

# Harsh Vashistha

**Current Position:** Postdoctoral associate in neuroscience at Yale University

**PI:** Damon Clark

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## EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE	START DATE-END DATE (MM/YYYY-MM/YYYY)	FIELD OF STUDY
IISER, Bhopal, M.P. India	BS-MS	08/2010 – 06/2015	Physics
University of Pittsburgh, Pittsburgh, PA, USA	PHD	08/2015 – 08/2021	Physics
Marine Biological Laboratory, Woods Hole, MA, USA	Other training	07/2022 – 08/2022	Methods in Computational Neuroscience
Yale University, New Haven, CT, USA	Postdoctoral Associate	09/2021– present	Neuroscience

## A. Personal Statement

My long-term career goal is to establish an independent research program in neuroscience focused on understanding how internal states and external sensory cues interact to shape adaptive behavior in animals. My current research integrates novel behavioral paradigms, neural circuit manipulation, and two-photon imaging in *Drosophila* to uncover principles of neural computation that are conserved across species. My background in physics provides a strong foundation for quantitative data analysis and mathematical modeling, while my training in biology allows me to manipulate neural circuits genetically and visualize their activity during sensorimotor transformation through imaging.

## B. Positions, Scientific Appointments and Honors

### Positions and Scientific Appointments

09/2021 – present Postdoctoral Associate, Yale University, New Haven, CT, USA  
08/2016 – 08/2021 Graduate Student Researcher, University of Pittsburgh, Pittsburgh, PA, USA  
08/2015 – 07/2016 Graduate Teaching Assistant, University of Pittsburgh, Pittsburgh, PA, USA  
06/2014 – 06/2015 Research assistant, Indian Institute of Science Education and Research, Bhopal, India

### Honors

2021 Provost's degree completion fellowship, University of Pittsburgh, USA  
2020 Andrew W. Mellon predoctoral fellowship, University of Pittsburgh, USA  
2019 Winner, 3 Minute Thesis, University of Pittsburgh, USA  
2013 Indian Academy of Science, Summer Fellowship, Indian Academy of Sciences, India  
2010 - 2015 INSPIRE fellowship, D.S.T., India

## C. Contribution to Science

1. **Cell size regulation in bacteria:** During my Ph.D., I studied the biophysical mechanisms underlying the size homeostasis in bacterial cells. I designed a microfluidic device to trap single bacterial cells and used time-lapse microscopy to measure their growth dynamics for hundreds of generations. I analyzed growth parameters like elongation rate, cycle duration and division fraction to help build a phenomenological model of cell size homeostasis. Next, I used multivariate statistical analysis to infer dependencies among growth parameters for stable growth. Finally, I used genetic perturbations to discover the molecular mechanisms that underlie effective size regulation in these cells. These results helped build a mechanistic understanding of size homeostasis in bacterial cells.

### Publications

- a. **Vashistha H**, Jammal-Touma J, Singh K, Rabin Y, Salman H. Bacterial cell-size changes resulting from altering the relative expression of Min proteins. *Nature Communications*. 2023 Sep 15;14(1):5710. PubMed Central PMCID: PMC10504268.
  - b. Kohram M, **Vashistha H**, Leibler S, Xue B, Salman H. Bacterial Growth Control Mechanisms Inferred from Multivariate Statistical Analysis of Single-Cell Measurements. *Current Biology*. 2021 Mar 8;31(5):955-964.e4. PubMed PMID: 33357764.
  - c. Stawsky A, **Vashistha H**, Salman H, Brenner N. Multiple timescales in bacterial growth homeostasis. *iScience*. 2022 Feb 18;25(2):103678. PubMed Central PMCID: PMC8792075.
  - d. Susman L, Kohram M, **Vashistha H**, Nechleba JT, Salman H, Brenner N. Individuality and slow dynamics in bacterial growth homeostasis. *PNAS*. 2018 Jun 19;115(25): E5679-E5687. PubMed Central PMCID: PMC6016764.
2. **Non-genetic inheritance in bacteria:** In the second project of my PhD, I focused on understanding the origin of phenotypic variability in isogenic bacterial populations. This variability enables cell populations to survive in changing environmental conditions. I designed a novel microfluidic device to trap two identical daughter cells following the symmetric division of a mother bacterial cell. I measured the growth dynamics of these sister cells over tens of generations and estimated the timescale over which their physical properties diverged—providing insights into the origin of variability within populations. I discovered that different physical properties diverge over different timescales. Some properties remain highly correlated and are inherited for approximately ten generations, thereby constraining variability in those traits.

### Publications

- a. **Vashistha H**, Kohram M, Salman H. Non-genetic inheritance restraint of cell-to-cell variation. *eLife*. 2021 Feb 1;10 PubMed Central PMCID: PMC7932692.
  - b. ElGamel M, **Vashistha H**, Salman H, Mugler A. Multigenerational memory in bacterial size control. *Phys Rev E*. 2023 Sep;108(3): L032401. PubMed PMID: 37849186.
3. **Microbial adaptive responses to environment and stress:** I collaborated with labs at Stanford and Carnegie Mellon University to investigate various aspects of microbial adaptation. In the first project, we studied how cells escape from confined spaces filled with varying densities of obstacles. We discovered that cells modulate their tumbling frequency based on obstacle density to maintain a constant rate of escape. In the second project, we investigated how bacterial cells adapt to sudden shifts in growth temperature and found that they undergo metabolic rearrangements to produce an adaptive response. In the third project, we examined how bacterial cells respond to random non-deleterious mutations. We found that cells can survive such mutations by reorganizing their gene expression patterns; however, these mutations and compensatory adjustments ultimately reduce their long-term survival probability.

