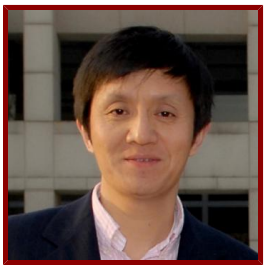
Stanford



Liqun Luo

Ann and Bill Swindells Professor and Professor, by courtesy, of Neurobiology

Biology

CONTACT INFORMATION

- **Alternate Contact**

  Mary Molacavage - Adminstrative Associate

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Bio

BIO

Dr. Luo grew up in Shanghai, China, and earned his bachelor's degree in molecular biology from the University of Science and Technology of China. After obtaining his PhD in Brandeis University, and postdoctoral training at the University of California, San Francisco, Dr. Luo started his own lab in the Department of Biology, Stanford University in December 1996. Together with his postdoctoral fellows and graduate students, Dr. Luo studies how neural circuits are assembled during development, and how their architectures enable them to perform specific functions in adults. Dr. Luo is currently the Ann and Bill Swindells Professor in the School of Humanities and Sciences, Professor of Biology, and Professor of Neurobiology by courtesy at Stanford University, and a Howard Hughes Medical Institute Investigator. He teaches neurobiology to Stanford undergraduate and graduate students. His single-author textbook “Principles of Neurobiology” (1st edition 2015; 2nd edition 2020) is widely used for undergraduate and graduate courses across the world.

Dr. Luo has served on the editorial boards of several scientific journals, including Neuron, eLife, and Annual Review of Neuroscience, Cell, and PNAS. He has also served on the Pew Scholar National Committee and Scientific Advisory Committee of Damon Runyon Cancer Research Foundation. He is recipient of the McKnight Technological Innovation in Neuroscience Award, the Society for Neuroscience Young Investigator Award, the Jacob Javits Award from National Institute of Neurological Disorders and Stroke, HW Mossman Award from American Association of Anatomists, the Lawrence Katz Prize, the Pradel Award of National Academy of Sciences, and the Education in Neuroscience award from Society for Neuroscience. Dr. Luo is a Member of the National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences.

ACADEMIC APPOINTMENTS

- Professor, Biology
- Professor (By courtesy), Neurobiology
- Member, Bio-X
- Faculty Fellow, Sarafan ChEM-H
- Member, Stanford Cancer Institute
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- Education in Neuroscience Award, Society for Neuroscience (2020)
- Pradel Award, National Academy of Sciences (2019)
- The Lawrence C. Katz Prize for Innovative Research in Neuroscience, Duke University (2013)
- Member, National Academy of Sciences (2012)
- Fellow, American Academy of Arts and Sciences (2012)
- Fellow, American Association for the Advancement of Science (2011)
- H.W.Mossman Award, American Association of Anatomists (2007)
- Investigator, Howard Hughes Medical Institute (2005)
- Jacob Javits Award, National Institute of Neurological Disorders and Stroke (2005)
- Technology Innovation Award in Neuroscience, McKnight Foundation (2002)
- Young Investigator Award, Society for Neuroscience (2002)

PROFESSIONAL EDUCATION

- B.S., Univ. of Sci. & Tech. of China , Molecular Biology (1986)
- Ph.D., Brandeis University , Biology (1992)

PATENTS

- He Z, Zhai Q, Wang J, Watts R, Hoopfer E, Luo L. "United States Patent 7,012,063 Reducing axon degeneration with proteasome inhibitors", Harvard & Stanford
- Luo L, Zong H. "United States Patent 7,282,621 Somatic recombination", Stanford
- Luo L, Tsai RY, Tasic B, Hippenmeyer S, Zong H. "United States Patent 9,125,385 Site-directed integration of transgenes in mammals", Stanford

LINKS

- LuoLab: http://web.stanford.edu/group/luolab/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

1. Assembly of the fly olfactory circuit

A central question in neural circuit assembly is how neurons connect specifically with their synaptic partners. We are using the fly olfactory circuit to investigate the general principles by which wiring specificity is established during development. The assembly of the fly olfactory circuit requires precise matching between axons from 50 olfactory receptor neuron types and dendrites from 50 projection neuron types. In the past 20 years, we have identified key cellular interactions and molecular mechanisms at specific steps of olfactory circuit assembly. More recently, we have also taken transcriptomic, proteomic, and live imaging approaches to complement genetic analyses of individual genes. We are currently integrating these approaches to deepen our understanding of the combinatorial cell-surface codes that instruct connection specificity.

