

Joseph D. Zak, Ph.D.

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SCHOLARLY PROFILE

My research has two objectives: first, to reveal the neural mechanisms through which the brain extracts salient information about physical objects in the environment; and second, to uncover the role of learning in the development of sensory circuits. My research uses electrophysiological, pharmacological, imaging, and computational approaches to meet these objectives.

EDUCATION

- 2015** **Ph.D. in Neuroscience**, Department of Physiology & Biophysics
University of Colorado Medical School, Aurora, CO
Thesis: Balancing excitation and inhibition in olfactory bulb glomeruli
Faculty Advisor: Nathan Schoppa, Professor of Physiology & Biophysics
NIH NRSA Pre-doctoral Fellowship, 2013-15
- 2008** **B.S. in Neuroscience**
University of Michigan, Ann Arbor, MI

RESEARCH EXPERIENCE

- 2015-** **Postdoctoral Fellow**, Department of Molecular & Cellular Biology
Harvard University, Cambridge, MA
Project: Information coding and normalization in olfactory sensory neurons
Faculty Advisor: Venkatesh Murthy, Professor of Molecular & Cellular Biology
NIH NRSA Postdoctoral Fellowship, 2017-20
NIH K99/R00 Pathway to Independence Award, 2020-25
- 2008-10** **Postbaccalaureate Research Assistant**
The Jackson Laboratory, Bar Harbor, ME
Project: Disruption of GABAergic circuits in a mouse model of Rett Syndrome
Faculty Supervisor: Zhong-wei Zhang, Professor of Research

PUBLICATIONS

1. Gire DH**, **Zak JD****, Bourne JN, Goodson N, Schoppa NE (2019) Balancing extrasynaptic excitation and synaptic inhibition within olfactory bulb glomeruli. *eNeuro*. 6(4):0247-19.2019 **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. *Nat. Commun.* 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

1. **Zak JD**, Reddy G, Vergassola M, Murthy VN (2019) Antagonistic odor interactions in olfactory sensory neurons are widespread in freely breathing mice. *bioRxiv.* 847525; doi: <https://doi.org/10.1101/847525>

PRESENTATIONS

Invited Presentations

Odor mixture coding in mouse olfactory receptor neurons

Society for Neuroscience, Annual Meeting (2019)

In vivo odor tuning and antagonism in individual olfactory sensory neurons

Ludwig-Maximilians-Universität (2019)

Extrasynaptic glutamate promotes nonlinearities in the balance of excitation and inhibition

Department of Neuroscience, Amgen (2019)

Normalization of sensory inputs to the olfactory bulb

Department of Biology, Stonehill College (2019)

Disruption of sensory transduction and odor coding in olfactory receptor neurons

Genetics Interest Group, The Jackson Laboratory (2018)

Electrical and chemical signaling in olfactory networks

Department of Biomedical Sciences, Western Michigan University School of Medicine (2018)

Non-linear interactions between excitation and inhibition gate olfactory bulb output

Ludwig-Maximilians-Universität München - Harvard University Young Scientist Forum (2016)

Intrinsic and pharmacologic mechanisms of signal filtering at olfactory bulb glomeruli

Novartis Institute for Biomedical Research (2015)

Neuroscience in the classroom

Denver Museum of Nature & Science Minds on Brains Workshop (2015)

Cellular and population analyses of signal filtering at olfactory bulb glomeruli

- Department of Molecular and Cellular Biology, Harvard University (2014)
- Department of Neurobiology, Duke University (2014).
- Department of Neurobiology & Anatomy University of Utah (2014)
- Rocky Mountain Regional Neuroscience Group, SfN Chapter (2014)

Control of GABA release and glomerular output by metabotropic glutamate receptors in the olfactory bulb

Front Range Neuroscience Group, SfN Chapter (2013)

Differential modulation of mitral and tufted cells in the olfactory bulb

A.R. Martin Lectureship, University of Colorado Medical School (2013)

TEACHING & ADVISING

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 2019-2020)
- “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)

Pedagogical Training

College Teaching Practices Certificate Program, Harvard University (2017)

Advising

Thesis advisor - Harvard College senior (2017-18)

Thesis Title: “Neural and behavioral effects of olfactory masking agents”

Harvard College junior (2016-17)

Visiting Scholar, Harvard University (2015-16)

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

Tutoring

Neuroscience Program Tutor, Molecular and Cellular Neuroscience, University of Colorado Medical School (2011-12)

HONORS & AWARDS

Fellowships & Funding

NIH NIDCD Pathway to Independence Award (K99/R00 DC017754), 2020-25

Title: Learning-mediated plasticity in cortical feedback projections to the olfactory bulb

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

Co-sponsor: Naoshige Uchida, Professor of Molecular and Cellular Biology, Harvard University

NIH NIDCD NRSA (F32 DC015938) Individual Postdoctoral Fellowship, 2017-20

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, 2013-16

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 (2012-16)

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

Presentation Awards

Outstanding Graduate Student Presentation, 29th Annual University of Colorado Research Forum (2013)

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

Outstanding Graduate Student Presentation, 28th Annual University of Colorado Research Forum (2013)

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

A.R. Martin Lectureship Invited Student Presentation, University of Colorado Medical School (2013)

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

Travel Awards

Young Scientist Travel Award, Harvard Brain Science Initiative (2019)

Postdoctoral Award for Professional Development, Harvard University (2017)

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