### Publications

- a. Knapp BD, Willis L, Gonzalez C, **Vashistha H**, Jammal-Touma J, Tikhonov M, Ram J, Salman H, Elias JE, Huang KC. Metabolic rearrangement enables adaptation of microbial growth rate to temperature shifts. *Nature Microbiology*. 2025 Jan;10(1):185-201. PubMed PMID: 39672961.
- b. Kohram M, Sanderson AE, Loui A, Thompson PV, **Vashistha H**, Shomar A, Oltvai ZN, Salman H. Nonlethal deleterious mutation-induced stress accelerates bacterial aging. *PNAS*. 2024 May 14;121(20): e2316271121. PubMed Central PMCID: PMC11098108.

- c. Rashid S, Long Z, Singh S, Kohram M, **Vashistha H**, Navlakha S, Salman H, Oltvai ZN, Bar-Joseph Z. Adjustment in tumbling rates improves bacterial chemotaxis on obstacle-laden terrains. *PNAS*. 2019 Jun 11;116(24):11770-11775. PubMed Central PMCID: PMC6575235.

4. **Depth motion detection and responses to aversive stimuli**: In my first postdoctoral project, I investigated how animals detect and respond to objects moving in depth using *Drosophila* as a model organism. I discovered that the brain integrates multiple visual features—such as luminance, contrast, and size changes—to efficiently detect an approaching or retreating object. Using a visual stimulus that evokes a strong perception of depth motion without size change, I showed that multiple cues contribute synergistically to depth motion detection. My tests on human subjects showed that this mechanism is likely conserved in both humans and flies. This work reveals shared computational strategies for depth motion detection across species. I also collaborated on a project investigating the neural mechanisms underlying behavioral responses to different types of aversive stimuli, including looming and fast translating objects.

#### **Publications**

- a. **Vashistha H**, Matos NCB, Clark DA. Multi-cue integration to detect approach in flies and humans. (In preparation).
- b. **Vashistha H**, and Clark, D. Perception of an expansion illusion through adaptation to temporal changes in luminance. (In preparation).
- c. Matos NCB, **Vashistha H**, Clark DA. Visual neural circuits for avoidance behavior in fruit flies. (In preparation).
- d. **Vashistha H**, Clark DA. Feature maps: How the insect visual system organizes information. *Current Biology*. 2022 Aug 8;32(15): R847-R849. PubMed PMID: 35944487.
5. **Direction selectivity in the fly olfactory system**: In my second postdoctoral project, I am co-leading a study to understand the neural mechanism of direction selectivity in fly olfactory neurons. To this end, we have built a novel optogenetic setup that simulates a moving odor stimulus. Using this setup in combination with two-photon imaging, we have discovered for the first time in any animal, a neural mechanism of direction selectivity in the olfactory system, which shares the same computational logic of directional selectivity as in the visual system. This work expands our understanding of sensory processing and supports the notion of shared computational motifs across sensory modalities.

#### **Publications**

- a. Santana GM\*, **Vashistha H\***, Emonet T, Clark DA. Widespread direction selectivity in olfactory neurons in fruit flies. [\*Co- first authors]. (In preparation)

Complete List of Published Work in My Bibliography:

<https://www.ncbi.nlm.nih.gov/myncbi/harsh.vashistha.1/bibliography/public/>

## **D. Teaching interests**

My teaching interests span neuroscience, biology, and physics. In neuroscience, I am interested in teaching and designing courses focused on neurobiology, sensory neuroscience, and computational approaches. In biology, I am interested in introductory courses, biophysics, and cell biology. In physics, I enjoy teaching dynamical systems, quantum mechanics (I & II), and mathematical methods. I also aim to train students in practical skills, including MATLAB programming and data visualization, to strengthen their research and analytical capabilities.

## **E. Conferences and Workshops**

- 2025 Indian *Drosophila* Research Conference, IISER Mohali, India (upcoming)
- 2025 Neurobiology of *Drosophila*, CSHL meetings, Cold Spring Harbor Laboratory, USA
- 2024 20th Anniversary Symposium, Kavli Institute for Neuroscience at Yale University, USA
- 2022 Methods in computational neuroscience, summer school, MBL, USA
- 2020 Data basics in Python, School of Computing and Information, University of Pittsburgh, USA
- 2019 American Physical Society (APS) march meeting, Boston, USA
- 2017 International Summer school on Theoretical Biophysics (ISTBP), Cargese, France
- 2013 IAS Summer Research program, IISER Kolkata, India

## F. Selected Presentations

- 2025 Visual feature integration to detect approach in flies and Humans, CSHL meetings, CSHL, USA
- 2024 Neural circuits for depth motion detection, Yale University, USA
- 2019 Molecular basis of size homeostasis in bacteria, Stanford University, USA
- 2019 Strength and longevity of non-genetic inheritance in bacterial cells, APS, Boston, USA
- 2017 Individuality and non-genetic inheritance in bacteria, ISTBP, Cargese, France
- 2015 Induction of ferromagnetic ordering in paramagnetic  $\text{CaRuO}_3$  by intrinsic tensile strain, IISERB, India

## G. References

### Dr. Hanna Salman

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University of Pittsburgh  
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### Dr. Damon Clark

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