2. Assembly of neural circuits in the mouse brain

We have studied a broad range of developmental processes in rodent brains using genetic tools we have developed. Some of these studies extend what we are learning in the fly, whereas others explore processes more prevalent in vertebrates. For example, cerebellar Purkinje cells have highly elaborate and planar dendritic trees, each of which receives presynaptic inputs from tens of thousands of granule cells. Our investigations of Purkinje cell dendrite morphogenesis have highlighted the importance of competitive interactions in dendritic growth and branching. Our studies of hippocampal network assembly have revealed that the same cell-surface proteins, teneurin-3 and latrophilin-2, can serve both as ligands and receptors to mediate attraction and repulsion, and these molecules are likely reused in the assembly

of multiple nodes of the hippocampal networks. We are investigating the function of these molecules in the assembly of additional circuits as well as how they work both as ligands and receptors.

3. Organization and function of neural circuits

We have used genetic and viral strategies to decipher the organizational principles of the fly and mouse olfactory systems, as well as the input–output architecture of norepinephrine, dopamine, and serotonin systems at the scale of the entire mouse brain. We are now also combining single-cell transcriptomics with activity recording, manipulation, and TRAPing, as well as behavioral analyses, to interrogate the functional organization of a variety of neural circuits. Recent discoveries include the dissection of dorsal raphe serotonin neuron subsystems, reward representation in cerebellar granule cells and shared cortex-cerebellum dynamics, the unit of organization and evolution of the cerebellar nuclei, differential encoding of task variables by prefrontal cortical projection neuron classes, temporal evolution of prefrontal cortical neuron ensembles that promote remote memory retrieval, and neural basis of thirst drive for motivated behavior.

4. Tool development

We continue to develop tools to interrogate neural circuit assembly and organization with increasing precision. The MARCM (mosaic analysis with a repressible cell marker) method in flies and MADM (mosaic analysis with double markers) method in mice allow the visualization and genetic manipulation of isolated single neurons. The Q system further expanded binary expression tools in flies. We recently developed tools to map circuit organization in mammals. The TRIO (tracing the relationship between input and output) and cTRIO (cell-type-specific TRIO) methods allow rabies virus–based input tracing to neurons defined by projection, or by cell type and projection. The TRAP (targeted recombination in active population) method enables genetic access to neurons based on their activity, which in combination with tools for labeling, tracing, recording, and manipulating neurons, offers a powerful approach for understanding how neural circuits process information and generate behavior.

Teaching

COURSES

2023-24

- Exploring Neural Circuits: BIO 222 (Spr)

2022-23

- Exploring Neural Circuits: BIO 222 (Spr)
- Principles of Neurobiology: BIO 154 (Win)
- Principles of Neurobiology: BIO 254, NBIO 254 (Win)

2021-22

- Exploring Neural Circuits: BIO 222 (Spr)

2020-21

- Exploring Neural Circuits: BIO 222 (Spr)
- Molecular and Cellular Neurobiology: BIO 154 (Win)
- Molecular and Cellular Neurobiology: BIO 254, NBIO 254 (Win)

STANFORD ADVISEES

Med Scholar Project Advisor

David Wang

Doctoral Dissertation Reader (AC)

Minseung Choi, Alex Hao, Dane Kawano, Ev Nichols, Massimo Onesto, Marija Pavlovic, Anay Ram Reddy, Abigail Rogers, Adarsh Tantry, Emma Theisen, Yandan Wang, Livia Wyss, Xiaochen Xiong

Postdoctoral Faculty Sponsor

Tom Hindmarsh Sten, Hui Ji, Cheng Lyu

Doctoral Dissertation Advisor (AC)

URee Chon, Ellen Gingrich, Zhuoran Li, Ethan Richman, Jun Song, David Wang, Alina Xiao, Chuanyun Xu

Doctoral Dissertation Co-Advisor (AC)

Lucas Encarnacion-Rivera

Doctoral (Program)

