

## Joseph D. Zak, Ph.D.

Department of Molecular & Cellular Biology  
Harvard University  
Cambridge, MA 02138

jzak@fas.harvard.edu  
(734) 476-6985

### SCHOLARLY PROFILE

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My research has two objectives: first, to understand how the brain extracts salient information about physical objects in the environment; and second, to understand the mechanisms through which internal neural representations are made from external stimuli. My main interest is the balance between neural excitation and inhibition within the mammalian olfactory system, as it pertains to normalization, signal filtering, and stimulus discrimination. My research uses electrophysiological, pharmacological, imaging, and computational approaches to meet these objectives.

### EDUCATION

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- 2015**      **Ph.D. in Neuroscience**, Department of Physiology & Biophysics  
University of Colorado Medical School, Aurora, CO.  
NIH NRSA pre-doctoral fellowship, 2013-15  
Faculty Advisor: Nathan Schoppa, Professor of Physiology & Biophysics
- 2008**      **B.S. in Neuroscience**  
University of Michigan, Ann Arbor, MI

### RESEARCH EXPERIENCE

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- 2015-**      **Postdoctoral Fellow**, Department of Molecular & Cellular Biology, Harvard University  
NIH NRSA postdoctoral fellowship, 2017-20  
Faculty mentor: Venkatesh Murthy, Professor of Molecular & Cellular Biology
- 2008-10**    **Research Assistant**, The Jackson Laboratory, Bar Harbor, ME  
Faculty Supervisor: Zhong-wei Zhang, Professor of Research

### PUBLICATIONS

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1. Gire DH\*\*, Zak JD\*\*, Bourne JN, Goodson N, Schoppa NE (2018) Stimulus strength-dependent alterations in the balance between extrasynaptic excitation and inhibition within olfactory bulb glomeruli. *Under Review*    \*\*equal contribution
2. Albeanu DF, Provost AC, Agarwal P, Soucy E, Zak JD, Murthy VN (2018) Olfactory marker protein (OMP) regulates formation and refinement of the olfactory glomerular map. *Nature Communications*. 9:5073
3. Zak JD, Grimaud J, Li R-C, Lin C-C, Murthy VN (2018) Calcium-activated chloride channels clamp odor-evoked spike activity in olfactory receptor neurons. *Sci. Rep.* 8:10600
4. Reddy G\*\*, Zak JD\*\*, Vergassola M, Murthy VN (2018) Antagonism in olfactory receptor neurons and its implications for the perception of odor mixtures. *eLife*. 7:e35958    \*\*equal contribution

5. **Zak JD** (2016) A computational framework for temporal sharpening of stimulus input in the olfactory system. *J. Neurophysiol.* 115(4):1749-51
6. **Zak JD**, Whitesell JD, Schoppa NE (2015) Metabotropic glutamate receptors promote disinhibition of olfactory bulb glomeruli that scales with input strength. *J. Neurophysiol.* 113(6):1907-20.
7. Gire DH, Franks KM, **Zak JD**, Tanaka KF, Whitesell JD, Mulligan AA, Hen R, Schoppa NE (2012) Mitral cells of the olfactory bulb are mainly excited through a multi-step signaling path. *J. Neurosci.* 32:2964-75
8. Zhang Z-W, **Zak JD**, Liu H (2010) MeCP2 is required for normal development of GABAergic circuits in the thalamus. *J. Neurophysiol.* 103(5):2470-81

## PREPRINTS

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1. Gire DH\*\*, **Zak JD\*\***, Bourne JN, Goodson N, Lynch BE, Dulla CG, Schoppa NE (2018) Thresholding of sensory inputs by extrasynaptic glutamate receptors in olfactory bulb glomeruli. DOI:10.1101/341958. \*\*equal contribution

