Saurabh Vyas

Contact Information	612 West 130 St., Zuckerman Institute, NY, New York, 10027 https://smvyas.github.io	301.980.2184 sv2648@columbia.edu

Professional Experience

Columbia University, New York, NY   2020 – present
Postdoctoral Research Scientist
Mortimer B. Zuckerman Mind Brain Behavior Institute
Advisor: Mark M. Churchland

Applied Physics Laboratory, Laurel, MD   2011 – 2014
Systems Engineer
Intelligent Systems & Robotics Group

Education

Stanford University, Stanford, CA   2014 – 2020
Ph.D. in Bioengineering
Thesis: "Neural population dynamics underlying motor learning"
Advisor: Krishna V. Shenoy
Donald B. Lindsley Prize (outstanding thesis award by *Society for Neuroscience*)

Johns Hopkins University, Baltimore, MD   2008 – 2014
M.S.E. in Biomedical Engineering
B.S. in Biomedical Engineering
B.S. in Electrical Engineering
University Honors

Awards

Donald B. Lindsley Prize in Behavioral Neuroscience, Society for Neuroscience	2021
Sammy Kuo Award in Neuroscience (Finalist), Stanford University	2018
Ruth L. Kirschstein National Research Service Award (F31), NIH	2017
Best Talk (1st Place), Stanford Bioengineering Retreat	2017
National Science Foundation IGERT trainee in Mind, Brain, and Computation	2015
Biosciences Travel Grant, Stanford University	2015
National Science Foundation Graduate Research Fellowship	2014
Ric Weiland Graduate Fellowship, Stanford University	2014
Graduated with University Honors, Johns Hopkins University	2012
Team Process Award, Design Day, Johns Hopkins University	2012
People's Choice Award, Medical Device Competition, Rice University	2012
Invention of the Year (Finalist), Johns Hopkins Office of Technology Transfer	2011
Project Award, Computer Integrated Surgery, Johns Hopkins University	2011
Robert C. Byrd Scholarship, State of Maryland	2008
Dorr Family Foundation Scholar, Scholarship for Academic Excellence	2008
Merit Scholastic Award, State of Maryland	2008
Distinguished Scholars, State of Maryland	2008
Advanced Placement Scholar with Distinction, CollegeBoard	2008
Science, Engineering, Apprentice Program Fellow, United States Naval Academy	2008
Science, Engineering, Apprentice Program Fellow, United States Naval Academy	2007

Publications

Journal Articles

Sun X*, O'Shea DJ*, Golub MD, Trautmann EM, **Vyas S**, Ryu SI, Shenoy KV, "Cortical preparatory activity indexes learned motor memories," *Nature*, 2021.

Al Borno M, **Vyas S**, Shenoy KV, Delp SL, "High-fidelity Musculoskeletal Modeling Reveals that Motor Planning Variability Contributes to the Speed-Accuracy Tradeoff," *eLife*, 2021.

Vyas S, O'Shea DJ, Ryu SI, Shenoy KV, "Causal role of motor preparation during error-driven learning," *Neuron*, 2020.

Vyas S, Golub MD, Sussillo D, Shenoy KV, "Computation through neural population dynamics," *Annual Review of Neuroscience*, 2020.

Trautmann EM, Stavisky SD, Lahiri S, Ames KC, Kaufman MT, O'Shea DJ, **Vyas S**, Sun X, Ryu SI, Ganguli S, Shenoy KV, "Accurate estimation of neural population dynamics without spike sorting," *Neuron*, 2019.
Preview by Rossi-Pool R & Romo R, "Low Dimensionality, High Robustness in Neural Population Dynamics," Neuron, 2019.

Even-Chen N[*], Sheffer B[*], **Vyas S**, Ryu SI, Shenoy KV, "Structure and variability of delay activity in premotor cortex," *PLoS Computational Biology*, 2019. ([*]equal contribution)

Vyas S, Even-Chen N, Stavisky SD, Ryu SI, Nuyujukian P, Shenoy KV, "Neural population dynamics underlying motor learning transfer," *Neuron*, 2018.
Preview by Natraj N & Ganguly K, "Shaping reality through mental rehearsal," Neuron, 2018.