Zhuoran Li, Alina Xiao

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Biology (School of Humanities and Sciences) (Phd Program)
- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Architectures of neuronal circuits.** *Science (New York, N.Y.)*
  Luo, L.
  2021; 373 (6559): eabg7285
- **Principles of Neurobiology (2nd edition)**
  Luo, L.
  Garland Science/CRC Press.2020
- **Neural landscape diffusion resolves conflicts between needs across time.** *Nature*
  Richman, E. B., Ticea, N., Allen, W. E., Deisseroth, K., Luo, L.
  2023
- **Toward building a library of cell type-specific drivers across developmental stages.** *Proceedings of the National Academy of Sciences of the United States of America*
  Lyu, C., Li, Z., Luo, L.
  2023; 120 (35): e2312196120
- **A neural circuit for male sexual behavior and reward.** *Cell*
  Bayless, D. W., Davis, C. O., Yang, R., Wei, Y., de Andrade Carvalho, V. M., Knoedler, J. R., Yang, T., Livingston, O., Lomvardas, A., Martins, G. J., Vicente, A. M., Ding, J. B., Luo, et al
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- **Expansion spatial transcriptomics.** *Nature methods*
  Fan, Y., Andrusivova, Z., Wu, Y., Chai, C., Larsson, L., He, M., Luo, L., Lundeberg, J., Wang, B.
  2023
- **Aging Fly Cell Atlas identifies exhaustive aging features at cellular resolution.** *Science (New York, N.Y.)*
  Lu, T. C., Brbi#, M., Park, Y. J., Jackson, T., Chen, J., Kolluru, S. S., Qi, Y., Katheder, N. S., Cai, X. T., Lee, S., Chen, Y. C., Auld, N., Liang, et al
  2023; 380 (6650): eadg0934
- **Origin of wiring specificity in an olfactory map revealed by neuron type-specific, time-lapse imaging of dendrite targeting.** *eLife*
  Wong, K. K., Li, T., Fu, T. M., Liu, G., Lyu, C., Kohani, S., Xie, Q., Luginbuhl, D. J., Upadhyayula, S., Betzig, E., Luo, L.
  2023; 12

- **Context-dependent requirement of G protein coupling for Latrophilin-2 in target selection of hippocampal axons.** *eLife*
  Pederick, D. T., Perry-Hauser, N. A., Meng, H., He, Z., Javitch, J. A., Luo, L.
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- **Hypothalamic neurons that mirror aggression.** *Cell*
  Yang, T., Bayless, D. W., Wei, Y., Landayan, D., Marcelo, I. M., Wang, Y., DeNardo, L. A., Luo, L., Druckmann, S., Shah, N. M.
  2023

- **Loss of Rai1 enhances hippocampal excitability and epileptogenesis in mouse models of Smith-Magenis syndrome.** *Proceedings of the National Academy of Sciences of the United States of America*
  Chang, Y., Kowalczyk, M., Fogerson, P. M., Lee, Y., Haque, M., Adams, E. L., Wang, D. C., DeNardo, L. A., Tessier-Lavigne, M., Huguenard, J. R., Luo, L., Huang, W.
  2022; 119 (43): e2210122119

- **In situ cell-type-specific cell-surface proteomic profiling in mice.** *Neuron*
  Shuster, S. A., Li, J., Chon, U., Sinantha-Hu, M. C., Luginbuhl, D. J., Udeshi, N. D., Carey, D. K., Takeo, Y. H., Xie, Q., Xu, C., Mani, D. R., Han, S., Ting, et al
  2022

- **Scent of a human: The mosquito olfactory system defies dogma to ensure attraction to humans.** *Cell*
  McLaughlin, C. N., Luo, L.
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- **Illuminating complexity in serotonin neurons of the dorsal raphe nucleus.** *Neuron*
  Baruni, J., Luo, L.
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- **Transcriptional and functional motifs defining renal function revealed by single-nucleus RNA sequencing.** *Proceedings of the National Academy of Sciences of the United States of America*
  Xu, J., Liu, Y., Li, H., Tarashansky, A. J., Kalicki, C. H., Hung, R., Hu, Y., Comjean, A., Kolluru, S. S., Wang, B., Quake, S. R., Luo, L., McMahon, et al
  2022; 119 (25): e2203179119

- **Isolation and RNA sequencing of single nuclei from Drosophila tissues.** *STAR protocols*
  McLaughlin, C. N., Qi, Y., Quake, S. R., Luo, L., Li, H.
  2022; 3 (2): 101417