## PRESENTATIONS

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### Invited Presentations

- “Extrasynaptic glutamate promotes nonlinearities in the balance of excitation and inhibition” Department of Neuroscience, Amgen (April 2019)
- “Normalization of sensory inputs to the olfactory bulb,” Department of Biology, Stonehill College (January 2019)
- “Disruption of sensory transduction and odor coding in olfactory receptor neurons,” Genetics Interest Group, The Jackson Laboratory (October 2018)
- “Electrical and chemical signaling in olfactory networks,” Department of Biomedical Sciences, Western Michigan University School of Medicine (May 2018)
- “Non-linear interactions between excitation and inhibition gate olfactory bulb output,” Ludwig-Maximilians-Universität München - Harvard University Young Scientist Forum (July 2016)
- “Intrinsic and pharmacologic mechanisms of signal filtering at olfactory bulb glomeruli,” Novartis Institute for Biomedical Research (November 2015)
- “Neuroscience in the classroom,” Denver Museum of Nature & Science Minds on Brains Workshop (April 2015)
- “Cellular and population analyses of signal filtering at olfactory bulb glomeruli,”
  - Department of Molecular and Cellular Biology, Harvard University (September 2014).
  - Department of Neurobiology, Duke University, (August 2014).
  - Department of Neurobiology & Anatomy University of Utah, (June 2014)
  - Rocky Mountain Regional Neuroscience Group (SfN Chapter) (May 2014)
- “Control of GABA release and glomerular output by metabotropic glutamate receptors in the olfactory bulb,” Front Range Neuroscience Group (SfN Chapter) (December 2013)
- “Differential modulation of mitral and tufted cells in the olfactory bulb,” A.R. Martin Lectureship, Department of Physiology & Biophysics, University of Colorado Medical School (May 2013)

### Conference Abstracts

- Zak JD**, Murthy VN (2019) Odor mixture representation in cortical projections to the olfactory bulb. Association for Chemoreception Sciences, Annual Meeting, Bonita Springs, FL
- Zak JD**, Murthy VN (2018) Coding of odor mixtures in cortical feedback projections to the olfactory bulb. Society for Neuroscience, Annual Meeting, San Diego, CA

Reddy G, **Zak JD**, Vergassola M, Murthy VN (2018) Antagonism in olfactory receptor neurons and its implications for the perception of odor mixtures. Annual Meeting of the American Physical Society, Los Angeles, CA

**Zak JD**, Grimaud J, Li R-C, Lin C-C, Yau, K-W, Murthy VN (2017) Calcium-activated chloride channels suppress odor-evoked activity in olfactory receptor neurons in vivo. Society for Neuroscience, Annual Meeting, Washington D.C.

**Zak JD**, Grimaud J, Li R-C, Lin C-C, Yau, K-W, Murthy VN (2017) Olfactory receptor neuron tuning and excitability in the absence of calcium-activated chloride channels. Conference on Frontiers in Olfaction, International Center for Theoretical Physics, Trieste, Italy

**Zak JD**, Gire DH, Schoppa NE (2015) Non-linear interactions between GABAergic inhibition and extrasynaptic glutamate gate output of olfactory bulb glomeruli. Society for Neuroscience, Annual Meeting, Chicago, IL

**Zak JD**, Schoppa NE (2014) Cellular and population analyses of signal filtering at olfactory bulb glomeruli. Society for Neuroscience, Front Range Chapter Meeting, Fort Collins, CO

**Zak JD**, Schoppa NE (2014) Cellular and population analyses of signal filtering at olfactory bulb glomeruli. Society for Neuroscience, Annual Meeting, Washington D.C.

**Zak JD**, Schoppa NE (2014) Cellular Mechanisms Underlying Olfactory Signal-Filtering at Olfactory Bulb Glomeruli. Association for Chemoreception Sciences, Annual Meeting, Bonita Springs, FL

**Zak JD**, Schoppa NE (2013) Control of glomerular output by metabotropic glutamate receptors in the olfactory bulb. Society for Neuroscience, Front Range Chapter Meeting, Fort Collins, CO

Bourne JN, **Zak JD**, Dulla CG, Schoppa NE (2013) Optical detection of glutamate transients within olfactory bulb glomeruli. Society for Neuroscience, Annual Meeting, San Diego, CA

**Zak JD**, Schoppa NE (2013) Control of glomerular output by metabotropic glutamate receptors in the olfactory bulb. Society for Neuroscience, Annual Meeting, San Diego, CA

**Zak JD**, Gire DH, Schoppa NE (2012) Balancing excitation and inhibition within olfactory bulb glomeruli. Society for Neuroscience, Front Range Chapter Meeting, Fort Collins, CO

**Zak JD**, Gire DH, Schoppa NE (2012) Balancing excitation and inhibition within olfactory bulb glomeruli. Society for Neuroscience, Annual Meeting 2012, New Orleans, LA

## TEACHING and ADVISING

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### Teaching

Responsibilities included leading discussion, overseeing labs, grading all assignments, meeting with students during office hours, holding review sessions.