Williams A, Kim TH, Wang F, **Vyas S**, Ryu SI, Shenoy KV, Schnitzer ML, Kolda TG, Ganguli S, "Unsupervised discovery of demixed, low-dimensional neural dynamics across multiple timescales through tensor components analysis," *Neuron*, 2018.

Vyas S, Huang H, Gale J, Sarma S[*], Montgomery E[*], "Complexity of Dynamics in STN Neuronal Systems is reduced in Parkinson's Disease compared to Epilepsy," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 2016. ([*]equal contribution)

Christensen AJ[*], Iyer SM[*], Francois A, **Vyas S**, Ramakrishnan C, Vesuna S, Deisseroth K, Scherrer G, Delp SL. "In Vivo Interrogation of Spinal Mechanosensory Circuits," *Cell Reports*, 2016. ([*]equal contribution)

Mendrik A, Vincken K, Kuijf H, Breeuwer M, Bouvy W, Bresser J, Alansary A, Bruijne M, Carass A, El-Baz A, Jog A, Katyal R, Khan A, Lijn F, Mahmood Q, Mukherjee R, Opbroek A, Paneri S, Pereira S, Persson M, Rajchl M, Sarikaya D, Smedby O, Silva C, Vrooman H, **Vyas S**, Wang C, Zhao L, Biessels G, and Viergever M, "MRBrainS Challenge: Online Evaluation Framework for Brain Image Segmentation in 3T MRI Scans," *Computational Intelligence and Neuroscience*, 2015.

Vyas S, Meyerle J, Burlina P, "Non-Invasive Estimation of Skin Thickness from Hyperspectral Imaging and Validation using Echography," *Computers in Biology and Medicine*, 2015.

Mukherjee R, **Vyas S**, Juang R, Sprouse C, Burlina P, "Endocardial Surface Delineation in 3D Transesophageal Echocardiography," *Ultrasound in Medicine and Biology*, 2013.

Vyas S, Banerjee A, Burlina P, "Estimating Skin Parameters from Hyperspectral Signatures," *Journal of Biomedical Optics*, 2013.

In Review / Preprints	Gorini C, Iyer SM, **Vyas S**, Ramakrishnan C, Deisseroth K, Delp SL, "Reversible temporally-specific inhibition of muscle using a light-activated chloride channel," *bioRxiv*, 2018.
Peer-reviewed Conference Submissions	O'Shea DJ[*], Trautmann EM[*], Sun X, **Vyas S**, Shenoy KV, "Motor cortical neural dynamics are finely spatially intermingled," Computational and Systems Neuroscience abstract (COSYNE), Online, 2021.

Vyas S, O'Shea DJ, Shenoy KV, "Causal role of motor preparation during error-driven learning," Advances in Motor Learning and Motor Control (MLMC), Chicago, I.L., 2019. *Talk*.

Willett FR, **Vyas S**, Michaels JA, Henderson JM, Shenoy KV, "Neural network models for closed-loop musculoskeletal arm control," Computational and Systems Neuroscience abstract (COSYNE), Lisbon, Portugal, 2019.

Lahiri S, Trautmann EM, Stavisky SD, Ames KC, Kaufman MT, O'Shea DJ, **Vyas S**, Sun X, Ryu SI, Ganguli S, Shenoy KV, "Accurate estimation of neural population dynamics without spike sorting." Computational and Systems Neuroscience abstract (COSYNE), Lisbon, Portugal, 2019.

Vyas S, Even-Chen N, Stavisky SD, Ryu SI, Nuyujukian P, Shenoy KV, "Neural population dynamics underlying motor learning transfer," Computational and Systems Neuroscience abstract (COSYNE), Denver, CO, 2018.

Vyas S, Even-Chen N, Stavisky SD, Ryu SI, Nuyujukian P, Shenoy KV, "Neural population dynamics underlying covert-to-overt motor learning transfer," Advances in Motor Learning and Motor Control (MLMC), Washington D.C., 2017. *Talk*.

Williams A, Kim TH, Wang F, **Vyas S**, Ryu SI, Shenoy KV, Schnitzer ML, Kolda TG, Ganguli S, "Dimension reduction of multi-trial neural data by tensor decomposition," Computational and Systems Neuroscience abstract (COSYNE), Salt Lake City, UT, 2017. *Talk*.