- **A preoptic neuronal population controls fever and appetite during sickness.** *Nature*
  Osterhout, J. A., Kapoor, V., Eichhorn, S. W., Vaughn, E., Moore, J. D., Liu, D., Lee, D., DeNardo, L. A., Luo, L., Zhuang, X., Dulac, C.
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- **Transcription factor Acj6 controls dendrite targeting via a combinatorial cell-surface code.** *Neuron*
  Xie, Q., Li, J., Li, H., Udeshi, N. D., Svinkina, T., Orlin, D., Kohani, S., Guajardo, R., Mani, D. R., Xu, C., Li, T., Han, S., Wei, et al
  2022

- **Fly Cell Atlas: A single-nucleus transcriptomic atlas of the adult fruit fly.** *Science (New York, N.Y.)*
  Li, H., Janssens, J., De Waegeneer, M., Kolluru, S. S., Davie, K., Gardeux, V., Saelens, W., David, F. P., Brbic, M., Spanier, K., Leskovec, J., McLaughlin, C. N., Xie, et al
  2022; 375 (6584): eabk2432

- **Mating-driven variability in olfactory local interneuron wiring.** *Science advances*
  Chou, Y., Yang, C., Huang, H., Liou, N., Panganiban, M. R., Luginbuhl, D., Yin, Y., Taisz, I., Liang, L., Jefferis, G. S., Luo, L.
  2022; 8 (7): eabm7723

- **An Explant System for Time-Lapse Imaging Studies of Olfactory Circuit Assembly in Drosophila.** *Journal of visualized experiments : JoVE*
  Li, T., Luo, L.
  2021

- **Cellular bases of olfactory circuit assembly revealed by systematic time-lapse imaging.** *Cell*
  Li, T., Fu, T., Wong, K. K., Li, H., Xie, Q., Luginbuhl, D. J., Wagner, M. J., Betzig, E., Luo, L.
  2021

- **Teneurins** *CURRENT BIOLOGY*
  Pederick, D. T., Luo, L.
  2021; 31 (15): R936-R937

- **Gut cytokines modulate olfaction through metabolic reprogramming of glia.** *Nature*
  Cai, X. T., Li, H., Borch Jensen, M., Maksoud, E., Borneo, J., Liang, Y., Quake, S. R., Luo, L., Haghighi, P., Jasper, H.
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- **A neural circuit state change underlying skilled movements.** *Cell*
  Wagner, M. J., Savall, J., Hernandez, O., Mel, G., Inan, H., Rumyantsev, O., Lecoq, J., Kim, T. H., Li, J. Z., Ramakrishnan, C., Deisseroth, K., Luo, L., Ganguli, et al
  2021

- **A genome-wide library of MADM mice for single-cell genetic mosaic analysis.** *Cell reports*
  Contreras, X., Amberg, N., Davaatseren, A., Hansen, A. H., Sonntag, J., Andersen, L., Bernthaler, T., Streicher, C., Heger, A., Johnson, R. L., Schwarz, L. A., Luo, L., Rulicke, et al
  2021; 35 (12): 109274

- **The relationship between birth timing, circuit wiring, and physiological response properties of cerebellar granule cells.** *Proceedings of the National Academy of Sciences of the United States of America*
  Shuster, S. A., Wagner, M. J., Pan-Doh, N., Ren, J., Grutzner, S. M., Beier, K. T., Kim, T. H., Schnitzer, M. J., Luo, L.
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- **Reciprocal repulsions instruct the precise assembly of parallel hippocampal networks.** *Science (New York, N.Y.)*
  Pederick, D. T., Lui, J. H., Gingrich, E. C., Xu, C., Wagner, M. J., Liu, Y., He, Z., Quake, S. R., Luo, L.
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- **Temporal evolution of single-cell transcriptomes of Drosophila olfactory projection neurons.** *eLife*
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- **Single-cell transcriptomes of developing and adult olfactory receptor neurons in Drosophila.** *eLife*
  McLaughlin, C. N., Brbi#, M. n., Xie, Q. n., Li, T. n., Horns, F. n., Kolluru, S. S., Kebschull, J. M., Vacek, D. n., Xie, A. n., Li, J. n., Jones, R. C., Leskovec, J. n., Quake, et al
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- **Generation of a DAT-P2A-Flpo mouse line for intersectional genetic targeting of dopamine neuron subpopulations.** *Cell reports*
  Kramer, D. J., Aisenberg, E. E., Kosillo, P. n., Friedmann, D. n., Stafford, D. A., Lee, A. Y., Luo, L. n., Hockemeyer, D. n., Ngai, J. n., Bateup, H. S.
  2021; 35 (6): 109123

