. Proc IEEE Engineering in Medicine and Biology Society Conference 2018.

- 2019 Backer KB, Kessler AS, Lawyer LA, Corina DP, **Miller LM**. A Novel EEG Paradigm to Simultaneously and Rapidly Assess the Functioning of Auditory and Visual Pathways. Journal of Neurophysiology, 122(4): 1312-1329.

Book Chapters

- 2009 **Miller LM**: Speech Perception: Physiological, E. Bruce Goldstein, (ed), Encyclopedia of Perception, Sage Publications, Inc., London; Thousand Oaks, CA; New Delhi; Singapore.
- 2015 **Miller LM**: Neural mechanisms of attention to speech, Hickok G and Small S, (ed), Neurobiology of Language, Elsevier.

Alternative Media

- 2016 Macarthur MJ, **Miller LM**: Vocal Deformance and Performative Speech, or In Different Voices, Sounding Out! Sound Studies Blog.
- 2018 Macarthur MJ, **Miller LM**: After Scansion: Visualizing, Deforming, and Listening to Poetic Prosody, Arcade (Colloquy Series).
- 2018 **Miller LM**: Vocal Analysis Tools, github.com.

Patents Granted

- 2020 Miller, LM Moore, BDM. Frequency-multiplexed speech: hierarchical neural characterization of continuous speech processing. U.S. patent 10,729,387 filed Jul 15, 2015, issued Aug 4, 2020
- Currently working with InnovationAccess to find licensee.

Courses

- 2005 Fall Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=36, Graduate Count=0
- 2006 Fall Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=51, Graduate Count=0
- 2007 Fall Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Undergraduate Count=12, Graduate Count=0
- 2008 Winter Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=0, Graduate Count=10
- 2008 Fall Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=58, Graduate Count=0
- 2009 Winter Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=1, Graduate Count=11
- 2009 Fall Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=100, Graduate Count=0

2010 Winter Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=1, Graduate Count=13

2010 Fall Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=134, Graduate Count=0

2011 Winter Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=1, Graduate Count=11

2012 Spring Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=0, Graduate Count=3

2013 Spring Quarter, Course Number=NPB100, Neurobiology, Units=4, Undergraduate Count=179, Graduate Count=0

2013 Spring Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=1, Graduate Count=15

2014 Spring Quarter, Course Number=NPB 165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=133, Graduate Count=0

2014 Spring Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=1, Graduate Count=10

2015 Spring Quarter, Course Number=NPB 165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=84, Graduate Count=0

2015 Spring Quarter, Course Number=NPB 100, Neurobiology, Units=4, Undergraduate Count=189, Graduate Count=0

2015 Fall Quarter, Course Number=NPB 100, Neurobiology, Units=4, Undergraduate Count=176, Graduate Count=0

2016 Spring Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=66, Graduate Count=0

2017 Spring Quarter, Course Number=NPB100, Neurobiology, Units=4, Undergraduate Count=202, Graduate Count=0

2017 Spring Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=2, Undergraduate Count=2, Graduate Count=14

2018 Spring Quarter, Course Number=NPB100, Neurobiology, Units=4, Undergraduate Count=162, Graduate Count=0

2018 Spring Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=30, Graduate Count=0

2019 Spring Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=3, Undergraduate Count=4, Graduate Count=7

2019 Spring Quarter, Course Number=NPB100, Neurobiology, Units=4, Undergraduate Count=112, Graduate Count=0

2020 Spring Quarter, Course Number=NPB165, Neurobiology of Speech Perception, Units=3, Undergraduate Count=35, Graduate Count=0

2020 Spring Quarter, Course Number=NPB100, Neurobiology, Units=4, Undergraduate Count=155, Graduate Count=0

- 2021 Spring Quarter, Course Number=NPB/NSC/PSC 211, Advanced Topics in Neuroimaging, Units=3, Undergraduate Count=5, Graduate Count=1
- 2021 Spring Quarter, Course Number=NPB 100, Neurobiology, Units=4, Undergraduate Count=120, Graduate Count=0

Curricular Development

- 2005 Developed new upper-division undergraduate course NPB165 "Neurobiology of Speech Perception". (Offered yearly since 2005)
- 2007 Developed new graduate-level course NSC/NPB/PSC 211 "Advanced Topics in Neuroimaging". (Offered yearly since Winter 2008).
- 2021 SHAPE course co-taught with Marit MacArthur (Univ. Writing Program), "Slow Listening: The Art and Science of Performative Speech". SHAPE is a Mellon Foundation funded project with the Mondavi Center to provide interdisciplinary undergraduate seminars on critical societal issues.