Markus Meister

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Born: Feb. 24, 1960

Academic Experience:

1980-1987	Graduate studies in physics and biology with Howard C. Berg at Caltech
1987-1991	Postdoctoral studies in neurobiology with Denis A. Baylor at Stanford
1991-1995	Assistant Professor of Biology at Harvard University
1977-1980	Studies in physics at the Technische Universität München, Germany
1995-1998	Associate Professor of Biology at Harvard University
1998-2012	Professor of Biology at Harvard University
2004	Visiting Professor, Division of Biology, California Institute of Technology
2005	Visiting Professor, Physics Department, Ecole Normale Supérieure, Paris
2012-	Professor of Biology, California Institute of Technology

Degree: PhD in Physics, California Institute of Technology, 1987

Honors:

1987-1989	Fellow of the Helen Hay Whitney Foundation
1989-1997	Lucille P. Markey Scholar
1993-1997	Pew Scholar in the Biomedical Sciences
1994-1999	NSF Presidential Faculty Fellow
1995-1998	Thomas D. Cabot Chair, Harvard University
1998-2012	Jeff C. Tarr Chair, Harvard University
2004	Moore Distinguished Visiting Scholar, California Institute of Technology
2005	Golden Brain Award for Vision and Brain Research, Minerva Foundation
2005-	Associate of the Neurosciences Research Program
2009	Lawrence C. Katz Prize for Innovative Research in Neuroscience

Other experience:

2002-2004	Harvard Center for Brain Science, Interim Director
2002-2006	McKnight Foundation, Scholar Award Scientific Advisory Committee
2003-2013	PLoS Biology, Member of Editorial Board
2008-2016	Princeton U, Department of Molecular Biology, Scientific Advisory Council
2008-2023	McKnight Foundation, Technology Award Advisory Committee
2008-	Cold Spring Harbor Laboratory, Scientific Advisory Council
2008-2019	Max Planck Institut für Neurobiologie, Martinsried, Chair of Advisory Board
2011-2019	Allen Institute for Brain Science, Project Mindscope, Chair of Advisory Board
2012-2019	Pew Scholars, National Advisory Committee
2012-2020	Helen Hay Whitney Foundation, Scientific Advisory Committee
2013-2024	Howard Hughes Medical Institute, Scientific Review Board
2015-	McKnight Endowment Fund for Neuroscience, Board of Directors
2016-2017	Secretary of Energy Advisory Board, Task Force on Biomedical Sciences

Research program:

I have a formal background in physics and many years experience in experimental and computational neuroscience. My research focus has been on neural circuits and computations in sensory systems: vision, olfaction, and vomeronasal sensation. Early on I pioneered the use of multi-electrode arrays for parallel recording from retinal neurons. Together with new approaches to visual stimulation, this helped reveal what visual processing is accomplished in the retina. We also showed how one can capture the neural code of the retina with computational models, and why the retina might perform this way from the perspective of normative theories. A parallel study of the early olfactory system showed that the rules of early sensory processing there are quite different from those in the retina, counter to prior claims.

A central mystery of sensory processing is how the brain can identify in the mass of sensory data the few bits that really matter for behavior. Further, how that selective filter can be adjusted from moment to moment as the animal's behavioral needs change, a dynamic process sometimes summarized as "attention". These questions led us into studies of the superior colliculus, a brain area that, at least in the mouse, coordinates the transformation from visual sensing to motor decisions.

A new research focus in my group is the dynamics of rapid learning. We want to trace what happens in the brain when an animal has a sudden insight, and can retain that memory for a long time after.

In all these endeavors we make prominent use of computational and mathematical models to capture the complexity of brain circuits and derive concrete predictions from hypotheses for observable phenomena.

Book:

Meister, M., K.H. Lee, and R. Portugues. 2025. Mathematics in Biology. Cambridge, Massachusetts: The MIT Press.

Patents:

Markus Meister, Kyu Hyun Lee, Yu-Li Ni. 2024-09-24. US Patent US12097033B2. Methods and systems for electrode pooling. https://patents.google.com/patent/US12097033B2

Markus Meister, Yang Liu. 2019-07-23. US Patent US10362429B2. Systems and methods for generating spatial sound information relevant to real-world environments. https://patents.google.com/patent/US10362429B2

Articles (in reverse order):

Available in PDF form at https://meisterlab.caltech.edu/publications**.**

Zheng, J., and M. Meister. 2025. The unbearable slowness of being: Why do we live at 10 bits/s? Neuron 113:192–204.

Zheng, J., R.A. Guimaraes, J.Y. Hu, P. Perona, and M. Meister. 2024. Mice in the Manhattan Maze: Rapid Learning, Flexible Routing and Generalization, With and Without Cortex. Cognitive Computational Neuroscience. Boston, MA.

Zhang, T., M. Rosenberg, Z. Jing, P. Perona, and M. Meister. 2024. Endotaxis: A neuromorphic algorithm for mapping, goal-learning, navigation, and patrolling. eLife. 12:RP84141.