- **Deep posteromedial cortical rhythm in dissociation.** *Nature*
  Vesuna, S., Kauvar, I. V., Richman, E., Gore, F., Oskotsky, T., Sava-Segal, C., Luo, L., Malenka, R. C., Henderson, J. M., Nuyujukian, P., Parvizi, J., Deisseroth, K.
  2020

- **Mapping mesoscale axonal projections in the mouse brain using a 3D convolutional network.** *Proceedings of the National Academy of Sciences of the United States of America*
  Friedmann, D., Pun, A., Adams, E. L., Lui, J. H., Kebschull, J. M., Grutzner, S. M., Castagnola, C., Tessier-Lavigne, M., Luo, L.
  2020

- **Loss of the neural-specific BAF subunit ACTL6B relieves repression of early response genes and causes recessive autism.** *Proceedings of the National Academy of Sciences of the United States of America*
  Wenderski, W., Wang, L., Krokhotin, A., Walsh, J. J., Li, H., Shoji, H., Ghosh, S., George, R. D., Miller, E. L., Elias, L., Gillespie, M. A., Son, E. Y., Staahl, et al
  2020

- **LIS1 determines cleavage plane positioning by regulating actomyosin-mediated cell membrane contractility.** *eLife*
  Moon, H. M., Hippenmeyer, S., Luo, L., Wynshaw-Boris, A.
  2020; 9

- **Cell-Surface Proteomic Profiling in the Fly Brain Uncovers Wiring Regulators.** *Cell*
  Li, J., Han, S., Li, H., Udeshi, N. D., Svinkina, T., Mani, D. R., Xu, C., Guajardo, R., Xie, Q., Li, T., Luginbuhl, D. J., Wu, B., McLaughlin, et al

2020

- **Skilled reaching tasks for head-fixed mice using a robotic manipulandum.** *Nature protocols*
  Wagner, M. J., Savall, J. n., Kim, T. H., Schnitzer, M. J., Luo, L. n.
  2020
- **Cerebellar nuclei evolved by repeatedly duplicating a conserved cell-type set.** *Science (New York, N.Y.)*
  Kebschull, J. M., Richman, E. B., Ringach, N. n., Friedmann, D. n., Albarran, E. n., Kolluru, S. S., Jones, R. C., Allen, W. E., Wang, Y. n., Cho, S. W., Zhou, H. n., Ding, J. B., Chang, et al
  2020; 370 (6523)
- **The Mind of a Mouse.** *Cell*
  Abbott, L. F., Bock, D. D., Callaway, E. M., Denk, W. n., Dulac, C. n., Fairhall, A. L., Fiete, I. n., Harris, K. M., Helmstaedter, M. n., Jain, V. n., Kasthuri, N. n., LeCun, Y. n., Lichtman, et al
  2020; 182 (6): 1372–76
- **Differential encoding in prefrontal cortex projection neuron classes across cognitive tasks.** *Cell*
  Lui, J. H., Nguyen, N. D., Grutzner, S. M., Darmanis, S. n., Peixoto, D. n., Wagner, M. J., Allen, W. E., Kebschull, J. M., Richman, E. B., Ren, J. n., Newsome, W. T., Quake, S. R., Luo, et al
  2020
- **Amygdala-Midbrain Connections Modulate Appetitive and Aversive Learning.** *Neuron*
  Steinberg, E. E., Gore, F. n., Heifets, B. D., Taylor, M. D., Norville, Z. C., Beier, K. T., Földy, C. n., Lerner, T. N., Luo, L. n., Deisseroth, K. n., Malenka, R. C.
  2020
- **Single-Cell Transcriptomes Reveal Diverse Regulatory Strategies for Olfactory Receptor Expression and Axon Targeting.** *Current biology : CB*
  Li, H. n., Li, T. n., Horns, F. n., Li, J. n., Xie, Q. n., Xu, C. n., Wu, B. n., Kebschull, J. M., McLaughlin, C. N., Kolluru, S. S., Jones, R. C., Vacek, D. n., Xie, et al
  2020
- **GluD2- and Cbln1-mediated competitive interactions shape the dendritic arbors of cerebellar Purkinje cells.** *Neuron*
  Takeo, Y. H., Shuster, S. A., Jiang, L. n., Hu, M. C., Luginbuhl, D. J., Rülicke, T. n., Contreras, X. n., Hippenmeyer, S. n., Wagner, M. J., Ganguli, S. n., Luo, L. n.
  2020
- **Brain Circuit of Claustrophobia-like Behavior in Mice Identified by Upstream Tracing of Sighing.** *Cell reports*
  Li, P. n., Li, S. B., Wang, X. n., Phillips, C. D., Schwarz, L. A., Luo, L. n., de Lecea, L. n., Krasnow, M. A.
  2020; 31 (11): 107779
- **Nurturing Undergraduate Researchers in Biomedical Sciences.** *Cell*
  Li, J. n., Luo, L. n.
  2020; 182 (1): 1–4
- **Phagocytic glia are obligatory intermediates in transmission of mutant huntingtin aggregates across neuronal synapses.** *eLife*
  Donnelly, K. M., DeLorenzo, O. R., Zaya, A. D., Pisano, G. E., Thu, W. M., Luo, L. n., Kopito, R. R., Panning Pearce, M. M.
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  Tasaka, G. I., Feigin, L. n., Maor, I. n., Groysman, M. n., DeNardo, L. A., Schiavo, J. K., Froemke, R. C., Luo, L. n., Mizrahi, A. n.
  2020
- **Optimizing Nervous System-Specific Gene Targeting with Cre Driver Lines: Prevalence of Germline Recombination and Influencing Factors.** *Neuron*
  Luo, L. n., Ambrozkiewicz, M. C., Benseler, F. n., Chen, C. n., Dumontier, E. n., Falkner, S. n., Furlanis, E. n., Gomez, A. M., Hoshina, N. n., Huang, W. H., Hutchison, M. A., Itoh-Maruoka, Y. n., Lavery, et al
  2020
- **Neocortex-Cerebellum Circuits for Cognitive Processing.** *Trends in neurosciences*
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  2019
- **Transsynaptic Fish-lips signaling prevents misconnections between nonsynaptic partner olfactory neurons.** *Proceedings of the National Academy of Sciences of the United States of America*
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2019