Vyas S, Christensen AJ, Mitelut C, Iyer SM, Gratiy S, Delp SL, Anastassiou C, "A point process approach to inferring connectivity from biophysical simulations of Ca2+ fluorescence," Computational and Systems Neuroscience abstract (COSYNE), Salt Lake City, UT, 2016.

Vyas S, Gammie J, Burlina P, "Computing Cardiac Strain from Variational Optical Flow in Four-Dimensional Echocardiography," IEEE CBMS: Computer-based Medical Systems, 2014. *Talk*. **Finalist - Best Student Paper Award**

Vyas S, Meyerle J, Burlina P, "Cross Validating Hyperspectral with Ultrasound-based Skin Thickness Estimation," IEEE Hyperspectral Image and Signal Processing: Evolution in Remote Sensing (IEEE WHISPERS), 2014.

Vyas S[*], Burlina P, Kleissas D, Mukherjee R[*], "Automated Walks using Machine Learning for Segmentation," International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI), Grand Challenge on MR Brain Segmentation (MRBrains13), 2013. *Talk*. (*equal contribution)

Vyas S, Banerjee A, Burlina P, "Machine Learning Methods for In Vivo Skin Parameter Estimation," IEEE CBMS: Computer-based Medical Systems, 2013.

Vyas S, Mukherjee R, Sosa F, Burlina P, "Endocardium Segmentation in 3D Transesophageal Echocardiography," IEEE ISBI: International Symposium on Biomedical Imaging: From Nano to Macro, 2013.

Vyas S, Banerjee A, Garza L, Kang S, Burlina P, "Hyperspectral Signature Analysis of Skin Parameters," SPIE-MI: Proceedings of SPIE Medical Imaging, 2013. *Talk*.

Peterson E, Mukherjee R, **Vyas S**, Cornish D, "Galaxy: Link Space Visualization and Analysis of Network Traffic," IEEE Visual Analytics in Science & Technology (VAST-MC3), 2013. **Honorable Mention – "Intriguing Visualization"**

Vyas S[*], Su S[*], Kim R[*], Kuo N, Taylor RH, Kang J, Boctor EM, "Intraoperative Ultrasound to Stereocamera Registration using Interventional Photoacoustic Imaging," SPIE-MI: Proceedings of SPIE Medical Imaging, 2012. (*equal contribution)

Conference
Abstracts

Willett F, **Vyas S**, Michaels JA, Henderson JM, Shenoy KV, "Feedback control dynamics explain motor cortical activity," Society for Neuroscience, Virtual, 2021.

Vyas S, O'Shea DJ, Ryu SI, Shenoy KV, "Causal role of motor preparation during error-driven learning," Society for Neuroscience, Chicago, I.L., 2019.

Verhein JR[*], **Vyas S**[*], Shenoy KV, "Towards a neural population-level understanding of the effects of methylphenidate (Ritalin) in motor cortex of reaching monkeys," Society for Neuroscience, Chicago, I.L., 2019. (*equal contribution)

Trautmann EM, O'Shea DJ, Sun X, **Vyas S**, Ryu SI, Shenoy KV, "Spatially heterogenous tuning in rhesus motor cortex revealed using neuropixels probes," Society for Neuroscience, Chicago, I.L., 2019.

Deo DR, Willett FR, Avansino DT, **Vyas S**, Even-Chen N, Hochberg LR, Henderson JM, Shenoy KV, "Neural representation of attempted movement of a paralyzed limb in a person, and implications for intracortical brain-computer interfaces," Society for Neuroscience, Chicago, I.L., 2019.

Sun X, O'Shea DJ, Trautmann EM, Golub MD, **Vyas S**, Fisher TG, Ryu SI, Shenoy KV, "Changes in neural population activity underlying the learning of novel arm dynamics," Society for Neuroscience, Chicago, I.L., 2019.

Verhein JR[*], **Vyas S**[*], Shenoy KV, "Towards a neural population-level understanding of the effects of methylphenidate (Ritalin) in motor cortex of reaching monkeys," Neural Control of Movement, Toyama, Japan, 2019. (*equal contribution)

Sun X, O'Shea DJ, Trautmann EM, Golub MD, **Vyas S**, Fisher TG, Ryu SI, Shenoy KV, "Exploration of distinct neural activity repertoire during learning of new arm dynamics," Neural Control of Movement, Toyama, Japan, 2019.