Jing, Z. and M. Meister. 2024. A Fast Algorithm for All-Pairs-Shortest-Paths Suitable for Neural Networks. Neural Computation. 36, 2710–2733.

Hahn, J., A. Monavarfeshani, M. Qiao, A.H. Kao, Y. Kölsch, A. Kumar, V.P. Kunze, A.M. Rasys, R. Richardson, J.B. Wekselblatt, H. Baier, R.J. Lucas, W. Li, M. Meister, J.T. Trachtenberg, W. Yan, Y.-R. Peng, J.R. Sanes, and K. Shekhar. 2023. Evolution of neuronal cell classes and types in the vertebrate retina. Nature. 624:415–424.

Shao, S., M. Meister, and J. Gjorgjieva. 2023. Efficient population coding of sensory stimuli. Phys. Rev. Res. 5:043205.

Li, Y., and M. Meister. 2023. Functional cell types in the mouse superior colliculus. eLife. 12:e82367.

Meister, M. (2022). Learning, fast and slow. Current Opinion in Neurobiology 75, 102555. 10.1016/j.conb.2022.102555.

Rosenberg, M., Zhang, T., Perona, P., and Meister, M. (2021). Mice in a labyrinth exhibit rapid learning, sudden insight, and efficient exploration. ELife *10*, e66175.

Liu, Y., Bernstein, J., Meister, M., and Yue, Y. (2021). Learning by Turning: Neural Architecture Aware Optimisation. International Conference on Machine Learning (ICML).

Lee, K.H., Ni, Y.-L., Colonell, J., Karsh, B., Putzeys, J., Pachitariu, M., Harris, T.D., and Meister, M. (2021). Electrode pooling can boost the yield of extracellular recordings with switchable silicon probes. Nat Commun *12*, 5245.

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Bagherian, D., Gornet, J., Bernstein, J., Ni, Y.-L., Yue, Y., and Meister, M. (2021). Fine-Grained System Identification of Nonlinear Neural Circuits. Proceedings of the 27th ACM SIGKDD Conference on Knowledge Discovery & Data Mining 14–24.

S. Beery, Y. Liu, D. Morris, J. Piavis, A. Kapoor, M. Meister, N. Joshi, and P. Perona (2020). Synthetic Examples Improve Generalization for Rare Classes. In 2020 IEEE Winter Conference on Applications of Computer Vision (WACV), pp. 852–862.

Qiao, M., and Meister, M. (2020). Factorized linear discriminant analysis for phenotype-guided representation learning of neuronal gene expression data. ArXiv:2010.02171 [Cs, q-Bio].

Liu, Y., Perona, P., and Meister, M. (2020). PanDA: Panoptic Data Augmentation. ArXiv:1911.12317 [Cs].

Li, Y.-T., Turan, Z., and Meister, M. (2020). Functional Architecture of Motion Direction in the Mouse Superior Colliculus. Curr Biol *30*, 3304-3315.e4.

Lee, K.H., Tran, A., Turan, Z., and Meister, M. (2020). The sifting of visual information in the superior colliculus. ELife *9*, e50678.

Gjorgjieva, J., Meister, M., and Sompolinsky, H. (2019). Functional diversity among sensory neurons from efficient coding principles. PLOS Computational Biology *15*, e1007476.

Qiao, M., Zhang, T., Segalin, C., Sam, S., Perona, P., and Meister, M. (2018). Mouse Academy: high-throughput automated training and trial-by-trial behavioral analysis during learning. BioRxiv 467878.

Liu, Y., Stiles, N.R.B., and Meister, M. (2018). Augmented Reality Powers a Cognitive Prosthesis for the Blind. BioRxiv 321265.

Real, E., Asari, H., Gollisch, T., and Meister, M. (2017). Neural circuit inference from function to structure. Curr Biol *27*, 189–198.

Krieger, B., Qiao, M., Rousso, D.L., Sanes, J.R., and Meister, M. (2017). Four alpha ganglion cell types in mouse retina: Function, structure, and molecular signatures. PLoS One *12*, e0180091.

Meister, M. (2016). Physical limits to magnetogenetics. ELife *5*, e17210.

Joesch, M., and Meister, M. (2016). A neuronal circuit for colour vision based on rod-cone opponency. Nature *532*, 236–239.

Joesch, M., Mankus, D., Yamagata, M., Shahbazi, A., Schalek, R., Suissa-Peleg, A., Meister, M., Lichtman, J.W., Scheirer, W.J., and Sanes, J.R. (2016). Reconstruction of genetically identified neurons imaged by serial-section electron microscopy. ELife *5*, e15015.

Teeters, J.L., Godfrey, K., Young, R., Dang, C., Friedsam, C., Wark, B., Asari, H., Peron, S., Li, N., Peyrache, A., et al. (2015). Neurodata Without Borders: Creating a Common Data Format for Neurophysiology. Neuron *88*, 629–634.

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Feinberg, E.H., and Meister, M. (2015). Orientation columns in the mouse superior colliculus. Nature *519*, 229–232.

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