**Instructor of Record**, Harvard University, Cambridge, MA

- “Neurobiology of Learning and Memory” Neuro 101 (fall/spring 2018-2019)
- “Neurobiology of Learning and Memory” Neuro 101 (fall/spring 2017-2018)
- “Neurobiology of Learning and Memory” Neuro 111 (fall/spring 2016-2017)

**Teaching Assistant**, Harvard University, Cambridge, MA

- “Becoming a Brain Scientist: Neuroscience and Psychology Research” MBB 102 (summer 2018)

**Guest Lecturer**, Harvard University, Cambridge, MA

- “Artificial and Natural Intelligence” FRSEMR 50F (spring 2019)

**Graduate Student Teaching Assistant**, University of Colorado Medical School, Aurora CO

- “Systems Neuroscience” NRSC 7610 (spring 2015)

**Undergraduate Teaching Assistant**, University of Michigan, Ann Arbor, MI

- “Neurobiology Laboratory” MCDB 423 (spring 2008)

### Certification

Certificate in teaching for undergraduates, Harvard University (2017)

**Advising**

Thesis advisor - Harvard College senior, 2017 - 2018

Thesis Title: "Neural and behavioral effects of olfactory masking agents"

Harvard College junior, 2016 - 2017

Visiting Scholar, Harvard University, 2015 - 2016

Graduate Student, Neuroscience Program, University of Colorado, 2014 - 15

**Tutoring**

Neuroscience Program Tutor, Molecular and Cellular Neuroscience, University of Colorado Medical School, 2011-2012

**HONORS and AWARDS**

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**Fellowships**

NIH NIDCD NRSA (F32 DC015938) Individual Postdoctoral Fellowship, 2017-2020

Title: Information coding in individual olfactory sensory axons

Sponsor: Venkatesh Murthy, Professor of Molecular and Cellular Biology, Harvard University

NIH NIDCD NRSA (F31 DC013480) Individual Predoctoral Fellowship, 2013-2016

Title: Balancing excitation and inhibition in olfactory bulb glomeruli

Sponsor: Nathan Schoppa, Professor of Physiology & Biophysics, University of Colorado

Co-sponsor: Diego Restrepo, Professor of Cell & Developmental Biology, University of Colorado

**Teaching Awards**

Harvard University Certificate of Distinction in Teaching (Spring 2018)

Harvard University Certificate of Distinction in Teaching (Fall 2017)

Harvard University Certificate of Distinction in Teaching (Spring 2017)

**Academic Recognition**

Sponsored Membership, AAAS/Science Program for Excellence in Science (2012-2016)

A.R. Martin Award for 1<sup>st</sup> Year Graduate Scholarship, University of Colorado Medical School (2011)

**Presentation Awards**

Outstanding Graduate Student Presentation, 29<sup>th</sup> Annual University of Colorado Research Forum (12/2014)

Top Student Poster Presentation, Front Range Neuroscience Group (SfN Chapter) (12/2014)

28<sup>th</sup> Annual University of Colorado Research Forum, Outstanding Graduate Student Presentation (12/2013)

Front Range Neuroscience Group (SfN Chapter), Invited Student Presentation (12/2013)

A.R. Martin Lectureship Invited Student Presentation, Department of Physiology & Biophysics, University of Colorado Medical School, (5/2013)

Top Student Poster Presentation, Front Range Neuroscience Group (SfN Chapter) (12/2012)

**Travel Awards**

Postdoctoral Award for Professional Development, Harvard University (6/2017)

Association for Chemoreception Sciences Annual Meeting, Travel Award (4/2014)

## **PROFESSIONAL SERVICE & ADDITIONAL PROFESSIONAL EXPERIENCE**

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### **Peer Review Service**

2018- **Data in Brief**, Editorial Board

### **Professional Development**

2016-2017 **IMPACT Fellow**, Massachusetts Institute of Technology

### **Committee Service**

2014-2015 Neuroscience Program Executive Committee, University of Colorado Medical School

2011-2015 Neuroscience Program Retreat Committee, University of Colorado Medical School

2011-2015 Neuroscience Program Student Recruitment, University of Colorado Medical School

### **Outreach**

2011-2015 Denver Regional Science Fair Outreach

2011-2015 Rocky Mountain Smell and Taste Center, Neuroscience Outreach

### **Professional Membership**

Association for Chemoreception Sciences, 2013 –

American Association for the Advancement of Science, 2012 –

Society for Neuroscience, 2011 –

*Updated 4/2019*