Vyas S, O'Shea DJ, Trautmann EM, Willett FR, Shenoy KV, "Motor cortical preparatory activity is causally involved in visuomotor learning," Society for Neuroscience, San Diego, C.A., 2018.

Trautmann EM, O'Shea DJ, **Vyas S**, Shenoy KV, "Recording large populations of neurons with single-cell resolution in nonhuman primates using Neuropixels," Cell-NERF Symposium: Neurotechnologies, Leuven, Belgium, 2018.

Even-Chen N, Sheffer B, **Vyas S**, Ryu SI, Shenoy KV, "Spatial encoding of reaches in preparatory motor cortical activity," Neural Control of Movement, Santa Fe, N.M., 2018.

Vyas S, Even-Chen N, Stavisky SD, Ryu SI, Nuyujukian P, Shenoy KV, "Brain-machine interface guided movements share a common neural substrate with overt movements," Society for Neuroscience, Nanosymposium on Motor Control and Internal Representations, Washington D.C., 2017. *Talk*. **Selected as SfN Hot Topic**.

Even-Chen N, **Vyas S**, Ryu SI, Shenoy KV, "The effect of task dimensionality on BMI performance," Society for Neuroscience, Washington D.C., 2017.

Sheffer B, Even-Chen N, **Vyas S**, Ryu SI, Shenoy KV, "Direction and distance decoding accuracy from plan activity in monkey motor cortex," Society for Neuroscience, Washington D.C., 2017.

Williams A, Poole B, Maheswaranathan N, Kim TH, Wang F, **Vyas S**, Shenoy KV, Schnitzer ML, Kolda TG, Ganguli S, "Low-dimensional representations of learning in multi-trial datasets," Society for Neuroscience, Washington D.C., 2017.

Vyas S, Christensen AJ, Iyer SM, Ramakrishnan C, Deisseroth K, Delp SL, "Optical and computational tools for analyzing somatosensory circuits," Society for Neuroscience, Chicago, IL, 2015.

Christensen AJ, Iyer SM, **Vyas S**, Francois A, Scherrer G, Deisseroth K, Delp SL, "Optogenetic tools for perturbing spinal neural circuits," Society for Neuroscience, Chicago, IL, 2015.

Iyer SM, Christensen AJ, **Vyas S**, Vesuna S, Francois A, Ramakrishnan C, Deisseroth K, Scherrer G, Delp SL, "Optogenetic interrogation of mammalian mechanosensory and nociceptive circuits," Society for Neuroscience, Chicago, IL, 2015.

Vyas S, Nguyen HV, Burlina P, Banerjee A, Garza L, Chellappa R, "Computational Modeling of Skin Reflectance Spectra for Biological Parameter Estimation through Machine Learning," SPIE: Proceedings of SPIE, 2012. *Talk*.

Patents   Burlina P, Banerjee A, **Vyas S**, Garza L, "Hyperspectral Imaging for Detection of Skin Related Conditions," U.S. Patent No. 8,761,476. Granted on June 24, 2014.

Talks   Simons-Emory International Consortium on Motor Control, Workshop on Neural Dynamics, "Computation through dynamics," 2020.

Princeton University, Prof. Tim Buschman's group, "What role does motor preparation play during motor learning," 2020.

Columbia University, Prof. Daniel Salzman's group, "What role does motor preparation play during motor learning," 2020.

Columbia University, Prof. Mark Churchland's group, "What role does motor preparation play during motor learning," 2020.

Stanford University, Department of Neurobiology, "The Shenoy Lab Evening," Stanford, CA, "Neural population dynamics underlying motor learning," 2019.

Advances in Motor Learning and Motor Control (MLMC), Chicago, IL, "Causal role of motor preparation during error-driven learning," 2019.

Massachusetts Institute of Technology, Prof. Mehrdad Jazayeri's group, Cambridge, MA, "Neural population dynamics underlying visuomotor learning," 2019.

University of Chicago, Prof. David Freedman's group, Chicago, IL, "Neural population dynamics underlying visuomotor learning," 2019.

Carnegie Mellon University, Profs. Byron Yu's & Matt Smith's groups, Pittsburgh, PA, "Neural population dynamics underlying visuomotor learning," 2019.

University of California, Berkeley, Prof. Jose Carmena's group, Berkeley, CA, "Neural population dynamics underlying visuomotor learning," 2019.