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  2019; 8

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  Wagner, M. J., Kim, T., Kadmon, J., Nguyen, N. D., Ganguli, S., Schnitzer, M. J., Luo, L.
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- **Temporal evolution of cortical ensembles promoting remote memory retrieval** *NATURE NEUROSCIENCE*
  DeNardo, L. A., Liu, C. D., Allen, W. E., Adams, E. L., Friedmann, D., Fu, L., Guenthner, C. J., Tessier-Lavigne, M., Luo, L.
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- **Ephrin-B3 controls excitatory synapse density through cell-cell competition for EphBs.** *eLife*
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  2019; 8

- **Ephrin-B3 controls excitatory synapse density through cell-cell competition for EphBs** *ELIFE*
  Henderson, N. T., Le Marchand, S. J., Hruska, M., Hippenmeyer, S., Luo, L., Dalva, M. B.
  2019; 8

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  2019

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- **Topological Organization of Ventral Tegmental Area Connectivity Revealed by Viral-Genetic Dissection of Input-Output Relations** *CELL REPORTS*
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- **Complementary Genetic Targeting and Monosynaptic Input Mapping Reveal Recruitment and Refinement of Distributed Corticostriatal Ensembles by Cocaine.** *Neuron*
  Wall, N. R., Neumann, P. A., Beier, K. T., Mokhtari, A. K., Luo, L. n., Malenka, R. C.
  2019

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  Ren, J. n., Isakova, A. n., Friedmann, D. n., Zeng, J. n., Grutzner, S. M., Pun, A. n., Zhao, G. Q., Kolluru, S. S., Wang, R. n., Lin, R. n., Li, P. n., Li, A. n., Raymond, et al
  2019; 8

- **Mapping Histological Slice Sequences to the Allen Mouse Brain Atlas Without 3D Reconstruction.** *Frontiers in neuroinformatics*
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  2018; 12: 93

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Xiong, J., Ren, J., Luo, L., Horowitz, M.
2018; 12

- **Dynamic salience processing in paraventricular thalamus gates associative learning** *SCIENCE*
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