Stanford University, Invited talk at Center for Mind, Brain, Computation, and Technology (MBCT), Stanford, CA, "Neural population dynamics underlying visuomotor learning," 2019.

Johns Hopkins University, Prof. Reza Shadmehr's group, Baltimore, MD, "Neural population dynamics underlying visuomotor learning," 2018.

Advances in Motor Learning and Motor Control (MLMC), Washington DC, "Neural population dynamics underlying covert-to-overt motor learning transfer," 2017.

Society for Neuroscience, Nanosymposium on Motor Control and Internal Representations, Washington DC, "Brain-machine interface guided movements share a common neural substrate with overt movements," 2017.

Stanford University, Bioengineering Retreat, Chaminade Resort & Spa, Santa Cruz, CA, "Neural population dynamics underlying motor learning transfer," 2017. **1st Place - Best Talk**

Stanford University, Invited talk to Neurosciences Ph.D. program candidates, hosted by Prof. Jay McClelland. "Neural Dynamics and Adaptation for Brain-Machine Interface Control." 2017

Stanford University, Bioengineering Retreat, Chaminade Resort & Spa, Santa Cruz, CA, "Towards a freely moving macaque model for motor neuroscience and brain-machine interfaces," 2016

Google, Invited talk by Dr. Thomas Dean, Mountain View, CA, "Estimating Neuronal Connectivity from Calcium Imaging Data," 2015

IEEE CBMS conference in New York, NY, "Computing Cardiac Strain from Variational Optical Flow in Four-Dimensional Echocardiography," 2014.

MICCAI workshop in Nagoya, Japan. "Automated Walks using Machine Learning for Segmentation," 2013.

ISBI conference in San Francisco, CA, "Endocardium Segmentation in 3D Transesophageal Echocardiography," 2013.

SPIE Medical Imaging conference in Orlando, FL, "Hyperspectral Signature Analysis of Skin Parameters," 2013.

SPIE conference in Baltimore, MD, "Computational Modeling of Skin Reflectance Spectra for Biological Parameter Estimation through Machine Learning," 2012.

SPIE Medical Imaging conference in San Diego, CA, "Intraoperative Ultrasound to Stereocamera Registration using Interventional Photoacoustic Imaging," 2012.

Teaching	EE 124: Introduction to NeuroElectrical Engineering, Stanford University *Co-instructor with Prof. Krishna Shenoy*	Winter 2018
	NBio 227: Techniques in Neuroscience, Stanford University *Guest lecturer on Brain Machine Interfaces*	Autumn 2017, 2018
	BIOS 230: Biomedical Data Analysis in Matlab, Stanford University *Co-developed and co-instructed 3-week mini course (with Nimit Jain)*	Spring 2015
Course Assistant	EE 364a: Convex Optimization, Stanford University	Spring 2017; Winter 2018, 2019
	EE 278: Statistical Signal Processing, Stanford University	Autumn 2018
	EE 376a: Information Theory, Stanford University	Winter 2017
	BioE 281: Biomechanics of Movement, Stanford University	Winter 2016
	CS 229: Machine Learning, Stanford University	Autumn 2015
	580.421: Systems Bioengineering Laboratory, Johns Hopkins University	Fall 2012
Outreach & Service	Computational Neuroscience Journal Club, Stanford University *Co-founder and co-organizer.*	2015 – 2018
	Stanford Biosciences Student Association, Stanford University	2016 – 2019

Mentored first-year biosciences (bioengineering) graduate students.

Center for Mind, Brain, & Computation, Stanford University   2015 – 2019
Organized the Monday evening seminar series; invited and hosted speakers.

Stanford Undergraduate Research Association, Stanford University   2018
Mentored undergraduate students interested in research opportunities.

Biomedical Engineering Society, Stanford University   2015
Mentored undergraduate students interested in bioengineering careers.

Boys and Girls Club, Palo Alto, CA   2015 – 2016
SAT tutoring for high school students in the east Palo Alto area.

ASPIRE Program, Johns Hopkins Applied Physics Laboratory   2013 – 2014
Mentored high school students in robotics, and computer vision.

College Prep Program, Johns Hopkins University   2013 – 2014
Developed an SAT curriculum; lectured a classroom of 20 students.

Tutorial Project, Johns Hopkins University   2012
Tutored math and reading to Baltimore City Elementary school students.